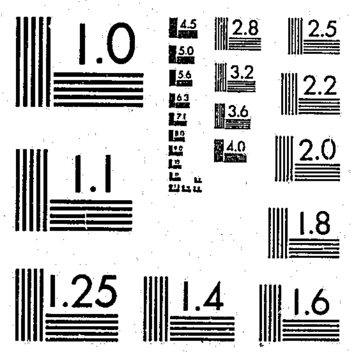

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AN EXAMINATION OF THE IMPACT OF INTENSIVE POLICE PATROL ACTIVITIES

Final Report

Pilot Grant NI 71-114-PG

Frank S. Budnick
Assistant Professor of Management Science
College of Business Administration
University of Rhode Island
Kingston, Rhode Island

PREFACE

This research was conducted with the cooperation of the Washington Metropolitan Police Department. The project was supported by Pilot Grant NI71-114-PG from the National Institute of Law Enforcement and Criminal Justice.

The study presents a crime-modeling technique which can be of value in studies which evaluate the effectiveness of crime-control programs. In addition, the technique may offer some advantages in learning more about the causal determinants of crime.

The study also focuses upon three months during 1970 in which intensive police patrol activities were conducted within certain sections of Washington, D.C. An evaluation of these periods is presented.

Lastly, Appendix B presents some considerations in attempting to mathematically describe the phenomenon of spatial displacement of crime. Hypothetical models are developed and serve as illustrations.

The author wishes to express his sincere appreciation to the Washington Metropolitan Police Department for its assistance and cooperation. Thanks go to Chief Jerry V. Wilson, Deputy Chief Theodore R. Zanders, Commander of the Special Operations Division, and Inspector Herbert F. Miller. Gratitude is expressed also to Inspectors John Dials, Charles J. Corcoran, and Shirley F. O'Neil, commanders of the three participating police districts.

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A special note of thanks goes to Milton Sirota of the Operations Planning Division. His encouragement and assistance were invaluable in planning and conducting the study.

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Finally, the author wants to express unmeasurable gratitude to his wife, Jane, for her unlimited patience and support, as well as her constructive comments in the writing and editing of this manuscript.

SUMMARY

The objectives in this research study, as stated in Chapter I, are the following:

(1) To develop and validate a crime-modeling technique which will be useful in estimating expected crime levels in evaluative studies.

(2) To appraise the strengths and weaknesses of the crime-modeling technique by examining its performance under varying parameters and by comparing its performance with that of more traditional models.

(3) To apply the crime-modeling technique in an evaluative study of the impact of intensive police patrol activities.

(4) To determine the impact of intensive police patrol activities upon the level of crime within the area of patrol.

(5) To examine for the generation of displacement effects (spatial and temporal) as a result of intensive police patrol activities.

(6) To develop a model which may be of value in predicting spatial displacement effects and to discuss considerations associated with the development of such models.

Crime Estimation Model

This study has resulted in the development of a crime-estimation model which might prove to be of considerable value in studies concerned with evaluating the effectiveness of crime-control programs. The crime-correlated area model is based upon the assumption that there exist a number of crime-related influences which operate upon a city as a whole. Due to the operation of these influences, it is believed that the levels of crime in various areas of a city might fluctuate in a similar manner. Thus, it is argued that the levels of crime between two areas might be highly correlated with one another. If the degree of association is high enough, the belief is that the level of crime within one area might be estimated as a function of the level within another area.

An analysis of monthly Index offense levels for reporting areas within Washington, D.C. revealed that:

(1) Crime levels between many areas of a city are significantly related to one another.

(2) Levels of Index offenses can be high correlated for two separate areas even though the areas are (a) spatially separated by a considerable distance, (b) dissimilar with regard to average level of crime, and (c) dissimilar with regard to socioeconomic and demographic characteristics.

Although the results supported the hypothesis concerning the existence of crime-correlated areas, the degree of correlation was not believed to be sufficiently high enough for prediction purposes. It was believed and later demonstrated that the use of more than one predictor area improves the degree of correlation. It was concluded that a better estimate of the level of crime in a given area would be achieved if the estimate is based upon the experiences of several other reporting areas. Thus, crime estimation models were developed using stepwise, multiple linear regression. Using multiple predictor areas, the independent variables in each crime estimation model represent the levels of crime in the predictor areas.

In order to determine the relative performance of the crime-correlated area model, it was compared with three of the more popular crime-estimation techniques. Results of the comparative analysis revealed that the crime-correlated area model and the exponential smoothing model provided the greatest predictive accuracy. Although the crime-correlated area model outperformed the exponential smoothing model, on the basis of lowest mean absolute deviation, further analysis indicated that the performance of the two models was similar.

Additional analyses of the crime-correlated area model, including changes in the time and area size parameters, indicated that relative performance of the model improves when the expected level of crime is large.

Conclusions

The results of this analysis indicate that the multiple prediction concept may prove useful in making ex post facto estimates of expected crime levels within an area. It can be, therefore, quite helpful in evaluating crime-control programs such as manpower studies, helicopter patrol programs, and high intensity street lighting programs. The model, in its current form, does not make futuristic estimates of crime. Whereas many other time-dependent modeling techniques allow for inclusion of information leading up to the experimental period, a virtue of the crime-correlated area concept is that it allows for causal forces to operate during the test period and for information related to their operation to be included in the estimating procedure.

In comparison with other popular crime estimation techniques, the model resulted in better performance. But, since the exponential smoothing model performed almost as well, one might argue for its selection on the basis of computational efficiency. However, it is believed that the crime-correlated area concept has potential benefits which can offset its more burdensome computational aspects.

The Manpower Experiment

This study was concerned with three one-month periods during 1970 in which the Special Operations Division of the Washington Metropolitan Police Department conducted high intensity police patrol activities within selected areas of the city. The effect, in each instance, was an increase in the level of police visibility within these areas, as well as the level of preventive patrol activity.

One part of the evaluation focused upon the crime deterrent effect within the test zones. Using Index offenses as the measure of criminal activity, a noticeable deterrent effect was found for two of the three experiments. This was reflected not only in the reporting areas having significant decreases in aggregate Index offenses, but also in the differences between actual and expected levels for specific Index crime categories.

By comparison of the increase in visibility and preventive patrol activities with the corresponding response in the level of crime, it was demonstrated that similar changes in manpower had resulted in dissimilar responses in crime. Possible reasons for the differential in responses are cited in the study.

In addition to examining for deterrent effects within the test zone, the first layer of peripheral reporting areas were examined for each month. The objective was to test for possible spatial displacement effects away from the experimental area. Focusing upon Index offenses, there was little evidence to substantiate the existence of widespread spatial displacement effects. To the contrary, the evidence suggested that the intensive police patrol activities had resulted in a pervasive deterrent effect which extended beyond the geographical boundaries of the experiment.

In reference to possible temporal displacement of crime, it was noted that the added manpower were on the streets for only two of the three shifts each day. The 12:00 a.m. - 8:00 a.m. shift was a normal manpower shift. It was suspected that there might be temporal displacement of crime from the high manpower shift to the shift having normal levels. An analysis of the time distribution of offenses offered no evidence which would substantiate temporal displacement.

Finally, the trend in Index offenses was plotted as a seven-day moving average for the month preceding, the month of, and the month following the experiment. The hope was to identify any trend effects during and following the experimental period. In both months which showed indications of a deterrent effect, the trend in crime moved downward in the initial stages of the experiment. Eventually though, the trend reversed itself and climbed toward previous levels. The suggestion was that offenders were somehow able to adapt to the changed environment and learned to operate within it. There were also no conclusive indications of a lag or residual deterrent effect extending beyond the end of the test period.

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CHAPTER I

INTRODUCTION

To provide an interim means of dealing with crime, the criminal justice system exists. Although the system professes, in part, to attack the root causes of crime, the more obvious objectives involve deterrence of crime. Deterrent forces are applied from each sector of the criminal justice system: the law enforcement sector, the courts, and the corrections sector.

THE NEED TO EVALUATE CRIME CONTROL PROGRAMS

There exists an ever present and unresolved problem of effectively evaluating the programs of these three sectors. There is a dearth of sound evaluative research. Good evaluative studies would be extremely helpful in the formulation of new policy by the various components of the criminal justice system. Of even greater importance would be the ability to determine the integrated deterrent effect resulting from the policies of all three sectors as well as related programs initiated outside the criminal justice system.

DETERRENCE BY THE LAW ENFORCEMENT SECTOR

This research is concerned with the deterrence of crime by the law enforcement sector.

The Need for Scientific Inquiry

There exists a tremendous need for scientific inquiry into resource allocations within the law enforcement sector. In particular, it is extremely important that more be learned about the effectiveness of manpower allocations. With salaries of personnel often comprising 80-90 percent of law enforcement operating budgets, manpower represents a sizeable use of resources across the nation. And yet, ther is little understanding about the effectiveness of such resources in combating crime. Studes are needed which address themselves to the whole concept of police presence and its effect upon crime.

Individuals involved in law enforcement research have lamented the lack of empirical research in this area. In discussing an economic approach to police patrol allocations, Misner and Hoffman refer to the general lack of understanding by saying ". . . we do not know the effectiveness of patrolmen in reducing crime."[1] Giertz bemoaned the same inadequacy in his effort to generate a cost-benefit analysis of the preventive patrol function.[2] Richard Larson, who has performed some excellent research related to the criminal justice system, indicates that "we stress the need for extensive experimental and analytical work to indicate to what extent preventive patrol deters crime."[3] This is reinforced by Hurter who states that "here is a place where experiments with beat structure, number of cars, foot patrols, helicopters, etc., should be instituted with an effort to determine their influence on the number of crimes reported of various types."[4]

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[1]Gordon E. Misner and Richard B. Hoffman, "Police Resource Allocation" (paper presented at the National Meeting of the American Association for the Advancement of Science, New York, N.Y., December 27, 1967), p. 4.

[2]See J. Fred Giertz, An Economic Analysis of the Distribution of Police Patrol Forces, Report to the National Institute of Law Enforcement and Criminal Justice (Springfield, Va.: National Technical Information Service, 1970).

[3]R.C. Larson, Models for the Allocation of Urban Police Patrol Forces (Cambridge, Mass.: M.I.T. Press, 1969), p. 3.

[4]Arthur P. Hurter, Jr., "Police Allocation Problems, Part I: A Framework for Evaluation," in Allocation of Resources in the Chicago Police Department, Report of Operations Research Task Force to the Office of Law Enforcement (Chicago: Chicago Police Department, 1969).

Police Presence as a Deterrent

Most law enforcement officials believe that the conspicuous presence of police officers acts as a deterrent to criminal activity. If police officers are visible within an area, it is believed that the perceived and actual risk associated with committing an offense is increased. Thus, the levels of actual and reported crime should decrease.

There have been a number of published studies related to the deterrent effect of police presence. Two of the most notable studies were conducted within New York City. The first of these was the Operation 25 study conducted within the 25th Precinct during 1954.[5] The other was the more recent 20th Precinct study conducted by the New York City Rand Institute.[6]

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[1]See "Operation 25," in Police Patrol Readings, ed. by Samuel G. Chapman (Springfield, Ill.: Charles C. Thomas Company, 1964), pp. 206-214.

[2]See S. James Press, "Some Effects of an Increase in Police Manpower in the 20th Precinct of New York City," (preliminary draft), New York City Rand Institute, February, 1971.

Most police departments have conducted studies concerning the deterrent effect of their manpower. The degree of formality of such studies has varied from casual observance to moderately well defined programs with statistical analysis of results. The results of such efforts are rarely published and are quite frequently not documented. Accordingly, the impact of police presence upon crime has not been conclusively demonstrated.

POLICE PRESENCE AND DISPLACEMENT OF CRIME

Besides reducing crime, another possible consequence of police presence is crime deflection or displacement. Some people refer to this phenomenon as a "spillover" effect. The belief is that certain types of crime could be spatially displaced or relocated as a result of crime prevention programs. The type of crime displaced would certainly depend upon the nature of the prevention program. For example, a program oriented toward higher standards for household security devices may result in displacement effects for residential burglary.

A Hypothetical Situation

Suppose that a city has instituted a saturation program within a section of the city. A potential offender, who encounters the presence of a police officer, would face a number of alternatives. These include:

1. Do not commit the offense.
2. Commit the offense.
3. Delay committing the offense until the additional manpower are removed from the area.
4. Move to an alternative target.

The first alternative is perhaps the optimal with regard to society. This decision would result in complete deterrence of the offense. If the second alternative is selected, hopefully the additional police presence would improve the chance of apprehension either during or after the commission of the offense. If an offense is to be committed it would be desirable if it is enacted in an environment which poses the maximum risk of detection and apprehension. The third alternative is one which does not eliminate the attempted offense. Rather, it results in what may be referred to as temporal deflection or displacement (movement in time). The intended offense is carried out, but at a time other than originally planned. The selection of an alternative time might conceivably place the offender in an environment characterized by greater risk. The final alternative results in the spatial deflection of the offender. As a consequence of the police presence, the offender makes the decision to move to an alternative site. This choice involves not only spatial displacement, but, to a certain extent must involve temporal displacement. Another consequence of this alternative is the possibility of "crime-switching."[7] This phenomenon involves selection of an alternative target and an alternative type of offense. For example, encountering a police officer as he is ready to attempt a robbery of a liquor store, an offender might move to a new area where he chooses to burglarize a residence.

[1]Marvin Wolfgang of the University of Pennsylvania has conducted studies related to this phenomenon. Results of the studies have, as yet, not been published.

Type of Offender

In discussing the spatial deflection concept, it is necessary to consider the types of offenders who would be affected. Certain types of offenders would be more likely to select the last of the previously mentioned alternatives than other types of offenders.

It is useful to distinguish two types of offenders according to whether they commit crimes of opportunity or crimes of need. This is a simple taxonomy of the motivations leading to commission of an offense. Crimes of opportunity might be considered to be those which are more spontaneous, arising primarily because of an unusual opportunity. These types of offenses are perhaps motivated most by a latent tendency toward criminal behavior. Examples might include the group of juveniles who discover keys in an open car and, therefore, take it on a joyride; or the mass looting of stores by crowds during a civil disturbance. When faced with an overt preventive force, such offenders are more likely to select the first alternative of not committing the offense. In contrast to crimes of opportunity, crimes of need might be defined as those which arise out of either an economic or pathological need. They might be crimes which are planned, or at least anticipated by the offender. Offenders in this category would include the professional criminal, the drug addict who has a need to commit an offense, or other habitual offenders.

It is the offender, who commits crimes of need, who is most likely to select the alternative of moving to an alternate target. A drug addict has a regular economic need to support his habit, and he might, therefore, have a regular need to participate in criminal activities. If his efforts are thwarted in an initial attempt at committing an offense, he must find an alternate target.

One objective of this research is to test for the existence of displacement effects.

CRIME ESTIMATION MODELS

Undoubtedly, the ability to predict the time and location of a crime would be extremely useful to law enforcement agencies in combating crime. Unfortunately, and for obvious reasons, the state of the art in applying predictive modeling techniques has not advanced far enough to provide reliable crime predictions.

Tremendous amounts of resources have been, and will continue to be, committed to reducing the level of crime within society. The fact exists, though, that little meaningful research has been conducted to evaluate the impact of such resource allocations. Although many factors tend to complicate research of this nature, attempts to determine the amount of crime which would have occurred in the absence of an experimental effect generally have been inadequate.

If such a capability existed, many types of evaluations could be conducted in a more meaningful fashion. For example, law enforcement agencies would be in a better position to evaluate the effectiveness of various manpower allocations and patrol strategies, as well as the impact of helicopter patrol and high intensity street lighting programs. In addition, the ability to determine an expected level of crime would be useful in evaluating crime-related programs initiated on a broader scale. Examples might include evaluation of drug treatment programs, programs which focus upon the problems of juveniles, changes in city ordinances (involving curfews or more stringent requirements on locking devices), and programs which would alter the composition and traditional functions of police departments. Evaluations of changes in the policy or structure of the other components of the criminal justice system also could be facilitated. For example, the legalization and government control of narcotics distribution could be examined for decreases in crime.

In order to evaluate the impact of these types of crime-control programs upon the level of crime, it is necessary to determine some measure of the amount of crime which would be expected in the absence of the program. By comparing actual levels of crime during the test period with the expected levels, one could obtain some measure of the impact of a particular program. In contrast to a <u>forecast</u> of crime levels, which would be useful in the development of daily deployment tactics by police departments, evaluative studies do not demand a futuristic estimate of crime levels. Estimates derived before, during, or after the experimental period would all be satisfactory for evaluative purposes.

OBJECTIVES OF CURRENT RESEARCH

In view of the demonstrated need for research in the area, this study has the following objectives:

1. To develop and validate a crime-modeling technique which will be useful in estimating expected crime levels in evaluative studies.

2. To appraise the strengths and weaknesses of the crime-modeling technique by examining its performance under varying parameters and by comparing its performance with that of more traditional models.

3. To apply the crime-modeling technique in an evaluative study of the impact of intensive police patrol activities.

4. To determine the impact of intensive police patrol activities upon the level of crime within the area of patrol.

5. To examine for the generation of displacement effects (spatial and temporal) as a result of intensive police patrol activities.

6. To develop a model which may be of value in predicting spatial displacement effects and to discuss considerations associated with the development of such models.

CHAPTER II

THE MANPOWER EXPERIMENT

This research was conducted with the cooperation of the Metropolitan Police Department of Washington, D.C. It focuses upon periods during 1970, in which the Department's primary tactical force conducted high intensity police patrol activities.

In order to provide the reader with some background about the study, the chapter first discusses the police department's organizational structure. The primary emphasis is upon those divisions which initiate visible deployments of police officers. Included in this section is a brief description of the tactical unit which participated in the experiment.

The chapter also presents a brief description of the experimental conditions and the geographic areas in which the experiment was conducted. Finally, the chapter discusses the sources and procedures used in gathering data on manpower and offenses.

ORGANIZATIONAL STRUCTURE

Figure 1-1 illustrates the organizational structure for the Metropolitan Police Department.[1] During the period of study the department operated with approximately 4500 police personnel.[2] Approximately seventy-five per cent of this number were associated with the Field Operations Bureau. This is the bureau which is most responsible for creating visible police presence within the city. Within the Bureau the Patrol Division, the Traffic Division, and the Special Operations Division are the primary divisions which create conspicuous police presence within the city.

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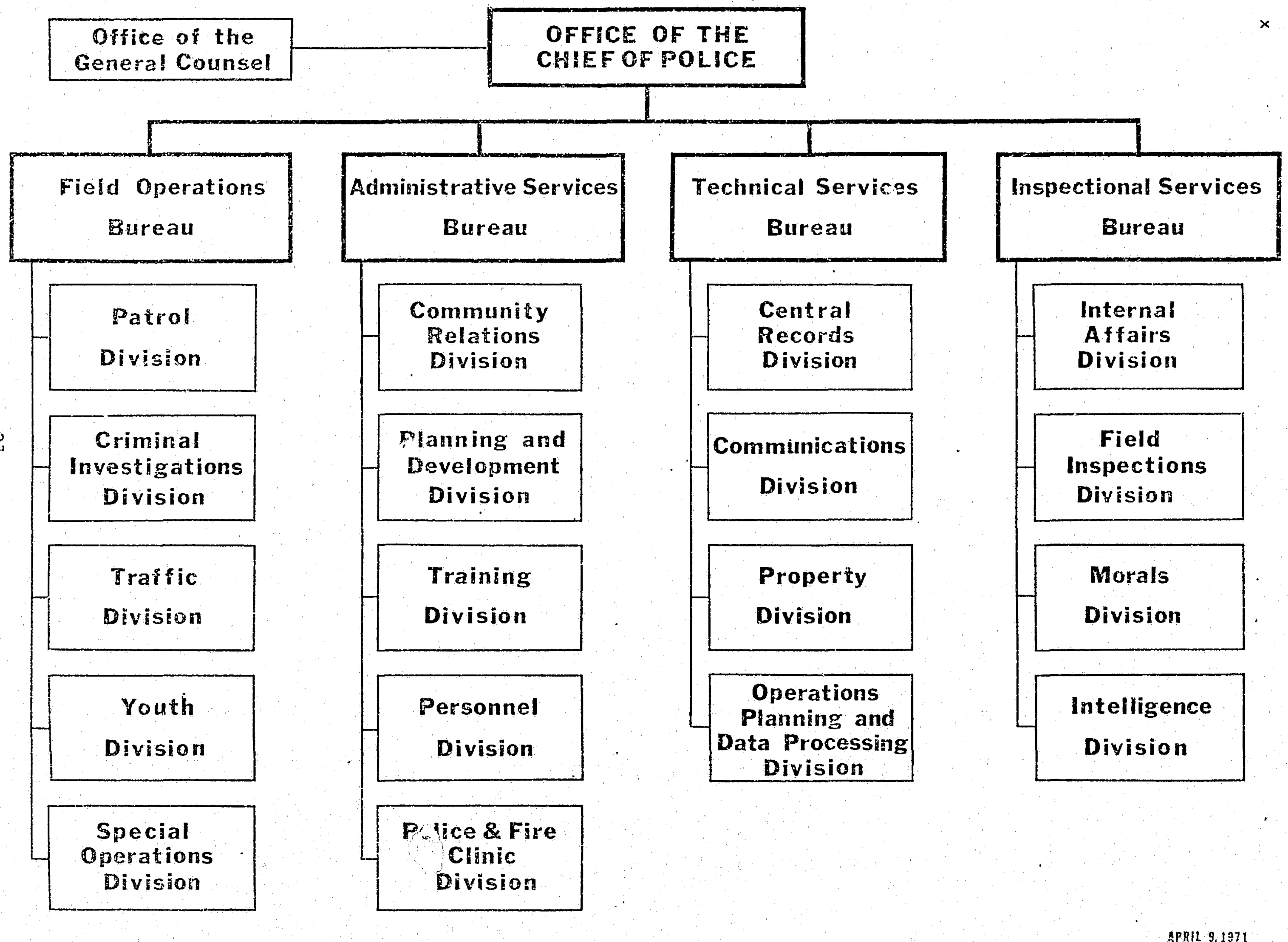
[1] Figure 1 is taken from the Annual Report of the Metropolitan Police Department, Washington, D.C. Fiscal Year 1970.

[2] The actual strength of the force on June 30, 1970 was 4,436.

Figure 2-1

METROPOLITAN POLICE DEPARTMENT, WASHINGTON, D.C.



Patrol Division

Patrol Division responsibilities can be divided generally into (a) responding to calls-for-service and (b) preventive patrol. The manpower which carry out these responsibilities are assigned to each of the city's seven police districts. Each district is concerned primarily with maintaining regularly patrolled beats through the use of patrol cars, footmen, and scooter patrols. In most districts, assignment of manpower to the regular scout car beats has the highest priority. These cars are assigned to particular beats and spend the largest percentage of their time responding to calls-for-service. After the scout car beats have been assigned, residual manpower are available for special assignments such as preventive patrol. In addition to the above resources, most districts operate rather modest tactical units. Men operating within these units are usually split between non-uniformed, casual clothes units and uniformed scooter and foot patrols, which are used for preventive patrol activities.

Traffic Division

This division is responsible for traffic control within the city. Using patrol cars, motorcycle patrols, and footmen, this division comprises but a small portion of total police manpower visible to the public. Very often, footmen directing traffic at intersections are unarmed cadet officers. In addition, their primary period of operation is during the daylight hours when traffic volumn is the greatest. Discussions with the Traffic Division Commander led the researcher to conclude that for the purposes of the experiment, the effect of their presence was almost negligible.

Special Operations Division

The Special Operations Division (SOD) is most appropriately identified as the tactical unit of the department. Operating throughout the entire city and autonomously from the districts, its major responsibility is crime prevention. Although this division has a variety of other responsibilities, including control of public demonstrations and special events, harbor patrol, and Presidential details, its primary effort is in preventive patrol activities. The Tactical Branch of SOD is the unit which carries out this effort on a city-wide basis. Its manpower are removed from the responsibilities of handling routine calls-for-service and are thus free to concentrate upon preventive activities. In addition, the Tactical Branch has the mobility to respond to needs which arise anywhere within the city and might be thought of as a trouble shooting group. It also has the capability of conducting saturation efforts within areas of the city which have serious crime problems. The Tactical Branch utilizes visible and casual clothes units and foot patrols. Visible operations are most often conducted using two-man patrol cars. Foot patrols are used on a regular basis, and may be increased or decreased depending upon the type of problem being addressed.

This study focuses upon the activities and impact of the Tactical Branch of SOD during three months in 1970.

EXPERIMENTAL SETTING

Experimental Condition

During 1970, SOD decided to embark upon a new crime prevention strategy. A common strategy employed by SOD was to utilize the Tactical Branch in a mobile fashion. Based upon daily or weekly crime trends, patrol units were assigned to problem areas within the city. These assignments were often of very short duration in order to minimize the predictability of patrol movements. Based upon an analysis of crime figures, performed by the Operations Planning and Data Processing Division, problem areas within the city were identified and recommendations were issued to SOD for purposes of planning a new intensive patrol strategy. The new strategy involved selecting a contiguous geographical area which had recently incurred high levels of crime and assigning the Tactical Branch to that area for a period of one month. The strategy was one of high visibility and high concentration within the selected area. Tactical Branch officers were removed from the area of intensive patrol only for special assignments. Otherwise all Tactical Branch resources were focused upon the area. The officers were deployed for only two shifts during any day. The 12:00 a.m. to 8:00 a.m. shift was not covered. In deploying officers, assignments were superimposed upon regular District deployments. District assignments were not to be changed or modified in light of SOD deployments.

Periods Studied

The new strategy was initiated during the summer of 1970. Three of the first four months were selected for evaluative purposes. These months were August, September, and November. October was excluded due to a discontinuity in the experimental condition. The researcher felt that the Tactical Branch officers were reassigned to other activities during the month for a period of time sufficiently long to disturb the experimental condition.

During the August experimental period, the Tactical Branch was assigned to eight contiguous reporting areas located in the Northeast section of the city. (A reporting area, as used within Washington, D.C., will be defined later in the chapter.) This set of reporting areas, located within the Fifth Police District, was selected due to the high incidence of robbery during the month of June. The zone was primarily a residential area. It had a mix of housing conditions which varied from substandard to moderate quality. One central strip of commercial development ran through the center of the area along H Street. The more serious crime problems for this area were residential burglary and street robbery.

The September experiment was conducted within the First Police District. Twelve reporting areas were selected to receive the intensive patrol activities. These twelve reporting areas were selected on the basis of high rates of crime for the more serious crime categories during the month of July. Compared with the August test zone, this zone was characterized by less residential concentration. There was a greater degree of openness due to wider streets, more schools and playgrounds, and more commercial development. The area was characterized by a greater variety of housing than the August test zone. Although there were pockets of substandard housing, there were also high rise apartments, as well as other moderate income housing.

The November experiment was conducted within the Third Police District. Seventeen reporting areas were involved in this last period studied. Three of these areas were actually added to the test zone on November 17. This was due to increases in crime within these reporting areas during the first part of the test period. Note is made of this in the evaluation portion of this study. The original fourteen areas were selected on the basis of high rates of incidence of burglary, robbery, and auto theft during August and September preceding the experiment. Visually, this test zone was more commercial than either of the preceding test zones. It was very close to the center of the downtown business district. Aside from the widespread commercial and office building development, a variety of housing types existed. In particular, there were large pockets of low income housing in the northern part of the test zone.

Appendix A presents more detailed socioeconomic and demographic data for the three test zones as obtained from the 1970 Census.

DATA COLLECTION

This section discusses the sources and procedures used in gathering data for the study.

Manpower Data

Since the experiment involved an increase in visible manpower, it was necessary to measure the relative increase in police presence. Thus, data had to be gathered which reflected normal levels of police presence within the experimental zone, and levels which existed during the experimental period.

District Deployments - In order to determine normal levels of police presence, it was necessary to gather data related to deployments within the involved districts. Discussions were held with personnel at each district in order to gain familiarity with deployment policies. In particular, regular visible deployments were identified. The visible resources always included the regular scout car beats. In addition, all districts had tactical units which provided certain levels of visibility. These units rarely operated with patrol cars. They generally operated through scooter patrols or footbeats. In addition to the scout cars and tactical units, most districts had other special beats which were manned on a regular basis.

Once the mix of visible resources had been identified, it was necessary to determine which of these resources was normally allocated to the respective test zones. This involved a mapping of patrol beats over the test zone. Scout car beats were rigidly defined, although they were modified sometimes in order to meet temporary needs. As an example, a scout car could have been assigned to cover both its regular area and a neighboring scout beat if the other scout car was off duty. Beat boundaries were obtained for other visible resources either from beat sheets or the daily assignment book (PSS Book). In those instances where a beat was partly within the test zone, an estimate was made of the percentage of the beat time expended inside the test zone.[3]

[3]This estimate assumed uniform coverage of the beat and it was based upon an estimate of the portion of the total beat area lying within the test zone.

Data concerning district deployments for both the month prior to, and the month of, the experiment were obtained from the district PSS books. These books reflect those officers on duty, their assigned activity, and the time on and off duty, and a periodic location check. Data concerning district deployments for the month prior to the experiment was used as an estimate of normal visibility levels for that time of year. This data served as a check on the districts to assure that deployments did not change significantly during the test period, in light of SOD's activities.

SOD Deployments.- Similar data had to be gathered for SOD Tactical Branch activities. Visible deployments within the test zone first had to be identified. These were most often one and two-man patrol cars, although footbeats were sometimes added. Data used to measure the added presence was obtained from daily roll call sheets. These sheets reflect information concerning officers on duty, their assigned activity, and hours on duty.

Comparisons between combined levels of visible manpower for both SOD and the involved district and the district deployments were used to estimate the relative increase in police visibility during the test period. The basis for this comparison will be presented in a later chapter.

Offense Data

For purposes of the study, it was necessary to determine which offenses would be included in the analysis. The offense categories of the Federal Bureau of Investigation provided the basis for selection. The Bureau utilizes both reported Index crimes and Part I offenses as a measure of general crime trends within the country. Nationwide Index offense data are published annually in the Uniform Crime Reports. These crimes represent the more serious offense categories. Included in this group are murder and non-negligent manslaughter, forcible rape, aggravated assault, robbery (excluding pick-pocket and purse-snatching), burglary, larcency over $50, and auto theft. Since the experiments were directed at reducing serious crime, it was decided to focus upon this set of crimes for evaluating the impact of increased police presence.[4]

[4]These crimes were used with one exception. From the standpoint of data reduction, it was more convenient to include larceny over $100 than larceny over $50.

Offense Reporting System - At the time of the experiment, the city of Washington, D.C. was sub-divided into six police districts. The Sixth District since has been divided into two police districts. The six-district system evolved from a precinct system. Although some jurisdictional boundaries had changed, a basic reporting system, created in late 1967, remained constant. This system subdivided the city into 360 areas to be used for reporting crime. These areas, sometimes referred to as Carney Blocks, constituted the smallest geographical units for which crime statistics were regularly gathered and summarized.[5] The geographic boundaries for these areas were selected using a variety of criteria. For example, the boundaries of a reporting area were in most instances coincident with streets or other natural boundaries. The size of an area was quite variable, and was based upon considerations of balanced demand for police services, as well as upon population and commercial density.

[5]Named after Lt. Michael D. Carney of the Washington Metropolitan Police Department, these areas were inspired by the Pauly Block system created previously in St. Louis.

Data Tapes - With the cooperation of police department officials, magnetic tapes were obtained which contained offense data for Fiscal Years 1968 through 1971. These served as the primary data base for the study. The four tapes contained offense data for over 380,000 crimes. Of these, over 200,000 were Index crimes. Recognizing that information might not be complete, records were screened to assure that information pertinent to the study had been recorded. This information included type of crime, date, and reporting area. Due to time and resource limitations, it was not possible to analyze the extent to which incorrect information was recorded. Those familiar with police departments are fully aware of the inconsistencies which can arise in classification of crimes. In addition, it is suspected that errors might have existed in designating the location of a crime via reporting area. Such errors were probably more prevalent in late 1967 and early 1968 shortly after the creation of the 360 reporting areas.

Computer programs were written which allowed for data reduction. These programs allowed for tabulation and summarization of offense data according to crime category, location, and time parameters.

CHAPTER III

CRIME ESTIMATION MODEL

In this manpower study, as in any similar type of evaluative study, the impact upon crime was determined by comparing actual levels of crime with those which would have been expected in the absence of the experimental condition. Therefore, it was necessary that a satisfactory method be identified for estimating the level of crime which otherwise would have been expected. Heretofore, the methods used in similar studies have been statistically unappealing and of questionable validity.

CRIME-CORRELATED AREA CONCEPT

In order to cope with this problem an alternative model was proposed. It was developed on the basis of a simple and rather intuitive assumption. The assumption was that there exists a set of crime-related factors which operate upon a city as a whole. These factors operate in such a way as to influence general crime levels in a city. While the most obvious of these factors is weather, other factors might include the pervasiveness of drug use, number of policemen in the city (assuming a fairly uniform distribution), general economic conditions, community attitudes and spirit, the general relationship between the community and the police, and various socioeconomic or demographic factors which collectively characterize the city as a whole.

It was hypothesized that as a result of the operation of these factors, the levels of crime in two areas might fluctuate in a similar manner. For example, severe weather conditions might cause crime levels in many areas of a city to decrease. Assuming a pervasive use of drugs, an increase in the street price of drugs could result in increased crime levels in a number of areas of the city. It was thus hypothesized that given any area in a city, there might be identified another area (perhaps a "sister" area) in which the rate of change in the level of crime might be very similar. If this is so, one might find that the levels of crime in two areas are highly correlated over time. And in an experiment such as the manpower study, one might estimate the level of crime in an experimental area based upon the level which occurs in a non-experimental area.

One apparent advantage of using this concept relates to greater use of information. Many of the traditional time-dependent crime modeling techniques allow for inclusion of information leading up to the experimental period. A virtue of the crime-correlated area concept is that it allows for causal forces to operate during the test period and for information related to their operation to be included in the estimating procedure.

A ganeral form of the model is:

$$x_{it} = f(x_{jt}) \qquad (3.1)$$

where x_{it} equals the level of crime occurring in area i during period t. It should be noted that this model implies an ex post facto estimate rather than a forecast of crime.

A secondary hypothesis related to the concept was that two areas might have highly correlated levels of crime even though they are dissimilar in certain ways. It was proposed that two areas might be dissimilar with regard to:

a. average level of crime

b. location

c. socioeconomic and demographic characteristics

This hypothesis infers that, even though two areas are dissimilar with regard to the above characteristics, they may have similar, or proportionate opportunity structures for crime. Thus, the operation of widespread crime influences might cause similar variations in the levels of crime.

PRELIMINARY ANALYSIS

Prior to testing the hypotheses, certain decisions had to be made concerning parameters in the analysis. One decision related to the definition of an area in testing for crime-correlated areas. In late 1967, the police department subdivided the District of Columbia into 360 standard reporting areas. These areas represent the smallest geographic units over which crime is summarized on a routine basis. Due to the fact that these areas were convenient, and that patrol boundaries often coincided with reporting area boundaries, these were chosen as the fundamental areas for testing the hypotheses.

Another decision concerned selection of an appropriate time period for summarizing crime data. The decision was in large part dictated by the duration of the manpower experiments. Since the manpower allocations were designed for one-month periods, it was decided to test for monthly correlations.

The last decision concerned the measure of crime to be used in testing the hypotheses. Since the impact of the manpower experiment was judged in part by the effect upon Index offenses, this category of offenses was selected.

Reporting Area Versus Reporting Area: Linear Model

To test for the existence of crime-correlated areas, it was decided to correlate monthly Index crime levels between reporting areas. Thirty months of Index offense data, beginning with March of 1968, were used as input for the analysis. A linear functional form was assumed such that the general model form, (1), becomes:

$$x_{it} = a + bx_{jt} \qquad (3.2)$$

This model assumes that the ratio of the changes in the levels of crime between two areas is constant.

Performing an exhaustive set of linear regressions, monthly Index crimes for each reporting area were correlated with those of each of the remaining 359 reporting areas.

A test of significance had to be conducted to determine whether the levels of monthly Index offenses were significantly correlated between two areas. This was achieved by performing a test to determine whether the true coefficient of correlation, ρ_{xy}, was significantly different from zero. The following test statistic was computed:

$$t = \frac{r_{xy}\sqrt{N-2}}{\sqrt{1-r_{xy}^2}} \qquad (3.3)$$

where: r_{xy} = sample coefficient of correlation

N = sample size

With this statistic having N-2 degrees of freedom, the hypothesis

$$H_o: \rho_{xy} = 0 \qquad (3.4)$$

was tested.

Results

Of the more than 60,000 sets of correlations performed, 13,243 or over 20 percent, of these proved significant at the .05 level. Table 3-1 summarizes those sample correlations of highest degree.

TABLE 3-1

SIMPLE COEFFICIENT OF CORRELATION AND ASSOCIATED FREQUENCY:
LINEAR MODEL FOR REPORTING AREAS

Sample r	No. of Correlations
.850-.900	1
.800-.849	10
.700-.799	183
.600-.699	1104
.500-.599	3013
.400-.499	5766

The results led to some interesting observations which tended to support the secondary hypotheses. It was found that for two areas to be highly correlated, they need not have similar levels of crime. Table 3-2 presents data which supports this observation. Shown are the relative Index crime levels for Fiscal Year, 1970, for the 11 pairs of reporting areas having the highest correlations. Similar results were reflected at lower levels of correlation.

Further observation of the results showed that some of the higher correlations involved areas located close to one another; others involved areas separated by considerable distance. From Table 3-2, reporting areas 345 and 340, 517 and 510, 517 and 516, and 515 and 514, are examples of areas which are adjacent to one another. The high correlations associated with these pairs are intuitively satisfying in the sense that crime opportunities and crime influencing variables would be expected to be similar within small, contiguous areas. The other pairs of reporting areas are separated by considerable distances. 833 and 311 provide an illustration of a high correlation between two areas in opposite ends of the city. And lastly, some higher correlations involved areas similar in socioeconomic and demographic characteristics; others were not similar.

TABLE 3-2

RELATIVE CRIME LEVELS FOR 11 HIGHEST CORRELATED PAIRS: LINEAR MODEL FOR REPORTING AREAS

r	Reporting Areas	Ratio of FY 1970 Index Totals
.872	832 & 323	296/191
.828	833 & 311	213/ 65
.825	515 & 838	640/148
.824	345 & 340	675/615
.818	337 & 332	730/225
.818	516 & 938	231/109
.813	517 & 510	446/258
.808	517 & 516	446/231
.802	515 & 514	640/375
.801	724 & 428	889/582
.800	338 & 509	454/241

MULTIPLE PREDICTOR AREAS

Although the results of the linear regression analysis tended to support the hypotheses concerning the existence of significant correlations between reporting areas, the degree of correlation was not believed sufficiently high enough for purposes of prediction. It was hypothesized that by utilizing multiple predictor areas, the degree of association might be improved to satisfactory levels. Or, a better estimate might be achieved if the level of crime in one reporting area was based upon the levels occurring in several other reporting areas. The logic supporting this argument was that the measure of crime being used is an aggregate of several different types of crime. It could be assumed that the correlation of Index offenses between two reporting areas is based substantially upon similarities in the behavior of one or more particular types of crime. For example, two areas might have similar burglary problems. Because burglary is the Index offense having the highest rate of incidence, similarities in burglary alone might account for a considerable degree of association between levels of Index offenses. Residual variation might be closely associated with the behavior of another type of crime. Thus, the justification for the introduction of other reporting areas (independent variables) might be based upon similarities in the behavior of other types of offenses between the two areas.

The general form of the model is:

$$x_{it} = h(x_{1t}, x_{2t}, \ldots, x_{nt}) \qquad (3.5)$$

where the independent variables are the levels of crime during period t for n selected predictor areas. For purposes of analysis, it was decided to employ a linear functional form which presumes an additive type of relationship. Thus, equation (3.6) expresses the relationship,

$$\hat{x}_{it} = a + \sum_{\substack{k=1 \\ k \neq i}}^{n} b_k x_{kt} \qquad (3.6)$$

where x_{it} represents the predicted (expected) level of crime occurring in area i during period t.

Model Development

In order to test the validity of the concept, it was decided to develop predictive models for a sample of 36 non-experimental reporting areas. Predictions were made for the month of September, 1970, which was one of the first experimental periods. Potential predictor areas (independent variables) were selected from those reporting areas geographically removed from the influence of the September manpower experiment.

Atypical Crime Levels - It was realized that crime estimates derived from the predictive models might be sensitive to atypical data points for the period of prediction. Thus, an atypical September level of crime in a predictor area would decrease the predictive accuracy of the model. A data point is normally not excluded as being atypical unless a supporting cause can be identified. Unfortunately, information concerning unusual changes in crime-influencing variables is not generally documented for geographic units the size of a reporting area. Therefore, prior to development of any models, September crime levels were examined for all potential predictor areas. Comparing the September level with the past 30 months, certain reporting areas were excluded as possible predictor areas. Exclusion was permitted only if comparisons made the level of crime appear suspiciously abnormal (relative not only to the area itself, but also to neighboring areas). Because of the large pool of over 200 potential predictor areas, it was believed that elimination of several areas would not seriously inhibit the development of a satisfactory predictive model.

Selection of Predictor Areas - Once a pool of potential predictor areas had been identified, a stepwise regression package was used for development of the crime estimation models.[1] The stepwise procedure for model development was believed to be the best of those procedures available and operational. Compared with the "forward-selection"[2] procedure for model development, Draper and Smith say of the stepwise procedure:

> The improvements involve the re-examination at every stage of the regression of the variables incorporated into the model in previous stages. A variable which may have been the best single variable to enter at any early stage may, at a later stage, be superfluous because of the relationships between it and other variables now in the regression. To check on this, the partial F criterion for each variable in the regression at any stage of calculation is evaluated and compared with a preselected percentage point of the appropriate F distribution. This provides a judgement on the contribution made by each variable as though it had been the most recent variable entered, irrespective of its actual point of entry into the model. Any variable which provides a nonsignificant contribution is removed from the model. This process is continued until no more variables will be admitted to the equation and no more are rejected.[3]

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[1]The package used was the BMD02R Stepwise Regression routine contained in BMD Biomedical Computer Programs, ed. by W.J. Dixon (Berkeley: University of California Press, 1970), pp. 233-257.

[2]Discussed in N.R. Draper and H. Smith, Applied Regression Analysis (New York: John Wiley and Sons, Inc., 1966), pp. 169-171.

[3]Ibid., p. 171.

For purposes of model development, two criteria were used for selection of the final mix of independent variables. First, the overall regression had to be significant at a predetermined level of significance. In order to determine whether the joint regression of the dependent variable on the independent variables was significant, a 5 percent level of significance was assumed. Computing the statistic

$$F = \frac{\frac{R^2}{(r-1)}}{\frac{(1-R^2)}{(N-r)}} \qquad (3.7)$$

where: r = number of variables in the correlation

N = sample size

R = coefficient of multiple determination

with r-1 and N-r degrees of freedom, the overall regression was determined significant if the computed F-ratio exceeded a critical F value corresponding to the level of significance and associated degrees of freedom.

The second criterion was the partial F criterion. Critical partial F values were selected so as to assure significance of 5 percent. The same critical value was used for determining variables to both enter and leave the model. In those instances in which the level of significance was overly restrictive for purposes of entering variables, the critical F values were revised to assure significance of 10 percent.

Preliminary Results

Models were developed for the 36 reporting areas, and estimations of September Index offense levels were generated. Table 3-3 summarizes the results of the crime estimates for the 36 areas. Ninety-five percent confidence intervals were established for the actual level of crime. In approximately 80 percent of the predictions (28/36), the actual level of crime for September fell within the 95 percent confidence interval. The reporting areas for which actual levels fell outside the computed confidence interval are denoted by an asterisk.

These 8 models were examined more closely to seek an explanation for their poor crime estimates. Compared with the other 28 models, the final correlation models for these eight involved a large number of predictor areas (independent variables). The number of independent variables was generally on the order of 10 or more. Multiple coefficients of correlation were all high for these models and the standard error terms were quite low. A form of sensitivity analysis was employed by making predictions at each step in the model development. Predicted levels were compared with actual levels of crime and deviations were noted. In addition, actual levels were compared with 95 percent confidence intervals. It was interesting that in almost every model, predictions were reasonably good and actual levels of crime were well within the 95 percent confidence intervals for the initial stages of model development. Eventually, though, a point was reached whereby further introduction of independent variables resulted in poorer estimations.

TABLE 3-3

COMPARISON OF ACTUAL AND PREDICTED LEVELS
OF INDEX OFFENSES FOR SEPTEMBER, 1970:
36 NON-EXPERIMENTAL REPORTING AREAS

Reporting Area	Sept. Index Offenses Actual	Sept. Index Offenses Predicted	Absolute Deviation	Standard Error of Estimate
114	6	4.8	1.2	1.1
125	7	5.9	1.1	2.0
316	20	13.4	6.6	3.3
330	11	10.4	.6	1.6
332	16	19.9	3.9	2.7
407	51	45.8	5.2	4.0
* 408	18	8.7	9.3	1.8
409	21	25.2	4.2	4.1
411	23	25.3	2.3	3.9
* 512	28	38.6	10.6	2.6
513	20	18.1	1.9	3.0
525	16	19.0	3.0	3.1
542	4	5.7	1.7	1.2
552	11	15.4	4.4	3.5
* 556	7	12.6	5.6	1.5
616	9	6.8	2.2	2.9
618	11	5.6	5.4	2.9
724	61	67.7	6.7	7.3
* 806	10	5.7	4.3	.9
813	10	13.0	3.0	2.4
* 814	16	11.1	4.9	1.2
* 815	7	13.4	6.4	2.9
816	6	4.9	1.1	2.1
820	12	12.0	0.0	2.0
828	4	4.8	.8	1.1
* 831	9	11.5	2.5	1.1
832	13	17.6	4.6	3.5
833	10	12.9	2.9	4.2
840	14	8.1	5.9	3.6
841	15	15.1	.1	2.6
848	6	8.9	2.9	2.4
902	17	24.0	7.0	4.8
* 906	9	13.0	4.0	1.1
910	15	15.1	.1	1.5
920	16	11.8	4.2	4.0
929	8	9.2	1.2	2.3

* Actual level outside 95 percent confidence interval

Overfitting a Model

It was suspicioned that the introduction of additional independent variables was resulting in what is often referred to as overfitting. "The fitting of regression equations that involve more independent variables than are necessary to obtain a satisfactory fit to the data is called overfitting."[4] From an intuitive standpoint, the problem of overfitting a model might be explained as follows. Given a set of potential independent variables, it might be hypothesized that there exists one best model describing the dependent variable. By "best model," it is inferred that the appropriate functional form, as well as the optimal set of explanatory variables have been identified. This model may involve only a subset of the group of possible independent or explanatory variables. If, in the process of developing a regression or correlation model, the best model has been attained, the further addition of independent variables might tend to contaminate the relationship. Inclusion of additional variables might serve to improve the fit of the model to the sample data points, but it might do this at the expense of generating a biased, or incorrect, model.

It is true that the inclusion of additional independent variables can improve the degree of correlation and diminish the residual sum of squares. The coefficient of correlation can always be made to equal unity by having the number of independent variables approach the sample size. Draper and Smith allude to this when they say,

[4] Ibid., p. 167.

We must be sure that an improvement in R^2 due to adding a new term to the model has some real significance and is not due to the fact that the number of parameters in the model is getting close to the saturation point—that is, the number of observations.[5]

What may ultimately occur is an excellent fit to the sample data points, but an inability to extrapolate for predictive purposes.

In the stepwise regression process of developing a model for purposes of prediction, the problem is one of identifying the optimal stage at which to terminate entrance of further independent variables. Several techniques were examined which purportedly help in resolving this type of problem. Mallow's C_p criterion,[6] which allows for graphic comparison of regression equations, and Allen's predicted sum of squares (PRESS)[7] technique for simulating prediction, were both examined to determine their usefulness. Actual application of the two techniques, using sample data, resulted in inconsistent results.

Some experimentation with various heuristics was conducted for the 36 models. In each instance, the heuristic involved identification of the stage in model development at which entrance of further independent variables should terminate.

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[5] Ibid., p. 63.

[6] See C.L. Mallows, "Choosing Variables in a Linear Regression: A Graphical Aid" (paper presented at the Central Regional Meeting of the Institute of Mathematical Statistics, Manhattan, Kansas, 1964); C.L. Mallows, "Choosing a Subset Regression" (paper presented at the Joint Statistical Meeting, Los Angeles, 1966), and J.W. Gorman and R.J. Toman, "Selection of Variables for Fitting Equations to Data," Technometrics, 8, 27-51 (1966).

[7] See D.M. Allen, "Mean Square Error of Prediction as a Criterion for Selecting Variables," Technometrics, 13, 37-51 (1971), and R.L. Anderson, D.M. Allen, and F.B. Cady, Selection of Predictor Variables in Linear Multiple Regression, Technical Report Number 5 (University of Kentucky, Department of Statistics, 1970).

Decision Rule Selected

A comparison was made of the performance of the various decision rules for termination. In addition, the behavior of predictions was observed for all 36 models by generating predictions at every step of model development. Observation of this behavior resulted in the conclusion that as the number of independent variables introduced to the model approached seven or eight (with sample size equal to 30), there is a strong possibility of overfitting. Predictions beyond this point quite often begin to degenerate. Thus, it was found that performance, in terms of accuracy of predictions, was best when tightening the level of significance on the partial F tests for determining entrance and exit of independent variables.

The rule selected, therefore, for determining cutoff points in model development was as follows: Set the level of significance for partial F tests at .05. If this level of significance permits the introduction of a large number of independent variables (7 or more, with the sample size being used) tighten the level of significance. On the other hand, if the level of significance is so tight that it appears to be overly restrictive regarding entrance, it should be increased. Such would be the case if the partial-F test permitted no entry of independent variables, or if it permitted so few that the standard error associated with the predictions was too large to assure meaningful predictions.

The problem of overfit, as related to developing predictive models, is apparently an unresolved one. It is still receiving the attention of statisticians. The above solution has been selected as an interim means of coping with the problem in this particular application. Application of the decision rule to the original 36 areas, as well as to several new reporting areas, resulted in actual levels falling outside the 95 percent confidence intervals in one case only. The mean absolute deviation between actual and predicted levels of crime was approximately 3.0. Measuring relative uncertainty of predictions by the ratio of the standard error of the estimate to the predicted level of crime,

$$\frac{\hat{\sigma}_{yx}}{\hat{Y}} \qquad (3.8)$$

the average ratio was approximately 22 percent. This measure of uncertainty, as might be expected, was much lower for higher crime areas.

OPERATIONAL CONSIDERATIONS

Application of the crime-correlated area concept, for purposes of evaluating a crime-control program, requires a number of operational considerations. The following discussion relates to these considerations and the approaches taken in evaluating the manpower experiment.

Potential Predictor Areas

An initial decision in applying the concept to an evaluative study is the identification of potential predictor areas. Areas should not be considered as potential predictors if they undergo any unusual or abnormal crime influences. Thus, areas which are influenced by the experimental condition or program should not be considered.

In the manpower experiment, between eight and seventeen reporting areas were part of the experimental zones, depending upon the month of the experiment. Thus, in developing a crime-estimation model for any reporting area, the other experimental reporting areas were not considered.

If it is suspected that the range of influence of the program extends beyond the geographical boundaries of the experimental condition, any areas falling within this range should be excluded. Since spill-over or displacement effects were believed possible as a result of saturation efforts, a range of potential influence was assumed. The range was arbitrarily selected to be at least a mile from any boundary of the test zone.

In addition to these areas, any areas which are known to incur an unusual crime influence, not related to the experiment, should be excluded. For example, the initiation of a methadone project, initiation of a juvenile program, or a localized change in police tactics would be sufficient justification for excluding an area. As mentioned earlier in this chapter, systematic documentation of such information is not done on a regular basis by most communities nor their police departments. Such is also the case for Washington, D.C.

In the manpower experiment, the number of reporting areas excluded for the above-mentioned reasons was usually 50 or more. Since there are 360 reporting areas within Washington, there remained a pool of approximately 250 to 300 potential predictor areas. This is an extremely large number of possible independent variables, and the number of different combinations of variables which could be used in developing a model is staggering. To further reduce the number, it was decided to exclude low crime areas. Thus, any reporting areas which incurred less than 50 Index offenses per year (or less than 5 per month) were excluded. Elimination of these areas reduced the pool to approximately 200 variables.

Atypical Data

As mentioned earlier in the chapter, estimates of crime levels based upon the use of the crime-correlated area concept might be sensitive to atypical crime levels. Because of the lack of documentation of abnormal crime-influences, it is believed that some form of data analysis can aid in identifying unusual periods. A variety of statistical techniques might be used in identifying these periods. Clustering analysis might prove very useful, especially in accounting for the not so obvious changes in crime patterns. For purposes of the manpower study, a less sophisticated approach was used. It was assumed in this study that the marginal benefits derived from using a more sophisticated technique would not be substantial.

In developing models, crime levels for the month of the prediction were screened for all potential predictor areas. With comparisons made as discussed earlier in the chapter, an a priori exclusion of areas was performed if crime levels appeared suspiciously abnormal.

The Process of Model Generation

Generation of crime estimation models can involve a large number of potential independent variables. If all of these variables were to be considered as candidates for entrance, there would be a problem of identifying a program having the capacity to handle such a large number of variables.

In the manpower study, no program was identified which could handle 200 or more variables. The BMD02R Stepwise Regression program, which was finally selected, can handle a maximum of 80 variables. In order to give all variables some consideration in developing the crime-estimation models, a procedure was adopted whereby three preliminary runs were conducted. In each of the runs, approximately one-third of the potential independent variables were regressed against the dependent variable. Examination of each of the three generated models resulted in a skimming procedure. The independent variables included in each of the three models were combined to form a new group of independent variables to be used in a final summary run which determined the crime-estimation model.

The procedure for developing these models was tedious and time consuming. The prediction model developed for any reporting area involved four stepwise-regression runs. For example, models were developed for 12 experimental and 17 peripheral reporting areas involved in the September experiment. Thus, final models required 87 computer runs. The intention was to come as close as possible to the one, best predictive model. To do so, it was believed that all potential independent variables had to be given some consideration.

The conclusion based upon these experiences, was that the stepwise regression procedure will not guarantee the one, best model, even if all potential independent variables can be included in one large computer run. The stepwise process is a conditional procedure; entrance of another variable is contingent upon the existing mix of independent variables contained in the model. Also, it was concluded that there exist many <u>good</u> predictive models involving a number of combinations of predictor areas. Many of the models developed in the 3 preliminary runs were quite satisfactory. Thus, from the standpoint of operationally generating useful models for evaluative studies, there is no need to bother with <u>all</u> potential independent variables. Specially designed procedures might be used to select a subset of independent variables for model development. On the other hand, simple random selection procedures might indeed generate satisfactory pools of predictor variables for final model development.

SUMMARY

The results of this anælysis indicate that the multiple predictor concept can prove very useful in making ex post facto estimates of expected crime levels within an area. It should be remembered that this model is an <u>associative</u> model. The levels of crime in selected areas are used as proxies for the true causal determinants of the level of crime in other areas. For purposes of evaluating the impact of a crime-related experimental condition, these areas are similar to the concept of experimental control areas. They are similar in the sense that they should not be influenced by the experimental condition, nor should they be subjected to other abnormal crime influences. But, the selection of these "predictor" areas is not based upon any similarities in socioeconomic or demographic characteristics, or in level of crime. The basis for selection is the association of the rates of change in crime between the experimental and "predictor" areas. Therefore, according to the results presented, it would not be counter-intuitive to find predictor areas selected which are quite dissimilar as compared with an experimental area.

The relative performance of the model appears to improve, the larger the expected level of crime. Since most studies are concerned with higher crime areas, the model would seem itself very well to such studies. Chapter IV discusses how area and time parameters might be re-defined in order to increase the relative magnitude of expected crime. Also presented are some results involving parameter changes.

Compared with the other time-dependent crime modeling techniques, the crime-correlated area concept allows for causal forces to operate during the test period, and for information related to their operation to be included in the estimating procedure. Chapter IV will also present a comparison of performances of the crime-correlated area concept versus traditional estimation techniques.

CHAPTER IV

PERFORMANCE CHARACTERISTICS OF THE CRIME-CORRELATED AREA MODEL

This chapter presents some performance characteristics of the crime-correlated area model. In the first section of this chapter, three of the more commonly employed crime estimation models are compared with the crime-correlated area model. Subsequent sections discuss model performance under varying parameters; specifically, increases in the area and time parameters.

COMPARISON WITH OTHER MODELS

In order to determine the relative performance of the crime-correlated area model, three of the more popular crime estimation models were selected for comparative analysis. The comparative analysis consisted of making monthly predictions of Index offense levels for twenty reporting areas over a period of one year. These predictions were made using each of the four crime estimation techniques. The reporting areas selected included some of those areas which were involved in the experimental periods. Therefore, to eliminate the influence of the manpower experiment, the period used in comparing the models was the one year period preceding the experiments.

The Crime Estimation Models

The three estimation models selected for comparison are all time dependent models. The first model estimates the level of crime for any month as the level which occurred in the previous month. This technique has been used in a large percentage of research studies conducted by police departments. If X_t is defined as the number of reported crimes (of a particular type) during month t, this model suggests that:

$$x_t = x_{t-1} \qquad (4.1)$$

The second model bases its estimates upon the level occurring during the same calendar period in the previous year. For the comparative study, the level of crime for any month is estimated by the level occurring during the same month of the previous year.

The third model is the exponential smoothing model. As a special type of moving average, the level of crime expected during any month is computed as

$$S_t(x) = \quad x_{t-1} + (1-\alpha)S_{t-1}(x) \qquad (4.2)$$

where

$S_t(x)$ = expected level of crime during month t

x_{t-1} = level of crime during month t-1

$S_{t-1}(x)$ = previously computed estimate of crime for month t-1.

α = smoothing constant $(0 \leq 1)$

This model is a constant model with no trend adjustment.[1]

[1]The reader is referred to Smoothing, Forecasting, and Prediction, by Robert Goodell Brown, for an excellent discussion of exponential smoothing models.

The value of the smoothing constant reflects how responsive the smoothed values or estimates are to recent data. The larger the smoothing constant, the greater the responsiveness. It might be noted that the first of these three models can be viewed as a special case of the exponential smoothing model where $\alpha = 1.0$.

In order to utilize the exponential smoothing model an appropriate value had to be determined for the smoothing constant. It was decided that the model should be run with historical data, allowing α to fluctuate between 0.0 and 1.0 in .1 increments. Using the twenty reporting areas, predictions were made at each level of α for the months of June and July, 1969. These months were the two preceding the twelve month period selected for comparing the various models. Since it was desirable to select a value of the smoothing constant which results in the greatest predictive accuracy, the mean absolute deviation of predicted levels of crime from actual levels was computed for each level of α. On the basis of the results, it was decided to allow α to vary between .2 and .7 (in .1 increments) for the twelve month comparative analysis.

Results of the Comparative Study

The comparative analysis involved crime estimates for the twelve month period of August, 1969 through July, 1970. Estimates were made for the twenty selected reporting areas using the four models. Five separate sets of crime estimates were generated using the exponential smoothing model; one set each for the six different levels of α. Tables 4-2 through 4-13, which present the comparative results, only include data for the best exponential smoothing model. The best model, in this instance, refers to the level of α which resulted in the greatest predictive accuracy for the twelve month period. Table 4-1 indicates the sum of the absolute deviations and the mean absolute deviation for the 240 predictions at each α. It can be observed that the degree of predictive accuracy was very close for smoothing constant values between .4 and .6.

TABLE 4-1

PREDICTIVE ACCURACY FOR VARIOUS LEVELS OF SMOOTHING CONSTANT: TWENTY REPORTING AREAS AND TWELVE MONTH TOTALS

Smoothing Constant	Sum of Absolute Deviations	Mean Absolute Deviation
.2	1543.71	6.43
.3	1439.23	5.99
.4	1398.73	5.82
.5	1390.03	5.79
.6	1410.38	5.87
.7	1448.11	6.03

For purposes of summarizing results in Tables 4-2 through 4-13, the experiences associated with $\alpha = .5$ were selected as representative of the best exponential smoothing models. For purposes of simplification in presenting the results, Model I, II, and III will refer to the previous month, previous year, and exponential smoothing models, respectively. Model IV will refer to the crime-correlated area model. Each table summarizes results for one month and does so by presenting actual levels of Index offenses for the month and the deviation of the predicted level for each of the four models. The deviation is computed as the actual level minus the predicted level. The sum of absolute deviations and the mean absolute deviation for each model are computed at the bottom of each table.

TABLE 4-2

CRIME ESTIMATES FOR AUGUST 1969

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	6	-2	3	-.5	-.6
338	60	19	21	22.6	-2.3
340	79	29	37	31.8	1.2
407	94	-32	4[illegible]	36.4	-1.0
428	62	5	30	18.3	4.2
525	27	11	3	8.4	-4.8
552	38	5	30	13.8	4.1
630	84	28	54	32.0	36.2
706	5	3	3	1.7	4.4
711	14	-3	-2	0.0	-1.3
715	32	4	-5	-1.2	-1.7
725	36	3	22	7.3	6.5
813	8	-11	1	-7.3	-7.8
820	18	-2	9	3.3	1.4
831	10	2	4	3.7	2.1
838	20	6	17	8.8	-3.8
906	8	1	1	.1	-2.9
915	24	-1	-1	3.5	.6
926	13	8	0	5.4	3.8
929	16	4	11	3.9	6.2
Sum of Absolute Deviations		179.0	303.0	210.0	96.9
Mean Absolute Deviation		8.95	15.15	10.50	4.84

TABLE 4-3

CRIME ESTIMATES FOR SEPTEMBER 1969

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	9	3	6	2.2	3.2
338	63	3	29	16.6	2.9
340	56	-23	14	-8.6	3.8
407	71	-23	34	-1.0	6.5
428	53	-9	15	2.7	-13.6
525	26	-1	14	.5	2.0
552	27	-11	8	-1.0	-1.2
630	59	-25	23	-5.2	-14.4
706	4	-1	2	-.7	-.7
711	6	-8	-2	-8.3	-8.8
715	29	-3	3	1.3	1.4
725	47	11	26	18.4	11.8
813	10	2	-5	.5	-5.7
820	16	-2	4	2.4	1.3
831	6	-4	1	-2.2	-5.8
838	9	-11	5	-5.3	-3.9
906	6	-2	-4	-1.4	-3.5
915	29	5	12	8.3	3.7
926	9	-4	0	-3.1	-.5
929	15	-1	5	2.7	3.3
Sum of Absolute Deviations		152.0	212.0	92.4	98.0
Mean Absolute Deviation		7.60	10.60	4.62	4.90

TABLE 4-4

CRIME ESTIMATES FOR OCTOBER 1969

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	15	6	11	7.2	.3
338	42	-21	8	-8.2	-22.5
340	50	-6	15	-1.6	-7.1
407	71	0	13	6.7	-27.2
428	57	4	12	8.6	1.0
525	25	-1	3	-2.7	-1.0
552	21	-6	2	-4.6	-8.4
630	66	7	30	10.5	3.8
706	14	10	6	10.3	10.8
711	10	4	-13	0	1.6
715	38	9	8	6.9	9.2
725	35	-12	13	-2.8	-13.7
813	6	-4	-4	-6.7	-9.5
820	20	4	10	4.6	3.4
831	12	6	8	5.8	7.1
838	14	5	10	3.9	-4.6
906	9	3	3	2.0	.5
915	27	-2	12	2.2	7.6
926	16	7	-1	7.7	7.7
929	12	-3	4	-1.5	-.3
Sum of Absolute Deviations		120.0	186.0	104.5	147.3
Mean Absolute Deviation		6.00	9.30	5.22	7.36

TABLE 4-5

CRIME ESTIMATES FOR NOVEMBER 1969

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	12	-3	6	1.1	-1.1
338	54	12	22	9.8	7.7
340	65	15	10	7.7	6.0
407	63	-8	-2	-8.5	-5.9
428	37	-20	4	-16.6	-13.0
525	31	6	7	5.7	5.1
552	22	1	8	-2.5	-1.2
630	66	0	18	.9	-4.8
706	11	-3	8	1.7	4.2
711	19	9	3	6.8	5.6
715	34	-4	0	1.2	1.6
725	32	-3	14	.2	-1.9
813	7	1	-3	-.8	-4.8
820	20	0	12	3.2	6.3
831	23	11	19	12.9	9.2
838	16	2	6	1.8	7.3
906	11	2	-2	2.8	4.7
915	13	-14	-8	-10.9	-11.9
926	8	-8	-17	-6.1	.5
929	14	2	4	1.9	2.6
Sum of Absolute Deviations		124.0	173.0	103.10	105.4
Mean Absolute Deviation		6.20	8.65	5.15	5.27

TABLE 4-6

CRIME ESTIMATES FOR DECEMBER 1969

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	5	-7	0	4.9	-3.3
338	37	-17	-4	-15.1	-3.7
340	67	2	12	8.7	9.0
407	74	11	18	10.3	7.0
428	40	3	-7	-2.7	-7.4
525	28	-3	10	1.3	3.5
552	10	-12	-1	-13.8	-16.7
630	44	-22	3	-16.8	3.7
706	14	3	7	6.7	3.0
711	18	-1	-6	3.5	-3.7
715	31	-3	-3	-1.5	-4.9
725	20	-12	-15	-14.9	8.5
813	10	3	6	.2	4.0
820	15	-5	8	-2.7	-3.5
831	14	-9	7	-.6	3.0
838	17	1	-4	3.9	4.0
906	14	3	2	5.0	8.2
915	20	7	6	1.1	-4.2
926	8	0	-14	-.1	-2.3
929	4	-10	-8	-9.8	-3.2
Sum of Absolute Deviations		134.0	141.0	123.6	106.8
Mean Absolute Deviation		6.70	7.05	6.18	5.34

TABLE 4-7

CRIME ESTIMATES FOR JANUARY 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	1	-4	-7	-7.0	-8.2
338	29	-8	-13	-11.6	4.4
340	54	-13	-8	-8.1	8.7
407	107	33	32	34.3	32.9
428	47	7	4	.2	4.0
525	26	-2	5	-.6	.8
552	25	15	8	7.8	6.8
630	60	16	26	5.5	14.4
706	6	-8	2	-5.7	-7.2
711	20	2	1	4.9	2.5
715	40	9	-10	8.1	-2.2
725	28	8	2	2.1	6.0
813	12	2	4	3.1	-1.2
820	12	-3	3	-3.9	-9.5
831	13	-1	8	.9	4.1
838	8	-9	-8	-7.6	-3.4
906	7	-7	0	-4.1	-6.9
915	33	13	15	11.1	13.6
926	9	1	-12	-2.0	-4.5
929	7	3	0	-1.1	-3.2
Sum of Absolute Deviations		166.0	168.0	129.7	144.5
Mean Absolute Deviation		8.30	8.40	6.48	7.22

TABLE 4-8

CRIME ESTIMATES FOR FEBRUARY 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	3	2	-2	-2.4	-2.7
338	26	-3	-2	-14.5	-10.5
340	38	-16	-2	-18.1	.2
407	64	-43	17	-21.3	-5.7
428	50	3	25	5.2	6.5
525	15	-11	-2	-11.3	-10.0
552	18	-7	5	-6.4	.7
630	59	-1	27	-1.4	-1.7
706	14	8	7	7.3	8.2
711	9	-11	-9	-8.2	-8.6
715	25	-15	-7	-11.3	-16.0
725	33	5	9	1.5	3.9
813	12	0	5	1.1	1.8
820	19	7	9	4.2	5.7
831	8	-5	4	-5.8	-2.0
838	7	-1	4	-3.5	1.3
906	8	1	3	0	-2.3
915	16	-17	4	-9.9	-.9
926	4	-5	-6	-4.6	-2.9
929	11	4	2	.6	-1.4
Sum of Absolute Deviations		165.0	151.0	138.6	93.0
Mean Absolute Deviation		8.25	7.55	6.93	4.65

TABLE 4-9

CRIME ESTIMATES FOR MARCH 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	5	2	-1	-.5	-4.0
338	26	0	-13	-7.3	-13.8
340	50	12	15	-.1	-8.1
407	60	-4	19	-8.4	-4.5
428	46	-4	26	-2.4	-7.6
525	24	9	11	3.2	2.3
552	10	-8	4	-7.6	-7.5
630	40	-19	11	-16.8	-6.3
706	12	-2	3	-.8	4.3
711	15	6	-4	3.0	-4.8
715	42	17	7	13.5	2.8
725	33	0	10	3.5	5.7
813	8	-4	0	-2.4	1.9
820	10	-9	3	-7.5	-.9
831	4	-4	-4	-6.0	-3.5
838	9	2	6	-2.3	-1.6
906	5	-3	-8	-4.5	-3.4
915	19	3	13	0	-5.1
926	6	2	-4	-1.5	-.8
929	11	0	0	1.5	2.3
Sum of Absolute Deviations		110.0	162.0	92.8	91.2
Mean Absolute Deviation		5.50	8.10	4.64	4.56

TABLE 4-10

CRIME ESTIMATES FOR APRIL 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	3	-2	-1	-2.2	-4.1
338	18	-8	-13	-15.3	-13.3
340	25	-25	-9	-28.1	-12.0
407	62	2	23	-10.7	-2.3
428	44	-2	7	-1.4	-6.8
525	13	-11	-13	-12.2	-.9
552	8	-2	1	-9.2	-6.4
630	58	18	3	7.8	11.3
706	11	-1	8	1.7	.8
711	13	-2	-2	-3.1	3.5
715	37	-5	20	-2.1	-.7
725	23	-10	8	-9.2	-6.1
813	22	14	10	12.5	8.7
820	12	2	6	-.4	-2.8
831	8	4	5	-.9	2.6
838	13	4	6	3.2	2.6
906	2	-3	-6	-4.5	-5.2
915	9	-10	-11	-13.5	-8.5
926	10	4	-1	2.7	-.8
929	11	0	4	.3	5.7
Sum of Absolute Deviations		129.0	157.0	141.0	105.1
Mean Absolute Deviation		6.45	7.85	7.05	5.25

TABLE 4-11

CRIME ESTIMATES FOR MAY 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	2	-1	-2	-2.2	-2.7
338	35	17	5	9.4	12.0
340	36	11	-8	-1.5	-14.3
407	39	-23	-17	-26.2	-16.0
428	52	8	20	5.8	-2.4
525	15	2	-11	-1.9	-2.3
552	21	13	1	8.2	7.0
630	54	-4	-9	-3.4	-11.2
706	4	-7	1	-7.9	-4.5
711	13	0	9	.5	-6.3
715	40	3	1	7.3	4.6
725	31	8	5	4.8	1.2
813	11	-11	-4	-5.2	-2.0
820	15	3	4	.3	-3.0
831	11	3	8	2.0	.2
838	10	-3	0	-2.1	-.3
906	6	4	-1	.2	2.5
915	18	9	-2	4.0	-4.2
926	6	-4	0	-2.8	.4
929	9	-2	-6	-1.3	-3.7
Sum of Absolute Deviations		136.0	114.0	97.0	100.8
Mean Absolute Deviation		6.8	5.7	4.85	5.04

TABLE 4-12

CRIME ESTIMATES FOR JUNE 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	7	5	-4	3.4	2.5
338	23	-12	-11	-11.1	-16.7
340	45	9	-17	.5	2.3
407	48	9	[illegible]	-7.8	-7.3
428	37	-15	-5	-11.7	-10.9
525	21	6	-5	.9	.9
552	25	4	-1	5.9	9.0
630	53	-1	9	.9	-7.3
706	7	3	3	.3	1.4
711	13	0	1	-1.6	-1.4
715	44	4	22	4.4	6.8
725	24	-7	2	-7.6	-4.1
813	13	2	0	2.8	1.6
820	7	-8	-4	-6.7	-6.2
831	11	0	2	1.1	2.8
838	11	1	1	1.1	1.6
906	4	-2	-2	-2.2	-1.6
915	19	1	1	-1.2	.2
926	8	2	-2	1.4	4.1
929	5	-4	-4	-4.8	-8.8
Sum of Absolute Deviations		95.0	103.0	77.4	97.5
Mean Absolute Deviation		4.75	5.15	3.87	4.87

TABLE 4-13

CRIME ESTIMATES FOR JULY 1970

Reporting Area	Actual Level	Model I Deviation	Model II Deviation	Model III Deviation	Model IV Deviation
125	8	1	0	2.4	1.7
338	25	2	-16	.7	-6.5
340	46	1	-4	4.7	8.5
407	69	21	7	12.4	3.5
428	43	6	-14	1.4	.2
525	16	-5	0	-3.0	-4.5
552	13	-12	-20	-5.9	-6.6
630	40	-13	-16	-15.2	-18.6
706	10	3	8	.5	1.3
711	21	8	4	8.2	8.9
715	36	-8	8	-2.4	-1.9
725	22	-2	-11	-3.1	-10.4
813	17	4	-2	2.4	3.4
820	14	7	-6	3.1	1.0
831	9	-2	1	-1.0	-4.4
838	12	1	-2	.4	-.6
906	5	1	-2	.1	-2.6
915	13	-6	-12	-3.5	-2.0
926	10	2	5	1.6	2.4
929	15	10	3	7.4	2.7
Sum of Absolute Deviations		115.0	141.0	79.4	91.7
Mean Absolute Deviation		5.75	7.05	3.97	4.58

Table 4-14 summarizes the relative accuracy of predictions for the entire twelve-month period. Using the sum of absolute deviations for the 240 different predictions as a measure of accuracy, Model IV, or the crime-correlated area model, performed the best. The exponential smoothing model (Model III) performed second best, the previous month model (Model I) next, and the previous year model performed the worst. Looking at the results month by month, it is interesting to note that the exponential smoothing model results in the greatest predictive accuracy in seven of the twelve months. The crime-correlated area model performed best in the remaining five months.

The results indicate that the relative performance of the exponential smoothing and crime-correlated area models is very similar. Excluding the first month, during which the exponential smoothing model performed very poorly, the relative accuracy over the remaining eleven month period is almost exactly the same.

Comparison by Reporting Area

To further compare the exponential smoothing and crime-correlated area models, it was decided to examine performance on a reporting area basis. Table 4-15 presents the mean absolute deviation of predictions, by reporting area, for the two models. It also indicates the average level of Index offenses, as well as the standard deviation in the level of offenses occurring during the twelve-month period.

TABLE 4-14

COMPARATIVE ACCURACY OF CRIME ESTIMATES FOR 12-MONTH PERIOD

	Model I	Model II	Model III	Model IV
Month	Mean Absolute Deviation	Mean Absolute Deviation	Mean Absolute Deviation	Mean Absolute Deviation
1	8.95	15.15	10.50	4.84 *
2	7.60	10.60	4.62 *	4.90
3	6.00	9.30	5.22 *	7.36
4	6.20	8.65	5.15 *	5.27
5	6.70	7.05	6.18	5.34 *
6	8.30	8.40	6.48 *	7.22
7	8.25	7.55	6.93	4.65 *
8	5.50	8.10	4.64	4.56 *
9	6.45	7.85	7.05	5.25 *
10	6.80	5.70	4.85 *	5.04
11	4.75	5.15	3.87 *	4.87
12	5.75	7.05	3.97 *	4.58
Sum of Absolute Deviations	1625.0	1951.0	1390.0	1278.2
Mean Absolute Deviation	6.77	8.12	5.78	5.32

* Minimum mean absolute deviation for particular month

As can be seen from Table 4-15, each model performed best in ten of the twenty reporting areas. To explore the performance of the two models further, Figure 4-1 presents for each model the graph of the mean absolute deviation versus the standard deviation of the monthly levels of crime for each reporting area. The objective is to determine how well each model tracks, given different levels of variability in the signal. It can be seen from Figure 4-1 that there appears to be almost a linear relationship between the accuracy of the predictive model and the standard deviations of the predicted variable. With this limited data, it seems that the crime-correlated area model had greater success than the exponential smoothing model in those reporting areas having a high variance in crime level. In seven of the ten areas having a standard deviation of reported crime greater than 5.0, the crime-correlated area model outperformed the other model.

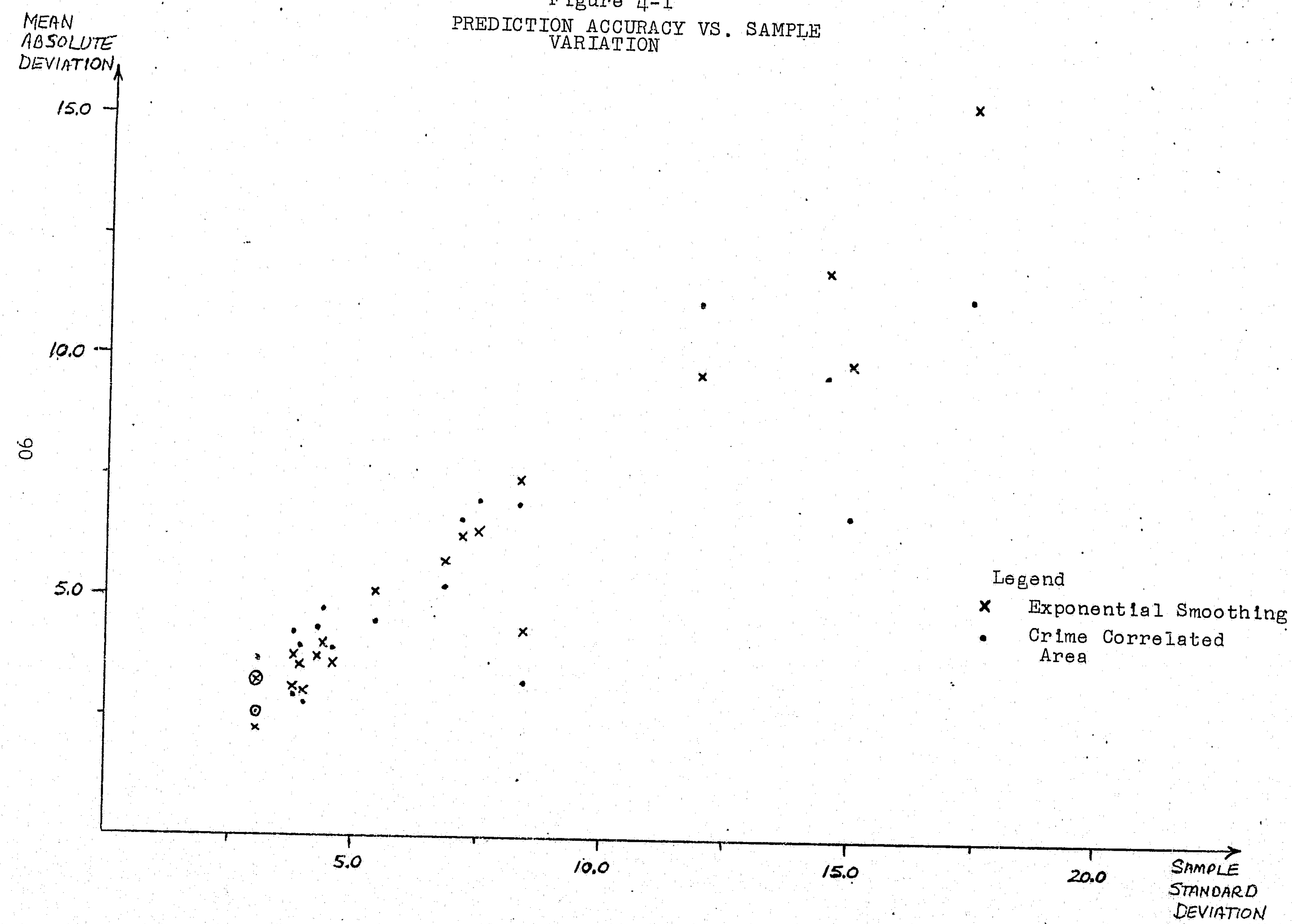
TABLE 4-15

MEAN ABSOLUTE DEVIATIONS
BY REPORTING AREA

Reporting Area	Average Level of Index Offenses	Standard Deviation	Model III	Model IV
125	6.33	4.0	3.00	2.86 *
338	36.50	14.5	11.85	9.69 *
340	50.91	15.0	9.95	6.76 *
407	68.50	17.4	15.33	11.26 *
428	47.33	7.5	6.41 *	7.00
525	22.25	8.4	4.30	3.17 *
552	19.83	8.3	7.49	6.92 *
630	56.91	11.9	9.70 *	11.14
706	9.33	3.8	3.77 *	4.23
711	14.25	4.4	4.00 *	4.75
715	35.66	5.4	5.10	4.48 *
725	30.33	7.2	6.28 *	6.65
813	11.33	4.3	3.75 *	4.36
820	14.83	3.9	3.52 *	3.75
831	10.75	4.6	3.57 *	3.90
838	12.16	3.8	3.65	2.91 *
906	7.08	3.1	2.24 *	3.69
915	20.00	6.8	5.76	5.20 *
926	8.91	3.1	3.25	2.55 *
929	10.83	3.8	3.06 *	3.61

* minimum for the two models

Figure 4-1
PREDICTION ACCURACY VS. SAMPLE VARIATION



Other Performance Measures

Using data collected from the comparative analysis, Figure 4-2 presents a measure of the relative uncertainty of crime level estimates derived from the crime-correlated area model. Relative uncertainty, measured as the ratio of the standard error of the estimate to the estimated level of crime, is graphed as a function of the level of crime estimated by the model. The 240 data points reflect what might be expected. That is, the relative uncertainty associated with a prediction decreases as the magnitude of the prediction increases. For purposes of using the model, the implication is that the confidence interval which one may associate with a prediction is likely to be more satisfying to the analyst when the levels of crime being estimated are of higher magnitudes.

In addition, Figure 4-3 presents a measure of the relative precision of estimated crime levels as a function of the actual level of crime. Relative accuracy, measured as the ratio of the absolute deviation to the actual level of crime, is plotted as a function of the actual level. Using the 240 data points, there is strong evidence that the relative accuracy of predictions improves as the level of crime being estimated increases in magnitude.

CONTINUED

1 OF 3

Figure 4-2

RELATIVE UNCERTAINTY OF PREDICTIONS
VS. MAGNITUDE OF PREDICTION

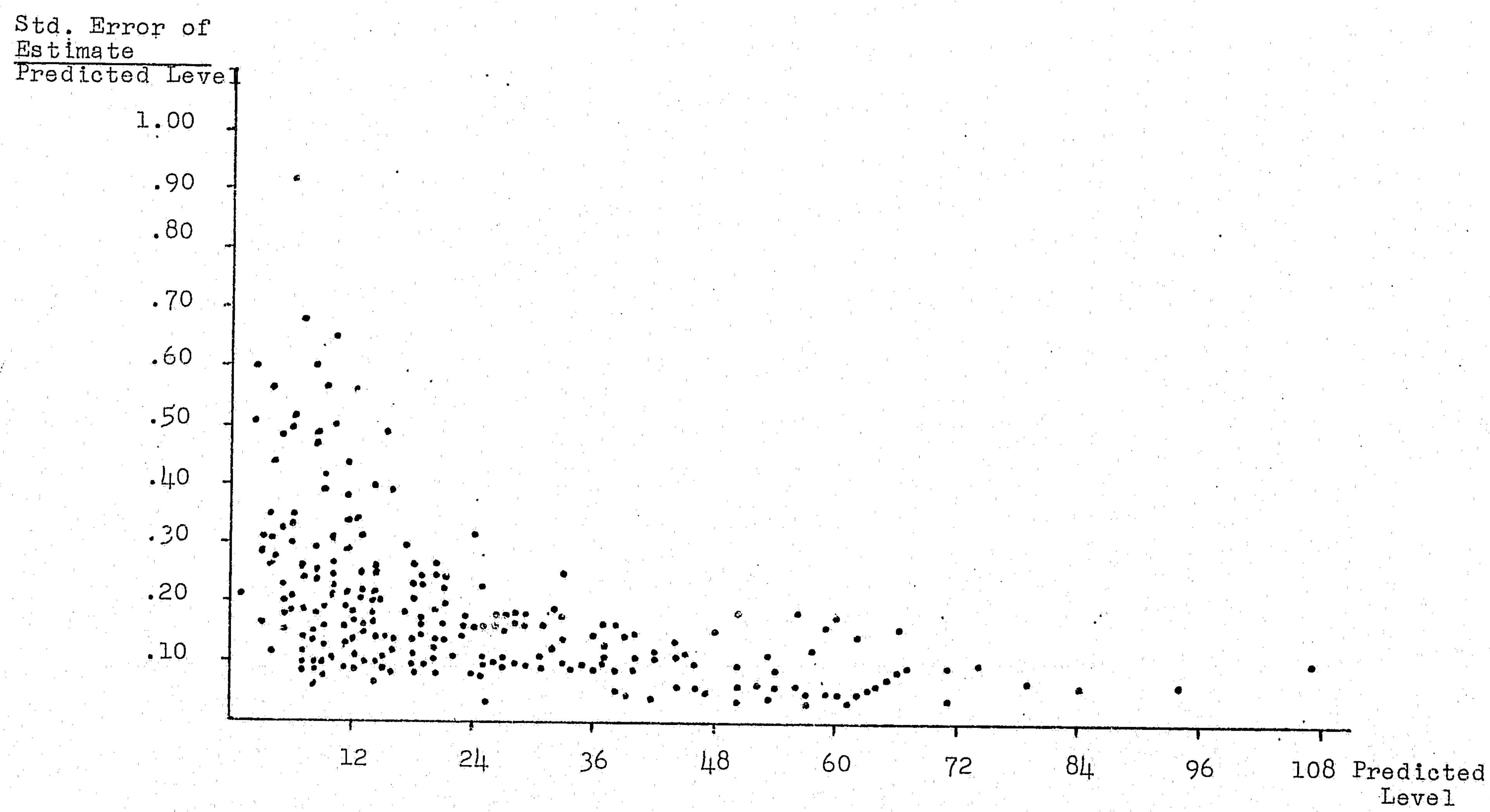
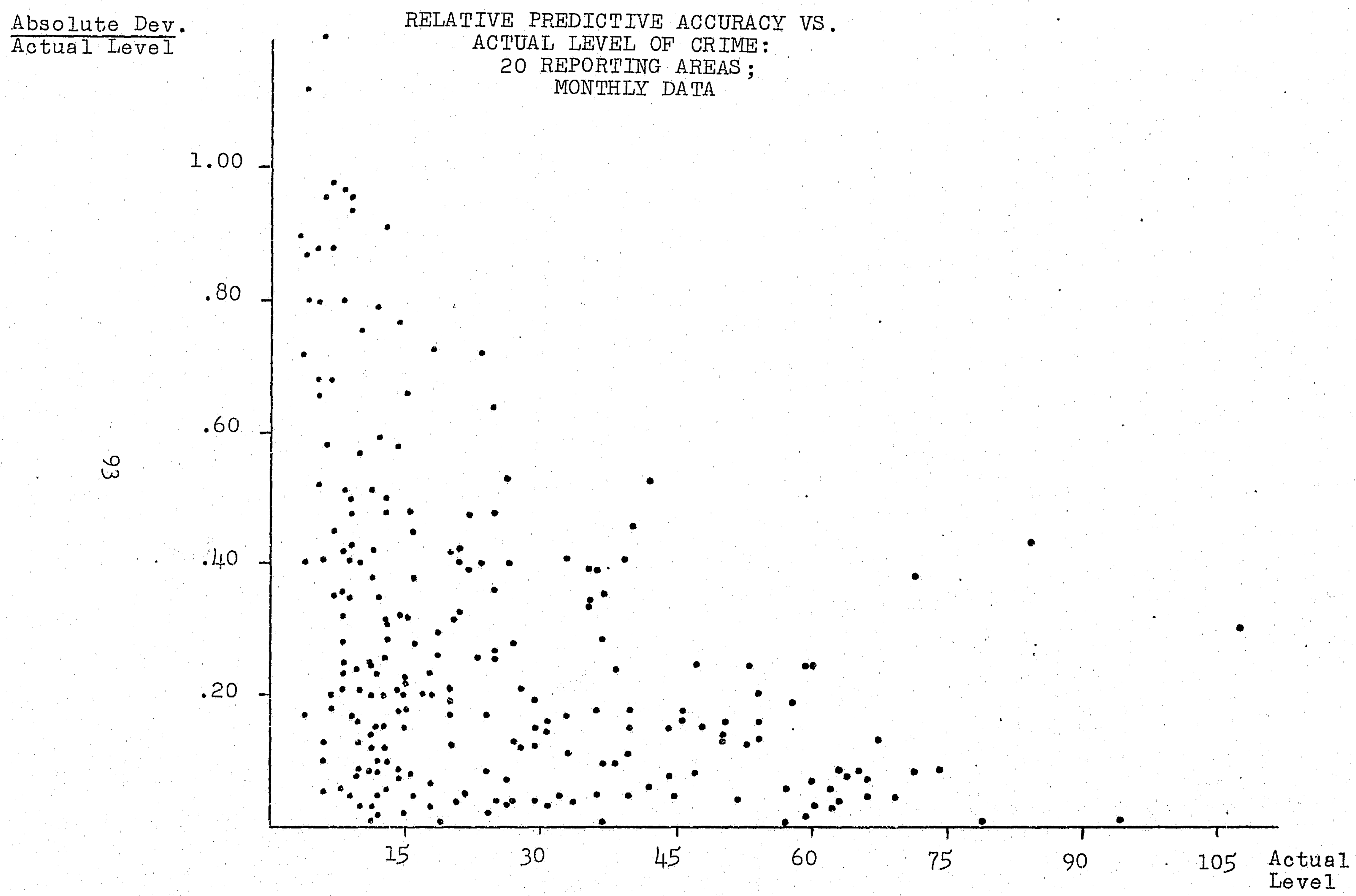


Figure 4-3

RELATIVE PREDICTIVE ACCURACY VS.
ACTUAL LEVEL OF CRIME:
20 REPORTING AREAS;
MONTHLY DATA



CHANGING MODEL PARAMETERS

The implication thus far is that the crime-correlated area model can be a very good means of estimating the level of crime on an ex post facto basis within an area of a city. This conclusion is based upon the performance experienced in estimating monthly levels of Index offenses for very small areas within Washington, D.C. The reporting areas and the monthly time parameter were selected as the units for testing the model, for reasons discussed in Chapter III. The experience discussed in the previous sections of this chapter offer evidence which indicates that model performance is better when the level of crime being estimated is large. This section discusses some parametric changes.

Increasing the Area Parameter

One means of increasing the general magnitude of crime being estimated is to summarize incidence data over larger areas. Thus, redefining the area parameter in the model to represent clusters of reporting areas or police districts, one might expect the relative performance of the crime estimating model to improve.

In order to test this hypothesis, the city was subdivided into twenty-three clusters of reporting areas. Each cluster was composed of between fifteen and twenty contiguous reporting areas, and monthly Index offense levels were aggregated to provide cluster totals. Monthly estimates of Index offenses were made for each cluster over a six-month period beginning with February, 1970. The predictor variables were selected from the monthly Index offense totals for the remaining twenty-two clusters. In essence, the level of crime in one cluster was estimated on the basis of the levels occurring in one or more of the other clusters. The number of months of input data ranged from n = 23 for February estimates to n = 28 for the July estimates.

Table 4-16 summarizes the results for the six-month period. In generating the estimates it was observed that the degree of correlation between clusters was much higher than between reporting areas. And final models frequently involved only two independent variables. The average coefficient of correlation associated with the first variable to enter the model was .85. This higher degree of association should be expected. By focusing upon crime levels for large areas, the sporadic variation which might occur in an individual reporting area tends to be dampened in the aggregation process.

Figure 4-4 portrays, as in Figure 4-3, the relative prediction error as a function of the actual level of crime. Compared with Figure 4-3, the general tendency is the same. Relative error of prediction tends to decrease as the actual level of crime increases. It can be observed, though, that there is cor iderable variability in the relative prediction error at certain levels of actual crime.

TABLE 4-16

SIX MONTHLY PREDICTIONS: TWENTY-THREE CLUSTERS OF REPORTING AREAS

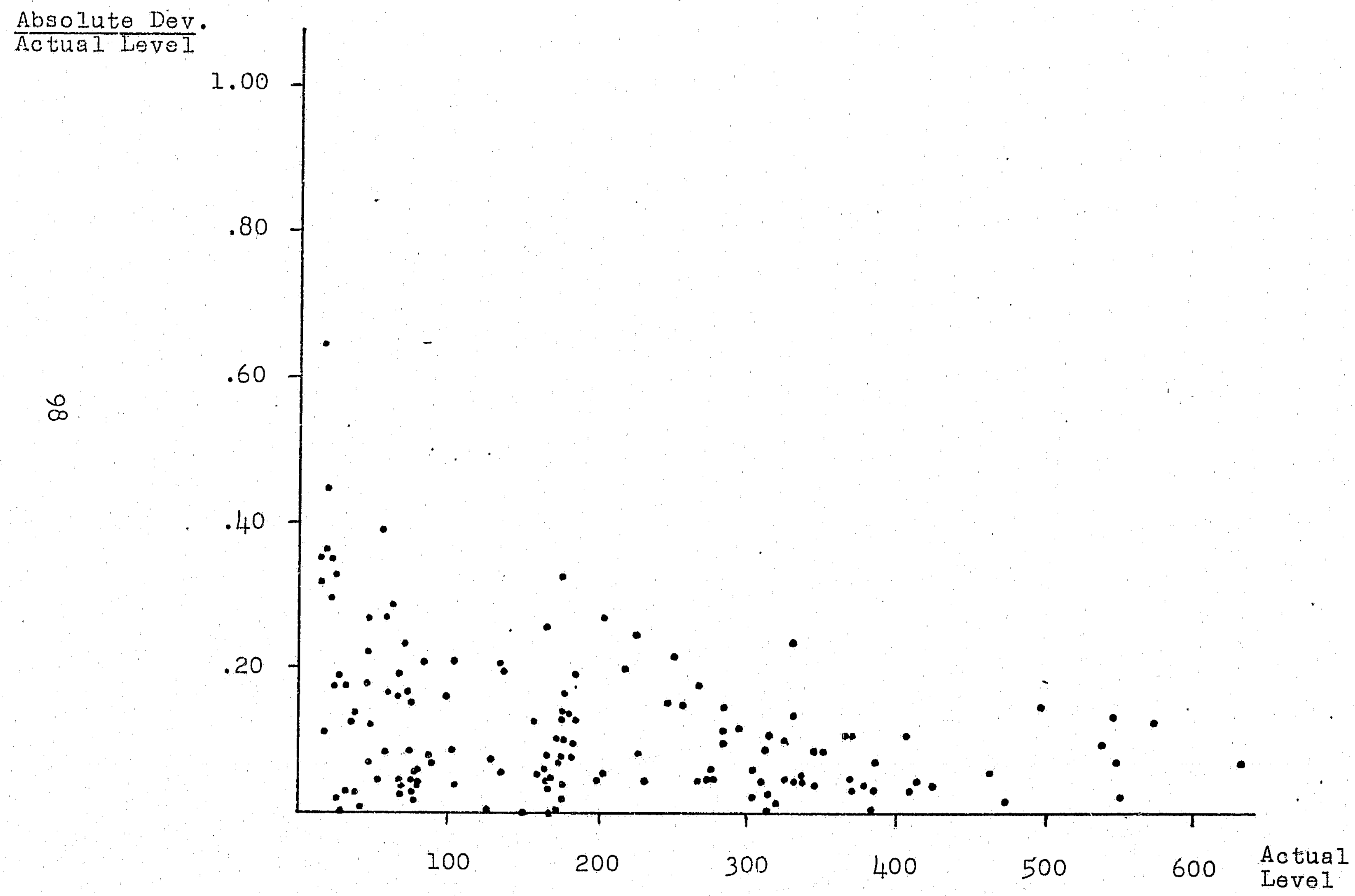
Cluster	February 1970 Actual	February 1970 Deviation	March 1970 Actual	March 1970 Deviation	April 1970 Actual	April 1970 Deviation
1	75	-5.0	74	12.3	56	15.3
2	14	4.6	14	9.2	17	-1.9
3	30	1.1	20	7.1	27	1.2
4	42	-9.6	40	.6	29	5.3
5	55	-21.7	56	-5.4	43	12.0
6	56	4.1	76	-11.9	81	-17.3
7	165	-14.3	181	16.1	164	8.8
8	322	33.3	407	46.4	314	36.5
9	384	-13.8	369	43.2	370	12.8
10	472	-13.0	461	27.8	425	20.3
11	338	-19.8	369	-20.2	344	16.4
12	260	.1	314	4.6	302	-20.2
13	105	5.0	133	-8.1	138	-27.2
14	78	3.8	68	16.1	61	17.9
15	101	-9.4	83	6.7	86	7.5
16	171	12.4	164	.5	174	-7.3
17	226	22.2	282	-29.1	226	56.6
18	494	-76.2	545	-80.0	536	-56.2
19	173	25.9	273	-18.4	244	-38.1
20	157	-21.9	179	-26.7	172	-23.0
21	182	20.0	202	12.7	182	20.1
22	312	-10.1	324	15.0	255	39.1
23	168	2.5	197	10.2	166	44.8

TABLE 4-16 Continued

Cluster	May 1970 Actual	May 1970 Deviation	June 1970 Actual	June 1970 Deviation	July 1970 Actual	July 1970 Deviation
1	66	10.7	67	-3.4	72	-2.9
2	14	5.0	25	-4.6	21	-6.2
3	18	8.2	19	7.0	25	.6
4	33	4.3	36	-1.4	54	-7.9
5	46	5.9	51	-2.9	65	-12.4
6	77	-3.9	67	2.3	66	-2.1
7	147	-.2	161	10.0	184	-24.4
8	383	-6.3	367	43.1	385	-27.1
9	352	34.2	344	34.1	330	47.1
10	546	-42.9	408	14.5	414	19.6
11	375	15.5	309	18.4	337	-18.2
12	307	-2.4	311	31	275	12.4
13	132	-9.8	126	-1.5	103	22.0
14	87	-6.9	98	-16.2	59	9.8
15	79	5.2	76	1.9	72	6.4
16	166	-9.8	170	-18.1	174	-29.1
17	270	-13.8	330	-14.4	302	-8.5
18	572	-78.7	550	11.0	631	-46.2
19	266	-50.4	248	-56.7	230	-11.1
20	163	-6.4	133	28.3	159	8.6
21	175	-15.1	175	3.8	173	57.7
22	293	-36.4	265	13.9	282	-12.3
23	176	19.1	203	14.0	215	-43.2

Figure 4-4

RELATIVE PREDICTIVE ACCURACY VS. ACTUAL LEVEL OF CRIME:
23 CLUSTERS; MONTHLY DATA



Increasing the Time Parameter

Another means of increasing the general magnitude of crime being estimated is to summarize incidence data over longer time periods. For example, analysts might estimate levels of offenses on a quarterly, semi-annual, or annual basis. In this research, monthly data for reporting areas was converted into quarterly data in order to examine the performance of the crime-correlated area model. The thirty months of original data were transformed into ten quarterly figures. Estimates of quarterly levels of crime were made for twenty reporting areas for eighth, ninth, and tenth quarters. In each set of quarterly estimates, data from all preceding quarters were used as input.

In the process of generating the models, it was discovered that quarterly correlations were even higher than with the twenty-three clusters in the previous section. The average coefficient of correlation for the first variable to enter each model was .91. It was believed that with such high correlations, and assuming acceptable levels of the standard error of the estimate, the level of crime in one area might be estimated on the basis of that found in one other area. This is the "sister" area concept initially hypothesized in Chapter III. For the quarterly estimates, therefore, models were developed having only one independent variable. Table 4-17 summarizes the results. Figure 4-5 which is similar to Figure 4-4, presents a graph of relative predictive accuracy. A close examination of these results indicates that the overall performance with quarterly data was not as good as previous results. This may be explained, in part, by the very small set of data points (n = 7, 8, and 9). And with estimates being based upon only one predictor variable, the limited history available on the variable decreases the reliability of the estimate.

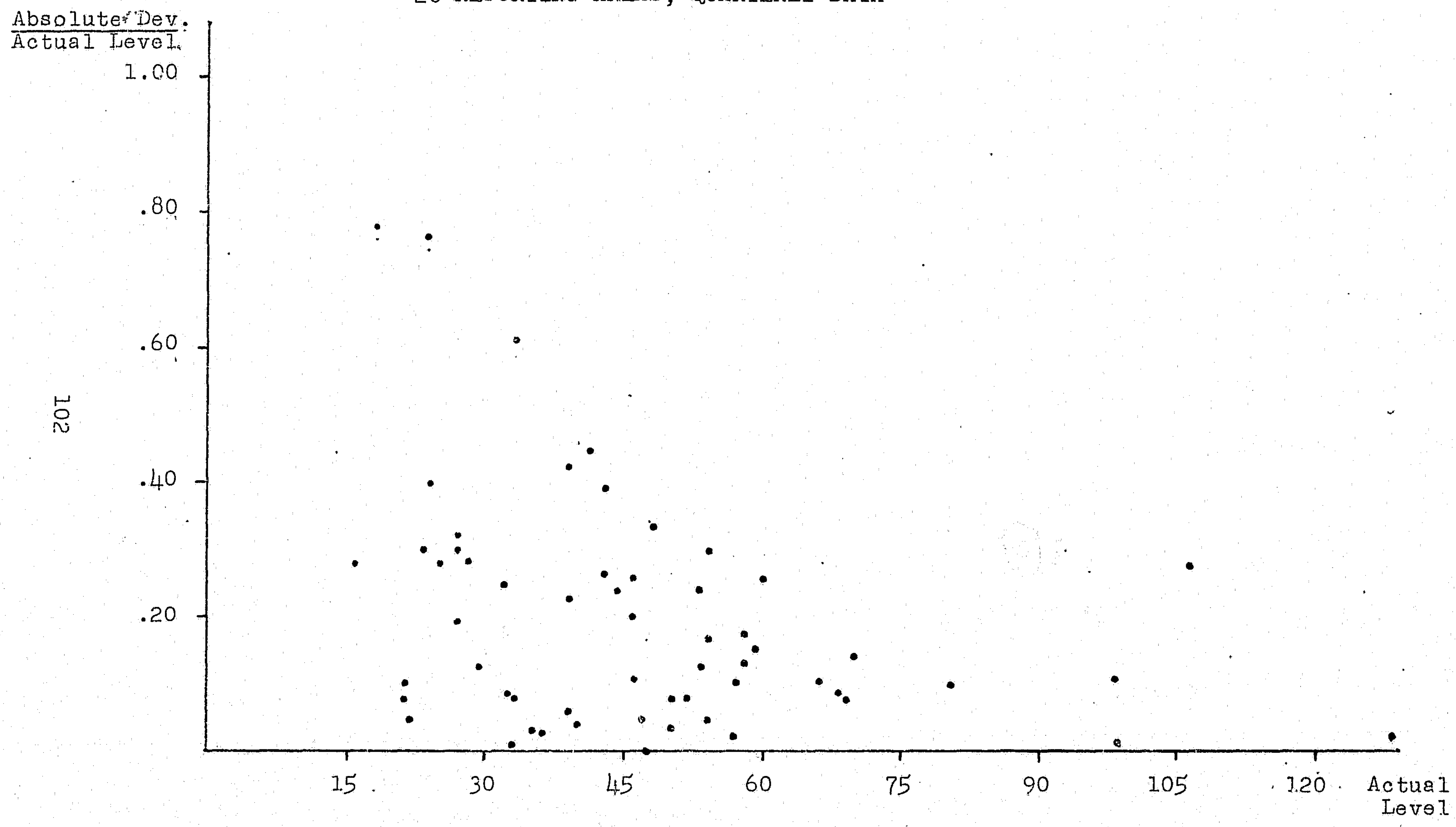
TABLE 4-17

QUARTERLY PREDICTIONS FOR TWENTY REPORTING AREAS

Area	8th Quarter (Dec,'69-Feb, 1970) Actual	8th Quarter Deviation	9th Quarter (Mar-May,1970) Actual	9th Quarter Deviation	10th Quarter (June-Aug, 1970) Actual	10th Quarter Deviation
307	32	-8.2	33	-20.2	18	14.1
328	58	-10.7	57	-5.7	54	3.2
334	23	7.1	43	-11.6	28	7.9
403	19	-2.9	18	-.1	16	-4.6
551	58	-8.1	43	-17.1	49	2.2
552	53	-12.9	39	9.1	46	-9.3
623	27	8.3	29	3.9	33	-2.8
705	22	1.1	24	9.8	27	-8.9
814	44	10.6	57	1.7	39	-2.5
815	25	7.2	54	-8.9	36	1.1
816	33	.4	39	-16.4	21	2.1
831	35	-1.3	23	17.6	27	-5.2
832	98	1.3	68	-6.5	53	7.0
841	41	18.6	50	2.4	52	4.6
904	70	-9.9	106	-28.2	98	-11.5
910	66	-7.1	47	-.3	54	-16.2
912	128	-3.6	80	8.2	59	9.0
915	69	-6.1	46	12.1	48	16.2
928	66	-.4	46	5.5	60	-16.0
934	32	3.0	41	10.2	40	1.8

Figure 4-5

RELATIVE PREDICTIVE ACCURACY VS. ACTUAL LEVEL OF CRIME:
20 REPORTING AREAS; QUARTERLY DATA



Simultaneous Increase in Parameters

As an additional possibility, there may be changes in both the area and time parameters. If both are increased, the magnitude of summarized crime levels will rise considerably faster. To explore the implications of such dual variation, the monthly data on the twenty-three clusters were transformed into quarterly data. As with quarterly data in the previous section, the degree of correlation between areas increased further. Whereas the average coefficient of correlation for the first entering variable had been .85 with monthly data, it increased to almost .96 with quarterly data. It was again decided to base the quarterly estimates upon the experiences of the most highly correlated cluster.

Table 4-18 presents the results for the three quarterly periods. Figure 4-6 offers a graphic portrayal of the results. The general trends in Figure 4-6 are the same as with earlier results. But, as with the quarterly predictions in the previous section, the relative error is sometimes sporadic. This may again be attributed to the reasons suggested in the previous section.

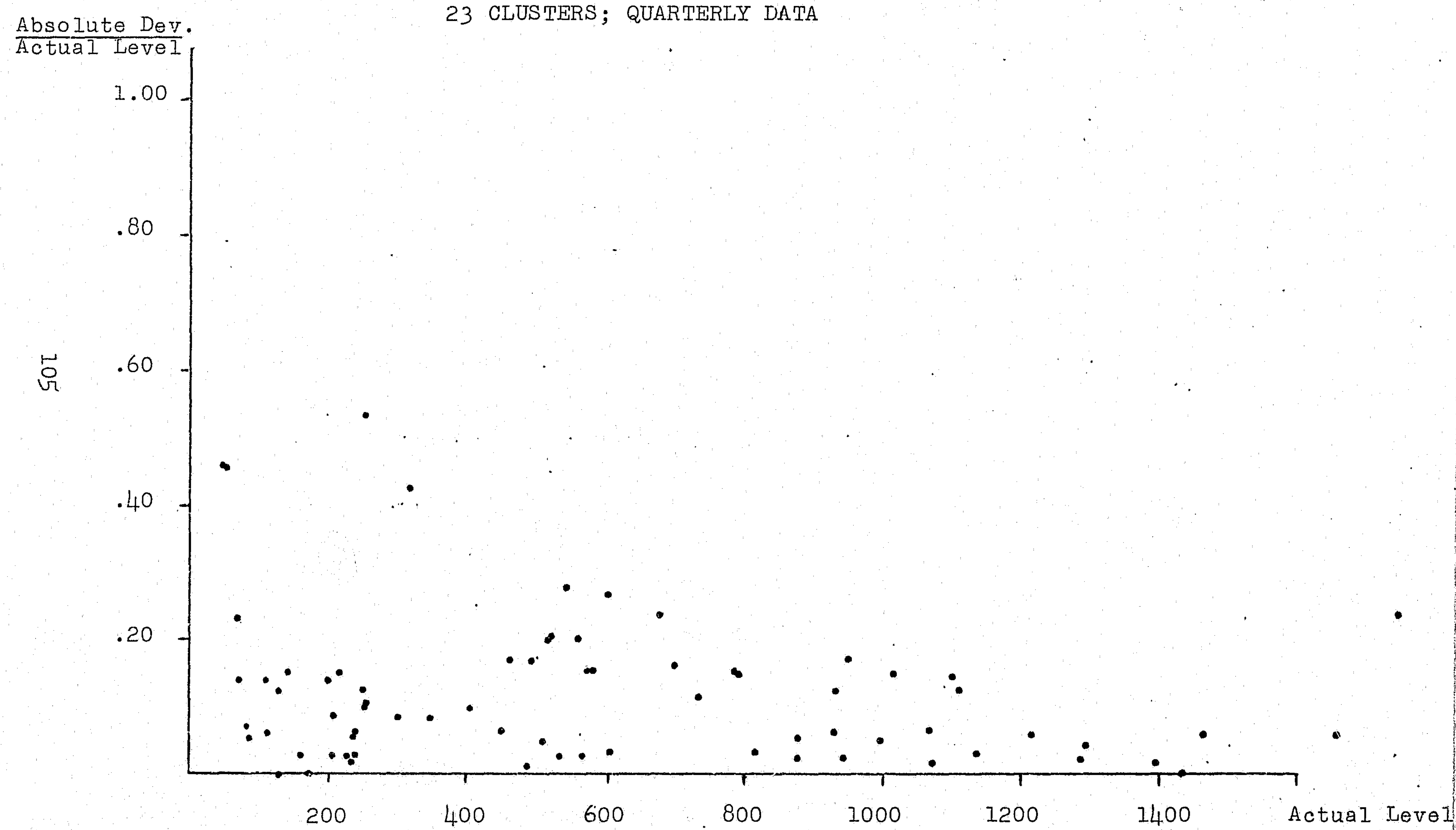
TABLE 4-18

QUARTERLY PREDICTIONS FOR TWENTY-THREE CLUSTERS

	8th Quarter (Dec,'69-Feb, 1970)		9th Quarter (Mar-May, 1970)		10th Quarter (June-Aug, 1970)	
Cluster	Actual	Deviation	Actual	Deviation	Actual	Deviation
1	245	-30.1	196	-28.0	222	-6.0
2	48	-22.1	45	-20.7	70	9.7
3	87	-4.9	65	-15.5	81	-6.0
4	111	5.6	102	14.2	129	-16.0
5	160	4.8	145	22.0	164	0.0
6	233	-5.2	234	-14.0	203	-6.0
7	577	88.4	492	-83.0	521	110.0
8	1292	-55.0	1104	-144.0	1135	-38.0
9	1216	74.0	1091	-160.0	1011	-149.0
10	1394	-30.0	1439	-7.0	1282	-26.0
11	1062	-74.0	1067	21.0	945	27.0
12	996	52.0	923	-118.0	875	49.0
13	344	-28.0	403	41.0	318	-136.0
14	251	-135.0	216	-32.0	205	-18.0
15	291	-26.0	248	27.0	237	-8.0
16	528	14.0	504	27.0	561	13.0
17	732	86.0	788	117.0	946	-166.0
18	1459	98	1653	103.0	1743	422.0
19	568	-88	783	-123.0	695	112.0
20	457	78	514	103.0	445	-28.0
21	675	156	559	-114.0	483	5.0
22	922	57	872	-17.0	815	31.0
23	599	-162	539	-151.0	601	23.0

Figure 4-6

RELATIVE PREDICTIVE ACCURACY VS. ACTUAL LEVEL OF CRIME:
23 CLUSTERS; QUARTERLY DATA



CHAPTER V

EVALUATION PROCEDURES

This chapter defines the various procedures used in evaluating the manpower experiments in the next chapter. Discussion centers on the measurement of manpower resources, measurement of deterrent effects within the test zone, measurement for spatial displacement effects to peripheral areas, measurement of temporal displacement effects, and measurement of lead and lag effects within the experimental zone.

MEASUREMENT OF MANPOWER

There are problems inherent in attempting to define and measure the manpower variable. First, the difficulty in defining the experimental manipulation is that it can be defined in more than one way. For example, it might be defined as an increase in preventive patrol activities, or more broadly, as an increase in conspicuous police presence. Second, although it would be of interest to examine the effects of the experimental manipulation under either definition, there is still the problem of measuring these variables. Determination of the experimental influence upon the level of crime is most meaningful when comparisons can be made between normal and test levels of the experimental variable. In other words, an evaluative study should be able to measure the relative increase in preventive patrol activities or conspicuous police presence associated with the observed change in the level of crime. But measurement is no easy matter. The problem involves assigning a relative measure to each type of resource and the lack of necessary data for making such an assignment.

If the experimental variable is defined as the level of conspicuous police presence, the entire mix of visible police resources must be considered. This would include patrol cars (one and two-man), footmen, and scooters. Determining a relative measure of visible police presence would require an estimate based upon the mix of resources. The estimate would have to account for such things as man-hours (or man-days) expended and perhaps some relative weighting of visibility depending upon the type of resource. For example, one hour of scooter activity might have a higher visibility index than one hour of foot patrol.

If the experimental variable is defined as the level of preventive patrol activity, a similar type of measure would have to be developed. Again the measure would have to account for the type of resource, the duration of service, and the assigned activity. As discussed earlier, some resources are assigned solely to preventive activities; others are not.

Another measurement problem is the intangible aspect of the quality of an officer. Quality is an important characteristic which influences the effectiveness of police presence. Merely increasing the number of police officers in an area is no guarantee of reduced crime. The way in which officers perform their duties is a significant factor. In addition, the relationship between the police and community can influence the effectiveness of manpower allocations.

Once the experimental variable has been selected and a satisfactory measurement technique has been identified, there is the problem of data. Police records generally will provide reasonable data on beat structures and manhours expended. This might suffice if police presence is the experimental variable. However, if preventive patrol activity is the chosen variable, this type of data is not adequate. Such was the case in the current study.

Due to both the definitional and measurement problems, manpower data is presented in the next chapter on the basis of assigned resources. For each month, data is presented which reflects the assigned levels of each type of resource operating within the test zone. Data was gathered from daily assignment sheets and is presented for both the involved district and the Tactical Branch. In addition, resources are designated as being either response oriented (scout cars) or prevention oriented. Naturally, all Tactical Branch resources are of the latter category.

MEASUREMENT OF DETERRENT EFFECT

Various critera may be used to judge the effectiveness of crime-control programs. The primary criterion used in this study was the impact upon Index offenses. As indicated earlier, Index offenses are often used as a proxy measure for the crime trend. It is believed that measurement of the incidence in Index offenses reflects the general trend in the more serious types of crime against property and persons.

To determine the impact upon crime levels, expected levels of Index offenses were computed for each reporting area involved in the experiment. The expected levels were computed using the crime-correlated area technique, and potential predictor areas were selected as described in Chapter III. Actual levels of Index offenses were compared with expected levels for the month of the saturation, and deviations were computed. The objective was to determine, by statistical evaluation, whether the difference can be reasonably attributed to the increased manpower. Thus, ninety-five percent confidence intervals were established around the point estimates to determine if any significant difference existed between the actual and expected levels. In the presentation of the results, those deviations which were found significantly large are indicated by means of an asterisk. It should be realized that nothing can be inferred from the direction of the deviation unless it is significantly large.

Analysis of the effectiveness of a crime-control program is more meaningful if one can determine the impact upon particular types of crime. For example, it would be more meaningful for police departments to know that certain types of manpower allocations have a definite impact upon some types of crime, and little or no effect upon other types. An analysis of the impact upon a group of offense categories might conceal the actual interrelationships which exist between crime-control efforts and criminal behavior. Thus, in addition to examining the general impact upon crime through an analysis of Index offenses, selected Index crimes were studied to determine their response to the increases in manpower. The analysis consisted of estimating expected levels of each crime type for the entire experimental zone, and comparing these levels with actual levels. Deviations were computed and significant differences were noted, based upon a ninety-five percent confidence interval established around the point estimate.

DISPLACEMENT EFFECTS

Examination for Spatial Displacement Effects

In order to investigate the likelihood of displacement effects, Index offense levels were studied for the first layer of reporting areas surrounding the test zone. Looking at the first layer of reporting areas presumes that displacement effects might be localized, very near the area of the crime-control program. If the displacement phenomenon exists and is not localized, this analysis would not detect it. The analysis in this portion of the study was similar to that used for reporting areas within the experimental zone. Assuming no intervention by other crime-related influences, a significant increase in actual offense levels over expected levels should be largely attributed to a displacement effect. On the other hand, a significant decrease might be viewed as evidence of a pervasive deterrent influence extending beyond the geographical boundaries of the crime-control program.

Expected levels of Index offenses were computed for each peripheral reporting area and confidence intervals were established around the estimate. These were compared with actual levels to determine if any significant difference existed. In addition, expected levels of selected Index crimes were computed for the peripheral zone, as a whole, in order to examine for movement of particular types of crime.

Examination for Temporal Displacement

Since the increases in manpower were restricted to two shifts during each day (8:00 a.m. - 4:00 p.m. and 4:00 p.m. - 12:00 a.m.), temporal displacement could have occurred. This belief follows from the contention that potential offenders might delay committing a crime until the additional manpower are removed. Thus it was suspected that the low manpower period (12:00 a.m. - 8:00 a.m.) might have evidenced increases in crime. In order to examine for such temporal displacement, the time-distribution of offenses was observed for the same month during the previous two years. It was decided that the experiences during the same month in the last two years would serve as the best estimate of the expected distribution of crime for the month of the experiment.

To test for temporal displacement, crimes were classified as occurring either during the high manpower period (8:00 a.m. - 12:00 a.m.) or the normal manpower period (12:00 a.m. - 8:00 a.m.). Data was first examined to determine whether the percentage of crime occurring during the normal manpower period had changed significantly from the expected percentage (based upon the previous two years). A chi-square test of independence of classification, using Yate's correction for continuity, was conducted with the data, as presented below. The first and second rows represent

12:00 a.m. - 8:00 a.m.	$n_{11} + n_{12}$	n_{13}
8:00 a.m. - 12:00 a.m.	$n_{21} + n_{22}$	n_{23}

where: n_{ij} = the number of offenses occurring during the i^{th} time period and j^{th} year for the month of interest

the crime levels during the 12:00 a.m. - 8:00 a.m. and 8:00 a.m. - 12:00 a.m. periods respectively. The sum contained in column one represents the experiences during the same month in the previous two years. Column two presents the experiences during the experimental period. The chi-square test was conducted for the test zone as a whole, and for each individual reporting area belonging to the test zone.

It was recognized that a significant change in the percentage of crimes occurring during the two time periods does not necessarily indicate a time displacement. For example, the data presented below indicated a situation in which the number of offenses is fifteen less than expected during the high manpower period. Although there

	Expected	Actual
12:00 a.m. - 8:00 a.m.	10	10
8:00 a.m. - 12:00 a.m.	20	5

is no difference between the expected and actual levels during the normal manpower period, the percentage of total crime occurring during that period has risen significantly (.33-.67). And, it would be a misinterpretation of the results to conclude that a time displacement had occurred within the area.

On the other hand, if no significant difference has been identified, one can more safely conclude that there has been no temporal displacement. This conclusion is valid whether there has been a significant increase or decrease, or no significant change in the level of crime within an area. If there has been a significant increase in crime within the area, and no significant change in the time distribution, the conclusion is that the net increase has been distributed between the two periods as expected. If the area has incurred a signficant decrease in crime, the conclusions would be that the net decrease has been spread, according to previous experience, between the two time periods. This latter conclusion can be interpreted as perhaps indicating a pervasive deterrent influence associated with the added manpower, into the normal manpower period.

In summary, significance in the chi-square test requires further examination of such factors as the direction of the change and the net change in the level of crime for the month, prior to forming any conclusions about temporal displacement. On the other hand, if there is not a significant difference in the chi-square test, one may conclude that offenses were distributed as expected.

EXAMINATION FOR LEAD-LAG EFFECTS

As another evaluative measure, the trend in Index offenses was examined by a seven-day moving average. The seven-day average was chosen to dampen the sporadic fluctuations which typically occur in daily offense data. The seven-day average also smooths the fluctuations which are common by day of the week. Crime on weekends generally is higher than the rest of the week. It was believed that a plot of the moving average would reflect the trend in crime before, during, and after the experimental period. In addition, such a plot may aid in identifying any lead time period between initiation of the program and response in the level of crime. Also, it was hoped that lag, or residual, effects of the experiment, if they exist, would be reflected in such a plot.

CHAPTER VI

RESULTS OF THE MANPOWER EXPERIMENT

This chapter presents the results of the three one-month manpower experiments. The format of the chapter is such that results are presented for each month in their entirety before discussing those for the next experimental period. Due to the fact that various types of analyses were conducted for each period, the author believes that consolidation and presentation of all results for one period at a time will enhance the reader's understanding of the integrated effects.

Each monthly evaluation includes the changes in manpower levels, the impact upon aggregate Index offense levels, and the impact upon specific types of Index offenses. In addition results are presented which test for the existence of spatial displacement effects and temporal displacement effects. Finally, a plot of a seven-day moving average of Index offense levels is presented in an effort to identify trend effects.

AUGUST EXPERIMENT

The first manpower experiment was conducted in the Fifth District and involved eight reporting areas.

Manpower Changes

Fifth District allocations and Tactical Branch deployments are noted below for the month of August. Note that the data is presented in terms of unit-tours and man-tours. A unit-tour would be any patrol unit assigned for an eight hour tour of duty, regardless of the number of men assigned to the unit. A two-man scout car would represent one unit. By the same token a two-man scout car assigned for an eight hour tour of duty represents two man-tours. In terms of general increase in visibility within the district, the 38.35 unit-tours per day added by the Tactical Branch represents approximately 72% increase over the district's 53.2 unit-tours per day. Notice that this computation weights the relative visibility of different types of units as equal. In terms of man-tours, the 64.4 daily average represents almost a 92% increase over the district average of 70.0. Excluding the scout cars as providing any significant preventive patrol activity, the 38.35 unit-tours per day represent a 139% increase in units assigned to preventive patrol above the district average of 27.8 unit-tours. Or in terms of man-tours assigned to preventive patrol, the 64.4 represents a 232% increase over the district average of 27.8.

TABLE 6-1

AUGUST MANPOWER DEPLOYMENTS (TOURS)

	District Allocations			Tactical Branch Allocations		
	Unit-Tours	Daily Avg.	Average Man-Tours	Unit-Tours	Daily Avg.	Average Man-Tours
2-Man Scout Cars	521	16.8	33.6	-----	-----	------
1-Man Scout Cars	268	8.6	8.6	-----	-----	------
2-Man Patrol Cars	---	-----	----	807.5	26.05	52.1
1-Man Patrol Cars	---	----	----	381.0	12.3	12.3
Foot Patrols	793	25.6	25.6	-----	----	------
Scooter Patrols	69	2.2	2.2	-----	----	------
	1652	53.2	70.0	1188.5	38.35	64.4

Effects Within The Test Zone

Impact Upon Aggregate Index Offenses - Table 6-2 indicates the actual and expected levels of Index offenses, as well as the deviations between the two, for each reporting area in the test zone during the experimental period.

In five of the eight test areas actual levels of Index offenses were less than expected levels. In two of the five cases, the differences were significant at the .05 level. In contrast, three of the eight comparisons resulted in actual levels being greater than expected levels. In one of the three instances, the difference was significant. Figure 6-1 shows the relative locations of the test reporting areas and summarizes these results. Areas reflecting increases in crime are shaded.

TABLE 6-2

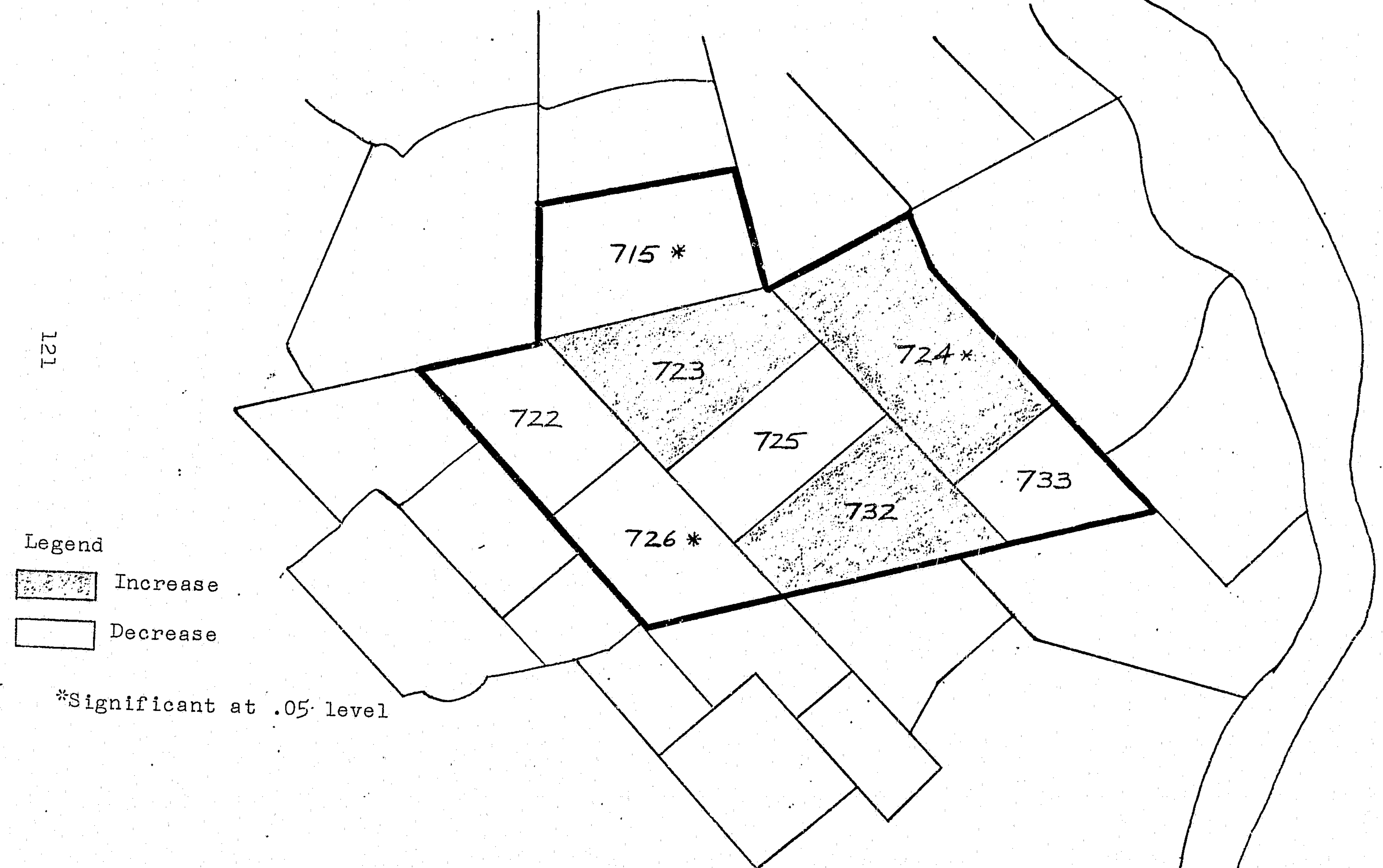
A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF TOTAL INDEX OFFENSES - AUGUST TEST ZONE

Reporting Area	Actual Level	Expected Level	Deviation
715	31.0	41.0	-10.0*
722	51.0	57.6	- 6.6
723	45.0	41.5	3.5
724	85.0	49.8	35.2*
725	25.0	29.7	- 4.7
726	49.0	60.2	-11.2*
732	35.0	32.1	2.9
733	19.0	20.7	- 1.7

*Indicates that actual and expected level were found to be significantly different at the .05 levels of significance.

Figure 6-1

AUGUST TEST AREAS



Impact Upon Specific Index Offenses - Table 6-3 presents a comparison between actual and expected levels of specific Index offenses. These figures reflect incidence rates for the total test zone, and are not broken out by specific reporting area.

TABLE 6-3

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC INDEX OFFENSES FOR THE ENTIRE AUGUST TEST ZONE

Offense	Actual Level	Expected Level	Deviation
Robbery	109.0	106.0	3.0
Burglary	116.0	105.8	10.2
Aggravated Assault	31.0	35.0	- 4.0
Auto Theft	66.0	81.5	-15.5

Actual levels of these offenses, when compared with expected levels, were lower for aggravated assault and auto theft, but higher for robbery and burglary. In no case, though, was the difference statistically significant at the .05 level.

Examination for Spatial Displacement Effects

In order to investigate the likelihood of spatial displacement, Index offense levels were examined for the first layer of thirteen reporting areas surrounding the test zone. Expected levels of crime were estimated using the same procedures as used with the test areas. Table 6-4 presents the results.

TABLE 6-4

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF OF INDEX OFFENSES FOR AUGUST: PERIPHERAL REPORTING AREAS

Reporting Area	Actual Level	Expected Level	Deviation
510	11.0	23.8	-12.8*
511	19.0	25.4	- 6.4
512	26.0	22.7	3.3
513	11.0	19.9	- 8.9*
711	18.0	14.4	3.6
712	24.0	19.7	4.3
713	24.0	30.1	- 6.1
714	35.0	34.3	.7
716	18.0	13.2	4.8*
721	20.0	17.8	2.2
727	20.0	27.9	- 7.9
728	13.0	18.2	- 5.2
736	0.0	0.0	0.0

*Significantly different at the .05 level

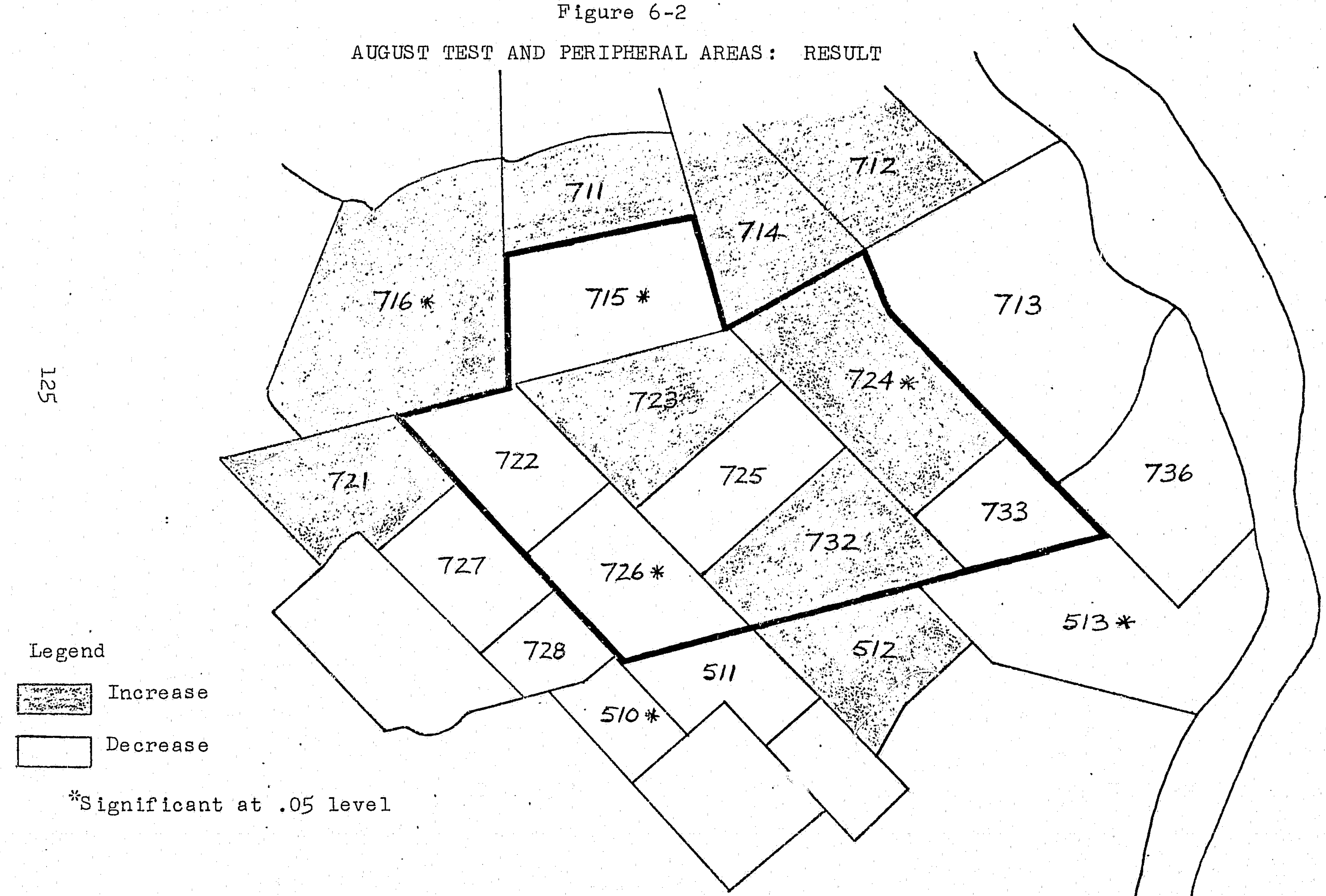
In six of the thirteen peripheral areas, actual levels of Index offenses were lower than expected levels. In six other areas actual levels were higher than expected levels (the thirteenth reporting area is essentially a zero-crime area surrounding D.C. General Hospital). Two of the peripheral areas registered significant decreases in Index offenses while one area showed a significant increase. Figure 6-2 presents composite results for both the test and peripheral zones.

In examining the peripheral reporting areas, there was no evidence of general displacement effects. For one cluster of peripheral areas (721, 716, 711, 714, and 712), point estimates indicated an increase in Index offenses. But of these five areas, only one (716) registered a significant increase. It is noteworthy to observe that three of the five areas (including reporting area 716) are adjacent to reporting area 715, which had a significant decrease in crime. It can only be suggested that this offers evidence of possible displacement effects.

Another cluster of peripheral areas (727, 728, 510, and 511), registered decreases in reported Index offenses. Of these, reporting area 510 was the only one realizing a significant decrease. It is interesting to note that these four areas, along with test areas 722 and 726, form a contiguous area recording decreases in crime. The results might infer an extension of the deterrent effect beyond the borders of the test area.

Figure 6-2

AUGUST TEST AND PERIPHERAL AREAS: RESULT



In order to examine for movement of particular types of crime, expected levels of specific Index offenses were computed for the composite area made up of the first layer of peripheral reporting areas. The comparisons between expected and actual levels are presented in Table 6-5.

TABLE 6-5

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC INDEX OFFENSES FOR TOTAL PERIPHERAL ZONE - AUGUST

Offense	Actual Level	Expected Level	Deviation
Robbery	61.0	75.5	-15.5*
Burglary	93.0	90.4	3.6
Aggravated Assault	27.0	22.0	5.0
Auto Theft	49.0	102.0	-53.0*

*Significant at .05 level

In the composite area, made up of the first layer of peripheral reporting areas, there was no evidence of significant inflows of particular types of crime. It is interesting to note significant decreases in robbery and auto theft within the group of peripheral areas. These decreases were most notable in the previously mentioned group of four reporting areas which recorded decreases in reported Index offenses.

Examination for Temporal Displacement

A chi-square test for changes in the time distribution of offenses was conducted as discussed in Chapter V. The percentage of offenses occurring during the high manpower and normal manpower periods was compared with expected percentages, based upon the same month in the previous two years. No significant difference was found for the total test zone or for any of the individual reporting areas.

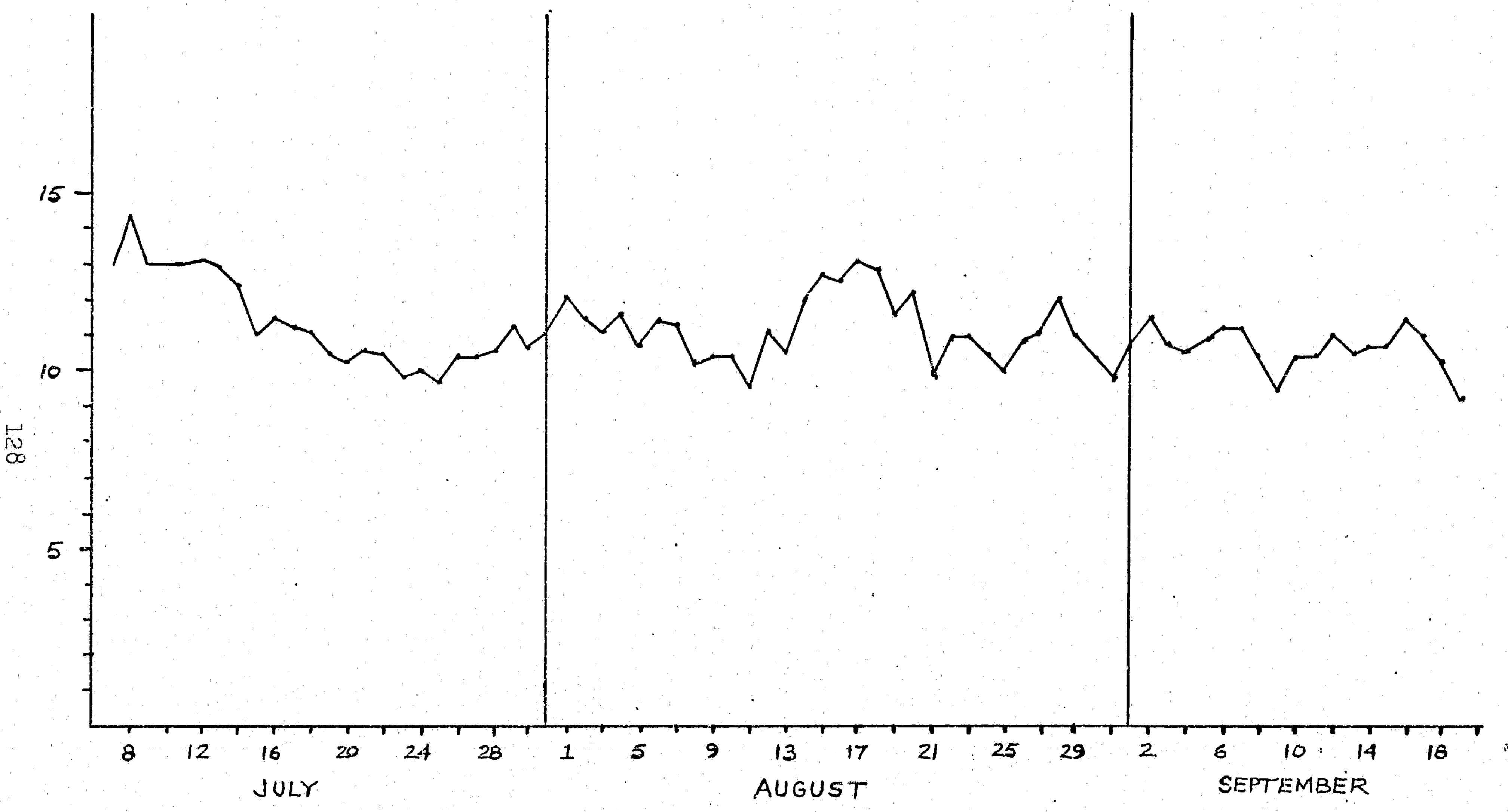
Thus, there was no evidence of any change in the time distribution of crime. In reporting areas 715 and 726, where significant decreases were noted in monthly Index offenses, it can be assumed that the decreases were not distributed between the two time periods in an unexpected manner. Similarly the significant increase in crime in reporting area 724 can be assumed to have been distributed between the two time periods in a manner not significantly different from historical distributions.

Crime Trend

Figure 6-3 presents a graph of the seven-day moving average for Index offenses for the entire test zone. As can be seen, there was no significant downward trend in Index offenses. Compared with July, there appeared to be very slight declining trend during the first eleven days. This was followed by an upward movement during the middle of the month and a leveling off during the end of the month. Although there were sporadic fluctuations in the average, the overall trend appeared fairly stable, offering no particular signs of a deterrent effect during the period of increased manpower.

Figure 6-3

7-DAY MOVING AVERAGE: AVERAGE TEST ZONE



SEPTEMBER EXPERIMENT

The second manpower experiment occurred in the First District and involved twelve reporting areas.

Manpower Changes

First District and Tactical Branch deployments are presented in Table 6-6. In terms of general increase in visibility within the district, the 38.1 unit-tours per day added by the Tactical Branch represents an increase of 130% over the district's 29.31 unit-tours per day. In terms of man-tours, the 64.7 daily average represents an increase of approximately 137% over the district average of 46.69. Looking at the primary preventive patrol resources, the 38.1 unit-tours per day by the Tactical Branch represents an increase of almost 350% in units assigned to preventive patrol activities. The level for the district was 10.92 unit-tours per day. Or expressing the level of preventive patrol activity in terms of man-tours, the 64.7 represents an increase of almost 400% over the district daily average of 16.24.

TABLE 6-6

SEPTEMBER MANPOWER DEPLOYMENTS (TOURS)

	District Allocations			Tactical Branch Allocations		
	Unit-Tours	Daily Avg.	Average Man-Tours	Unit-Tours	Daily Avg.	Average Man-Tours
2-Man Scout Cars	362	12.06	24.12	-----	-----	-----
1-Man Scout Cars	190	6.33	6.33	-----	-----	-----
2-Man Patrol Cars	61	2.06	4.12	800	26.6	53.2
1-Man Patrol Cars	----	-----	-----	345	11.5	11.5
1-Man Foot Patrols	85	2.83	2.83	-----	-----	-----
2-Man Foot Patrols	98	3.26	6.52	-----	-----	-----
Scooter Patrols	83	2.77	2.77	-----	-----	-----
	879	29.31	46.69	1145	38.1	64.7

Effects Within the Test Zone

Impact Upon Aggregate Index Offenses - Actual and expected levels of Index offenses, as well as deviations between the two, are indicated in Table 6-7.

In eight of the twelve test areas, actual levels of Index offenses were less than expected levels. In five of these eight cases, the differences were significant at the .05 level. The other four test areas resulted in actual levels being greater than expected, with one of the four - area 425 - being significantly greater. In viewing Figure 6-4 the decreases seemed to be recorded around the border of the test zone. The increases, with the exception of area 505, occurred in a pocket of contiguous areas (425, 426, and 729).

Whereas the August test did not offer evidence of a general decrease in crime, the September effort seems to reflect evidence of a more widespread decrease in Index Offense levels.

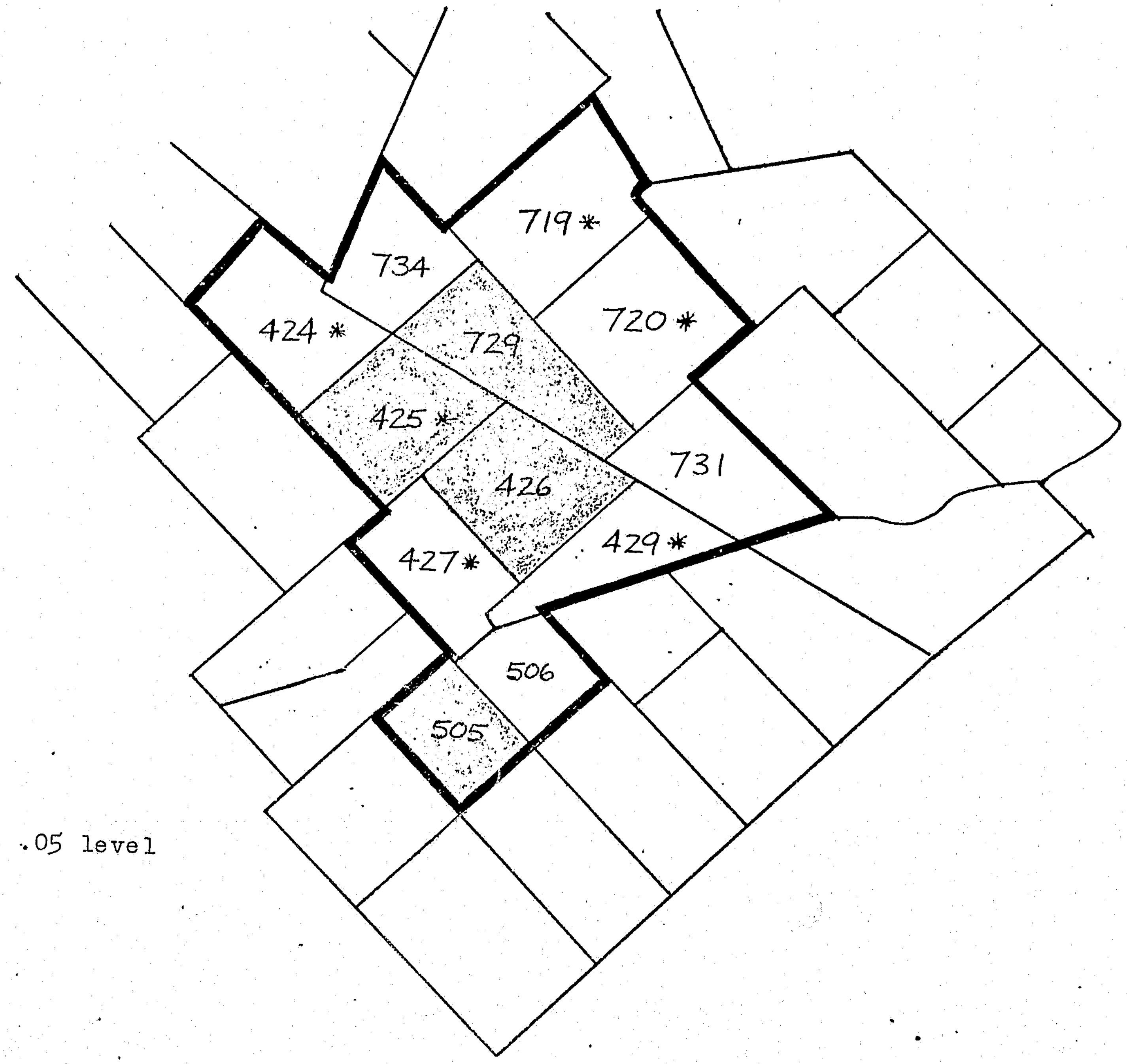
TABLE 6-7

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF TOTAL INDEX OFFENSES - SEPTEMBER TEST ZONE

Reporting Area	Actual Level	Expected Level	Deviation
424	17.0	26.8	- 9.8*
425	36.0	17.1	18.9*
426	23.0	18.8	4.2
427	17.0	39.0	-22.0*
429	8.0	16.0	- 8.0*
505	44.0	43.8	.2
506	14.0	16.6	- 2.6
719	26.0	39.1	-13.1*
720	23.0	35.0	-12.0*
729	19.0	15.5	3.5
731	13.0	16.8	- 3.8
734	15.0	20.3	- 5.3

*Actual and expected levels significantly different at the .05 level of significance.

Figure 6-4
SEPTEMBER TEST AREAS: RESULTS



Legend

Increase

Decrease

*Significant at .05 level

Impact Upon Specific Index Offenses - Table 6-8 indicates the results of the test concerning the impact upon four selected Index offenses. In all categories except aggravated assault, the actual

TABLE 6-8

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC OFFENSES FOR THE ENTIRE SEPTEMBER TEST ZONE

Offense	Actual Level	Expected Level	Deviation
Robbery	101.0	114.0	-13.0
Burglary	77.0	105.9	-28.9*
Aggravated Assault	35.0	22.4	12.6*
Auto Theft	30.0	32.5	- 2.5

*Significantly different at the .05 level

levels of the offense were less than expected levels. Burglary was down significantly. Aggravated assault, on the other hand, registered a significant increase.

Examination for Spatial Displacement Effects

The seventeen reporting areas bounding the test zone were examined to determine whether any spatial displacement was apparent. Table 6-9 reflects the results.

As can be seen in Figure 6-5, the first layer of peripheral areas recorded a general decline in Index offenses. In all but four reporting areas, actual crime was less than expected levels. Of the thirteen areas which recorded decreases, ten were found to be significantly lower than expected.

TABLE 6-9

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF INDEX OFFENSES FOR SEPTEMBER: PERIPHERAL REPORTING AREAS

Reporting Area	Actual Level	Expected Level	Deviation
416	17.0	14.9	2.1
417	18.0	25.7	- 7.7
423	41.0	53.7	-12.7*
428	25.0	42.0	-17.0*
504	31.0	41.8	-10.8*
507	10.0	7.6	2.4
508	3.0	6.7	- 3.7*
509	8.0	10.8	- 2.8*
521	31.0	31.3	- .3
522	20.0	26.3	- 6.3*
523	29.0	47.8	-18.8*
532	24.0	21.5	2.5
630	32.0	46.9	-14.9*
717	31.0	28.5	2.5
718	13.0	21.7	- 8.7*
721	10.0	18.8	- 8.8*
730	9.0	11.3	- 2.3

*Significantly different at the .05 level

Figure 6-5

SEPTEMBER TEST AND PERIPHERAL AREAS: RESULTS

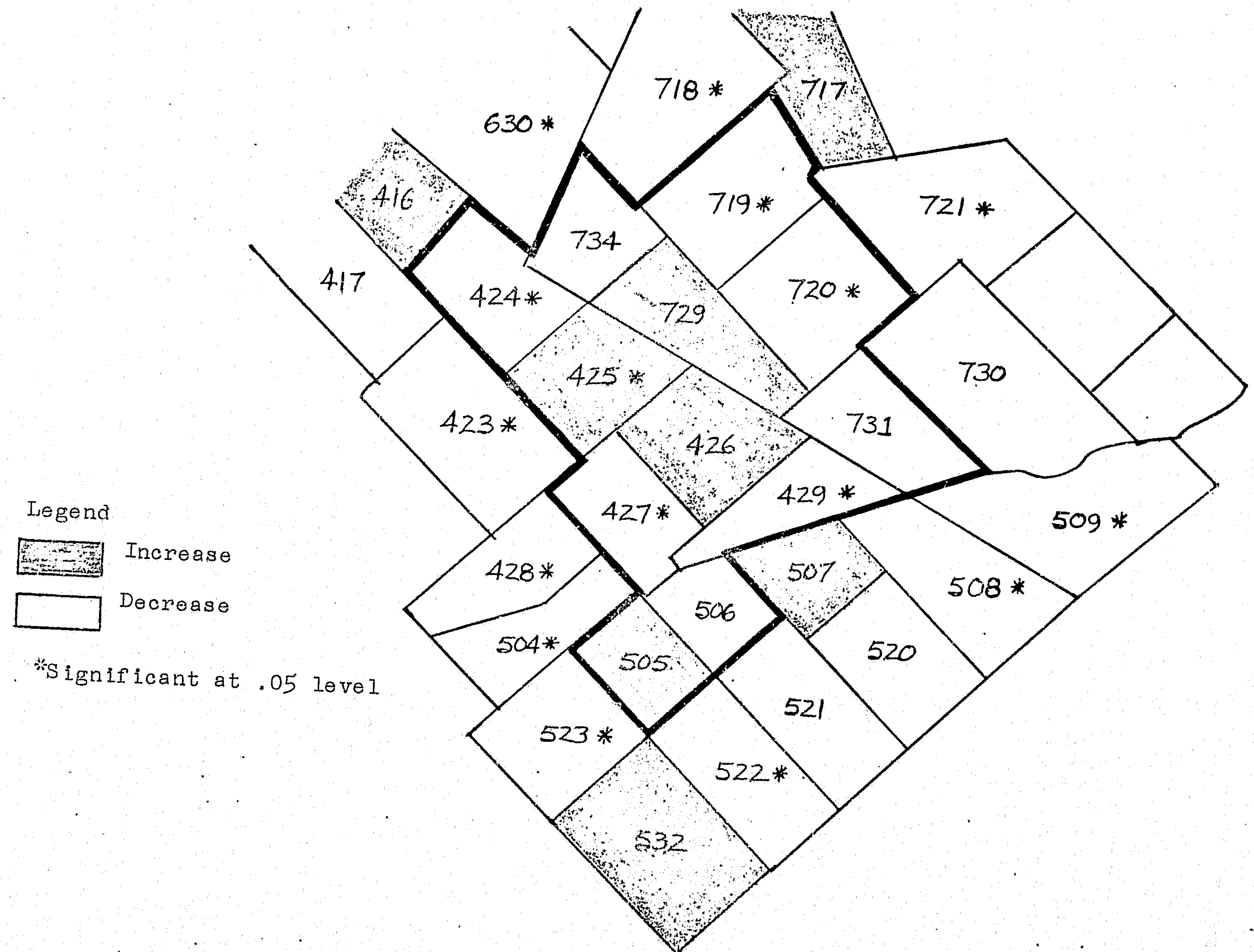


Table 6-10 indicates the impact upon four Index offenses within the composite area made up of the first layer of peripheral reporting areas. In all four crime categories, actual levels of

TABLE 6-10

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC INDEX OFFENSES FOR TOTAL PERIPHERAL ZONE - SEPTEMBER

Offense	Actual Level	Expected Level	Deviation
Robbery	112.0	162.6	-50.6*
Burglary	111.0	135.0	-24.0
Aggravated Assault	27.0	29.7	- 2.7
Auto Theft	62.0	71.8	- 9.8

*Significant at .05 level

incidence were lower than expected. The actual level of robbery was found to be significantly different than the expected level. The deviation between the actual and expected level of burglary was large (-24.0), but it was not judged significant due to a large standard error term associated with the estimate.

The evidence presented in these results seems to deny the existence of displacement effects in the first layer of bordering reporting areas. Contrary to a displacement phenomenon occurring in this set of areas, the results tend to imply a pervasive influence of the crime-control program beyond the boundaries of its application.

Examination for Temporal Displacement

In testing for significant changes in the percentage of crimes occurring in the high and normal manpower periods, no significant changes were found for the test zone as a whole or for any of the included reporting areas. Thus, the same types of conclusions can be suggested regarding reporting areas 424, 425, 427, 429, 719 and 720, as were made in the August experiment.

Crime Trend

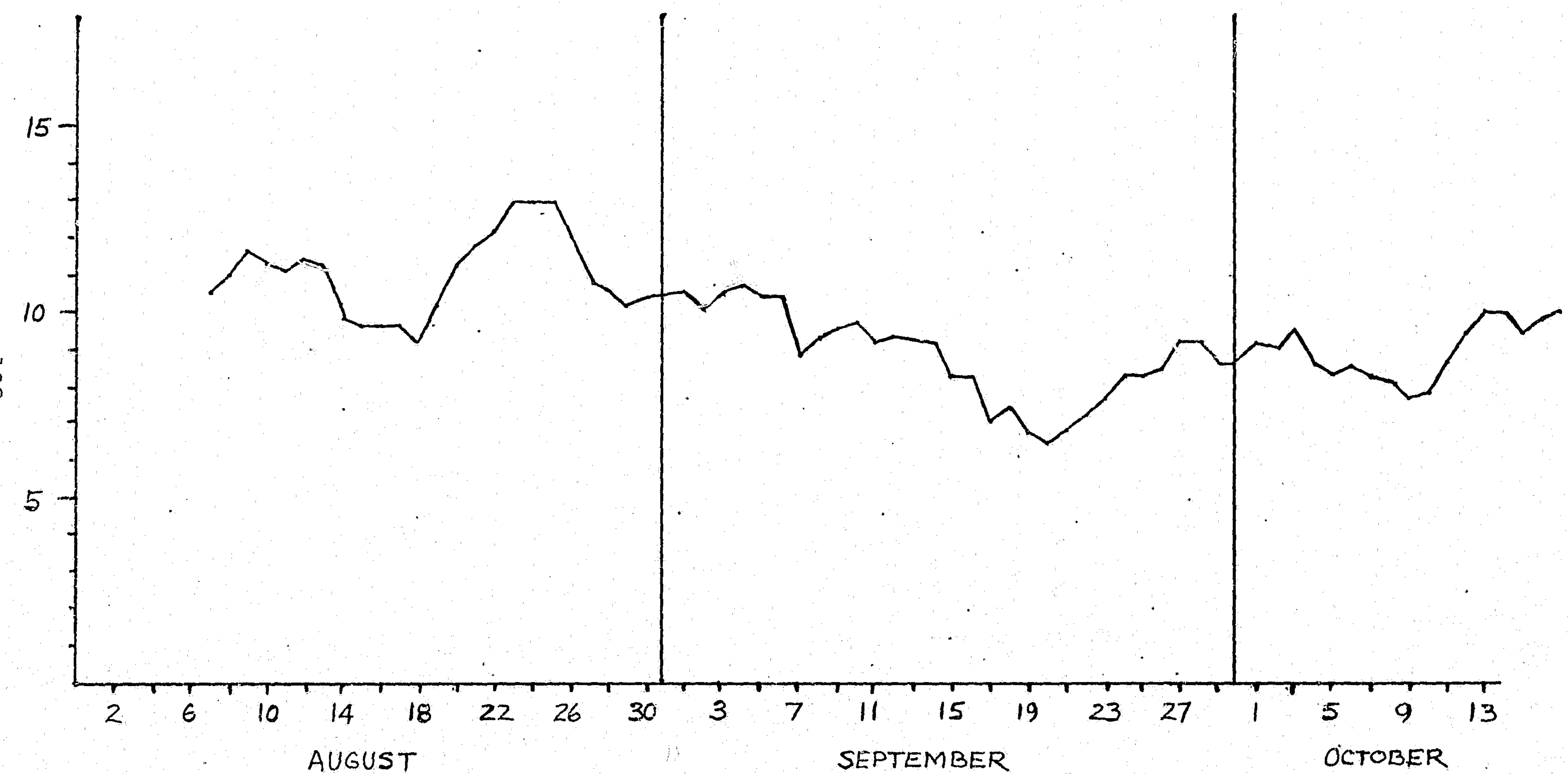
As can be seen in Figure 6-6, there existed a definite downward trend in Index offenses during the first 20 days of September. Although there is evidence that crime levels did not respond immediately to the influence of increased manpower, the general downturn of crime seemed to begin around the fifth day of the month. For the remainder of the month, beyond the first 20 days, the trend reversed, climbing upward toward previous levels. It should be observed that the average never quite attained the level that had existed prior to initiation of the manpower experiment. And, although there seemed to be a slight downward trend during the early part of October, it would be quite difficult to attribute this movement to any lag effect created by the manpower experiment.

NOVEMBER EXPERIMENT

The final manpower experiment selected for study occurred in the Third District during November of 1970.

Figure 6-6

7-DAY MOVING AVERAGE: SEPTEMBER TEST ZONE



Manpower Changes

Table 6-11 presents manpower deployments for the Third District and Tactical Branch for the month of November. As a measure of the general increase in visibility, the 34.26 represents about a 63 percent increase over the district's 54.39 unit-tours per day. Or in terms of man-tours, the 59.36 represents almost a 71 percent increase over the district average of 83.91. With reference to preventive patrol resources, the 34.26 unit-tours for the Tactical Branch represents an increase of almost 145 percent above the district average of 23.81 unit-tours per day; or, the 59.36 man-tours per day represents an increase of almost 210 percent above the district average of 28.33 man-tours.

TABLE 6-11

NOVEMBER MANPOWER DEPLOYMENTS (TOURS)

	District Allocations			Tactical Branch Allocations		
	Unit-Tours	Daily Avg.	Average Man-Tours	Unit-Tours	Daily Avg.	Average Man-Tours
2-Man Scout Cars	775.5	25.0	50.0	-----	-----	------
1-Man Scout Cars	173.	5.58	5.58	-----	-----	------
2-Man Patrol Cars	140.	4.52	9.04	779.5	25.1	50.2
1-Man Patrol Cars	76.	2.50	2.50	266.	8.58	8.58
Foot Patrols	210.5	6.78	6.78	18.	.58	.58
Scooter and Motorcycle Patrols	314.0	10.01	10.01	-----	-----	-------
	1689.0	54.39	83.91	1063.5	34.26	59.36

Effects within the Test Zone

Impact Upon Aggregate Index Offenses - Seventeen reporting areas were involved in the experiment. Table 6-12 contains the results of the experiment within the test areas. In eleven of the seventeen reporting areas, actual levels of Index offenses were less than expected levels. In four of the eleven areas, the differences were significant at the .05 level. It might be observed that the differences between actual and expected levels were rather large for reporting areas 418 and 420. The standard error terms for these predictions, though, were too large to conclude the existence of a significant difference. Of the six areas in which actual levels were greater than expected levels, the differences were significant for reporting areas 337, 428, and 503. Reporting area 414 reflected a fairly large deviation, but as with areas 418 and 420, the standard error term was too large to conclude a significant difference.

Increases in crime during the first half of the month resulted in the addition of three reporting areas to the original group of test areas. The three reporting areas, 337, 413, and 414, bordered the original test area. The relative ineffectiveness of the manpower experiment in areas 337 and 414 might be explained in large part by the increases in Index offenses which occurred during the first sixteen days of the month, prior to the inclusion of the areas in the experiment. The increases in these areas during the first sixteen days also might be indicative of possible displacement effects from the test zone.

TABLE 6-12

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF TOTAL INDEX OFFENSES - NOVEMBER TEST ZONE

Reporting Area	Actual Level	Expected Level	Deviation
337	56.0	40.8	15.2*
340	48.0	43.7	4.3
341	16.0	19.0	- 3.0
344	21.0	22.0	- 1.0
345	31.0	46.9	-15.9*
413	40.0	44.8	- 4.8
414	43.0	33.5	9.5
417	22.0	37.2	-15.2*
418	28.0	40.2	-12.2
419	20.0	21.5	- 1.5
420	20.0	32.1	-12.1
421	30.0	54.8	-24.8*
422	49.0	53.0	- 4.0
423	33.0	38.9	- 5.9
428	51.0	35.9	15.1*
503	31.0	21.8	9.2*
504	24.0	38.3	-14.3*

*Actual and expected levels significantly different at the .05 level of significance.

Figure 6-7

NOVEMBER TEST AREAS: RESULTS

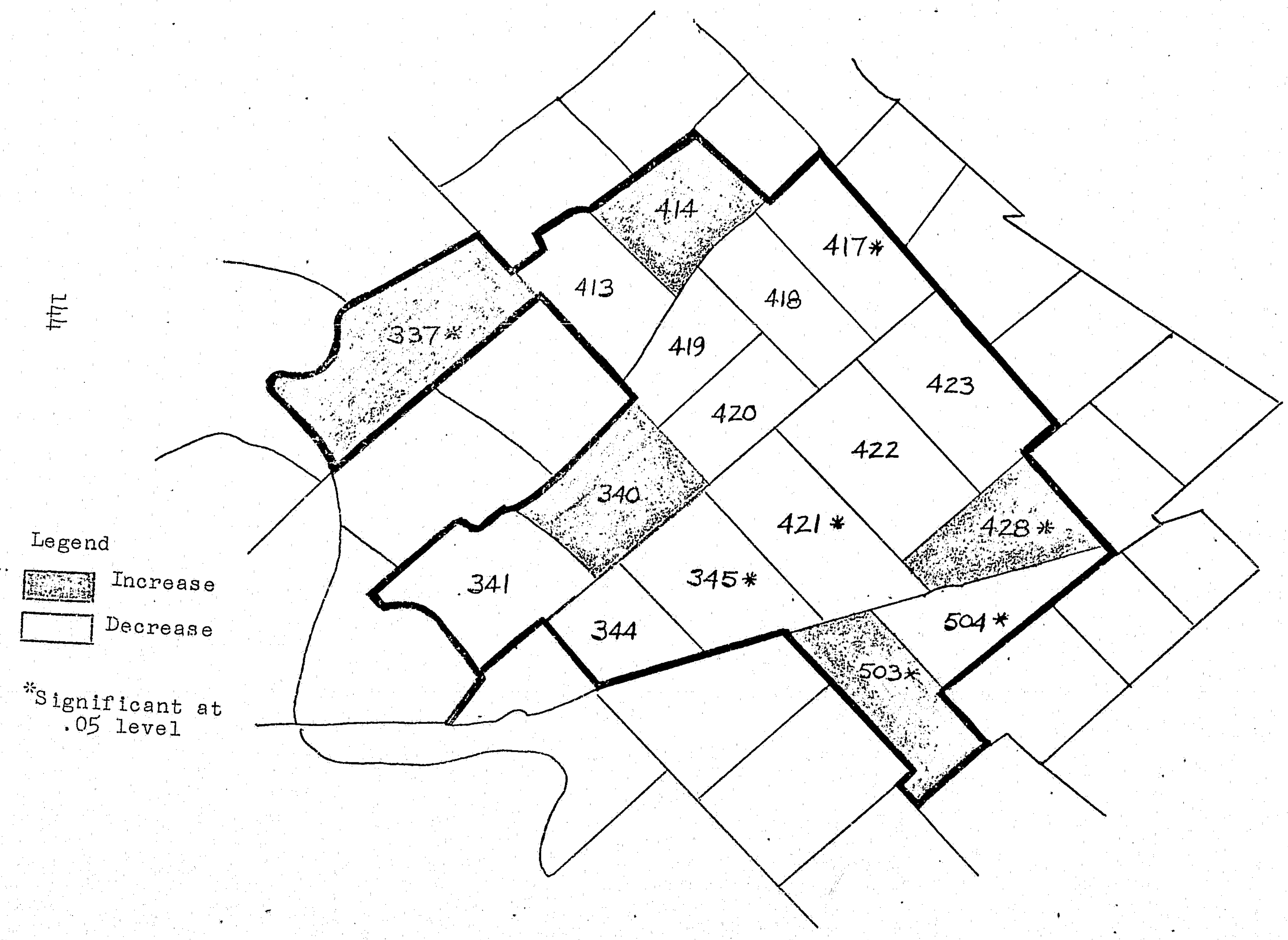
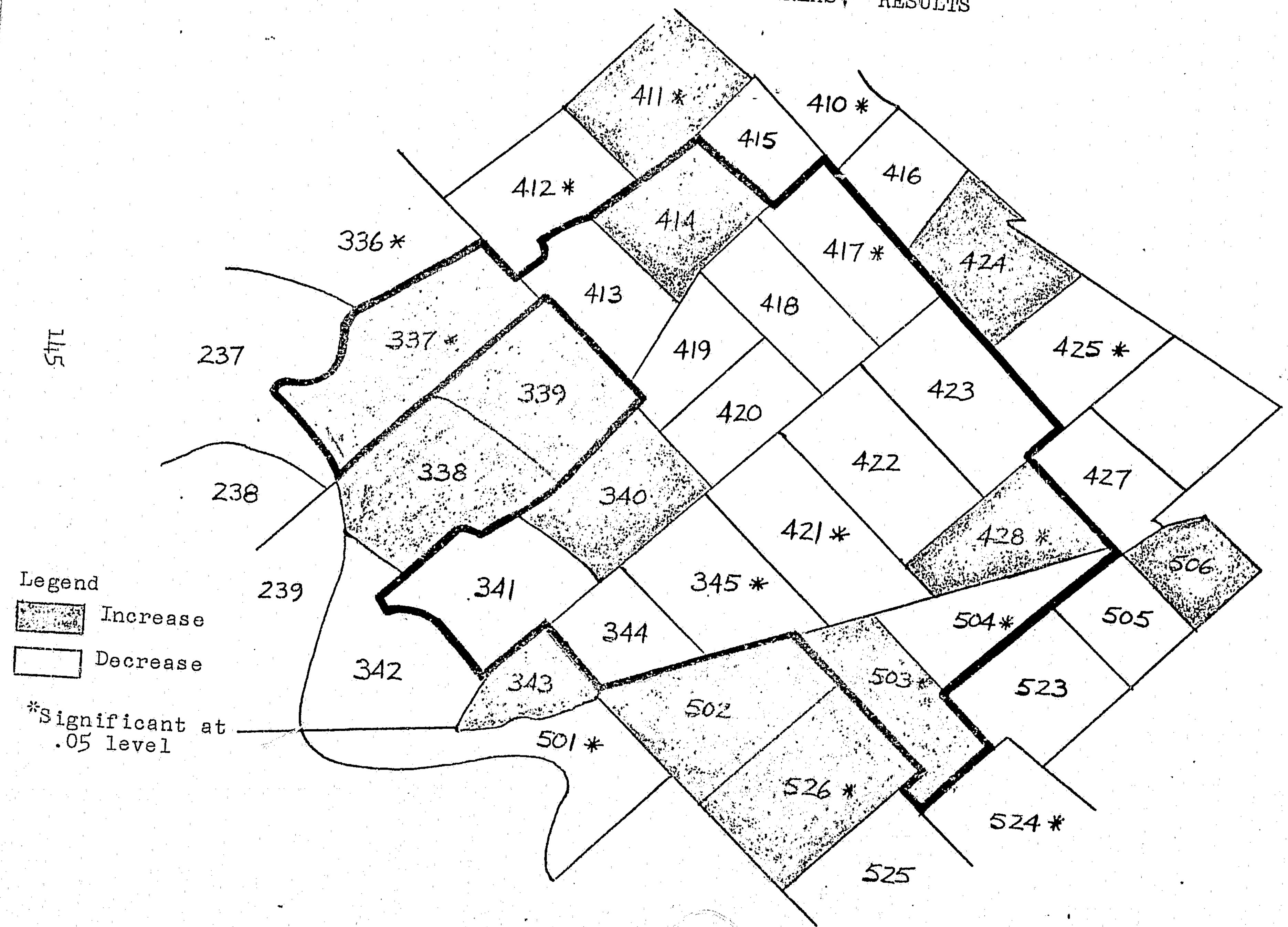


Figure 6-8

NOVEMBER TEST AND PERIPHERAL AREAS: RESULTS



Although the proportion of reporting areas recording significant decreases was not as high as that which occurred during the September experiment, the data reflect a general decrease in Index offense levels within the experimental area.

Impact Upon Specific Index Offenses - Table 6-13 indicates the result of the experiment upon particular types of Index offenses. Normal levels of aggravated assault were considered too low to make meaningful predictions. As can be seen, actual levels of

TABLE 6-13

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC INDEX OFFENSES FOR THE ENTIRE NOVEMBER TEST ZONE

Offense	Actual Level	Expected Level	Deviation
Robbery	177.0	211.7	-34.7*
Burglary	191.0	235.1	-44.1
Auto Theft	56.0	77.3	-21.3

*Significantly different at the .05 level

burglary, robbery, and auto theft were all less than expected levels. Although the deviations were fairly large in magnitude, a statistically significant decrease could be identified only in the case of robbery.

Examination for Spatial Displacement Effects

Table 6-14 contains the results of the experiment for the layer of twenty peripheral reporting areas. In fourteen of the twenty-three reporting areas, actual levels were less than expected levels of crime. In six of these fourteen areas, the differences were significant. Of the nine reporting areas in which actual levels exceeded expected levels, two areas reflected significant increases. It was observed that the expected level for reporting area 410 was high. Although the expected level does not seem out of line when compared with previous years, the level of crime apparently dropped considerably in August of 1970, and did not return to previous levels in the following months. Thus, it seems as if some crime influencing variable had operated upon area 410 in recent months leading up to November. Even though the actual level is significantly less than expected, it would be difficult to credit the manpower experiment entirely for the success.

A general overview of the peripheral area results would, as with September, tend to support the contention that the deterrent effect of the manpower experiment extends beyond the immediate boundaries of patrol. There is the isolated possibility of displacement, as indicated by reporting areas 411 and 526. But little certainty can be attached to such a proposition. Looking at Figure 6-8, it is interesting to note that for every reporting area having a significant increase in crime, there is at least one reporting area, either adjacent to or nearby, which has recorded a significant decrease in crime.

TABLE 6-14

A COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF INDEX OFFENSES FOR NOVEMBER: PERIPHERAL REPORTING AREAS

Reporting Area	Actual Level	Expected Level	Deviation
237	5.0	8.1	- 3.1
239	2.0	3.6	- 1.6
336	41.0	66.2	-25.2*
338	33.0	23.5	9.5
339	25.0	19.5	5.5
342	0.0	.9	- .9
343	3.0	1.5	1.5
410	6.0	14.7	- 8.7*
411	34.0	17.8	16.2*
412	66.0	74.9	- 8.9*
415	4.0	7.0	- 3.0
416	12.0	13.5	- 1.5
424	22.0	19.7	.3
425	12.0	25.9	-13.9*
427	33.0	37.4	- 4.4
501	11.0	22.3	-11.3*
502	33.0	28.8	5.2
505	44.0	45.8	- 1.8
506	20.0	19.7	.3
523	44.0	44.8	.8
524	1.0	3.4	- 2.4*
525	21.0	24.5	- 3.5
526	48.0	30.5	17.5*

*Significantly different at the .05 level

Table 6-15 indicates the impact upon four selected Index offenses for the entire peripheral zone. All four offenses reflected declines. Auto theft was the only offense which incurred a significant decline from the expected level.

TABLE 6-15

COMPARISON BETWEEN ACTUAL AND EXPECTED LEVELS OF SPECIFIC INDEX OFFENSES FOR TOTAL PERIPHERAL ZONE: NOVEMBER

Offense	Actual Level	Expected Level	Deviation
Burglary	191.0	198.6	- 7.6
Robbery	177.0	197.3	-20.3
Auto Theft	56.0	87.7	-31.7*
Aggravated Assault	69.0	74.9	- 5.9

*Significantly different at the .05 level

Examination for Temporal Displacement

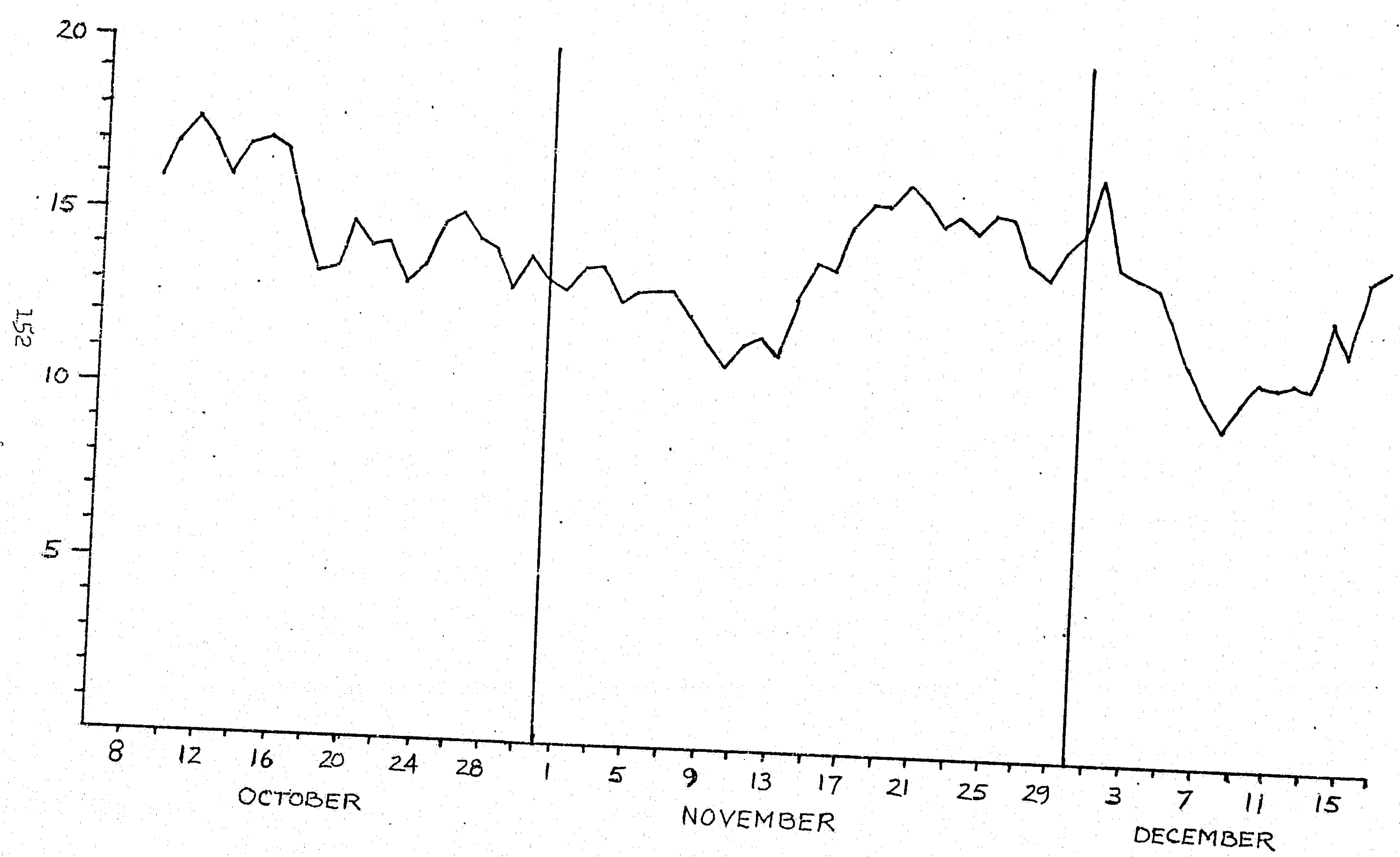
In testing for significant changes in the percentages of crime occurring during the high and normal manpower periods, only one reporting area (503) was found to have incurred a significant change. This area, which was identified earlier as having registered a significant increase in Index offenses during the experiment, had only one offense occur during the normal manpower period; thirty offenses occurred during the heavy manpower period. The fact that a larger percentage of monthly offenses occurred during the heavy manpower period might be attributed to a temporal displacement from the 12:00 a.m. - 8:00 a.m. period, the net increase in crime for the month occurring primarily during the 8:00 a.m. - 12:00 a.m. period, or some combination of the two. In either case, it is contrary to the expected outcome resulting from a crime prevention program.

Crime Trend

Figure 6-9 presents a graph of the seven-day moving average for Index offenses. Review of this plot indicates a definite downward trend during the first ten days of the month. Actually, it appears that the downward trend did not commence until the fourth day of November. This might provide evidence of a lead time period before crime levels responded in a downward manner. Beyond the thirteenth day of the month a pronounced upswing occurs, eventually leveling off around the twenty-first day of the month. At the end of the month there is no apparent deterrent trend in operation. Thus, there would be no evidence to confirm the theory of a lag effect. But, it is interesting to observe the rather dramatic downswing in the average during the first week following the experiment.

Figure 6-9

7-DAY MOVING AVERAGE: NOVEMBER TEST ZONE



CHAPTER VII

SUMMARY AND CONCLUSIONS

The objectives in this research study, as stated in Chapter I, are the following:

1. To develop and validate a crime-modeling technique which will be useful in estimating expected crime levels in evaluative studies.

2. To appraise the strengths and weaknesses of the crime-modeling technique by examining its performance under varying parameters and by comparing its performance with that of more traditional models.

3. To apply the crime-modeling technique in an evaluative study of the impact of intensive police patrol activities.

4. To determine the impact of intensive police patrol activities upon the level of crime within the area of patrol.

5. To examine for the generation of displacement effects (spatial and temporal) as a result of intensive police patrol activities.

6. To develop a model which may be of value in predicting spatial displacement effects and to discuss considerations associated with the development of such models.

This chapter summarizes separately, the development and performance of the crime-correlated area model and the experiences associated with the manpower experiment. Limitations of both are identified, and resulting conclusions are discussed. The reader is referred to Appendix B for a discussion of some considerations in developing a model to predict the spatial displacement of crime. This appendix also presents two hypothetical predictive models.

THE CRIME-ESTIMATION TECHNIQUE

This study has resulted in the development of a model which might prove to be of considerable value in studies which are concerned with evaluating the effectiveness of a crime-control program.

The Development of the Model

The crime-correlated area model is based upon the assumption that there exists a number of crime-related influences which operate upon a city as a whole. Due to the operation of these influences, it is believed that the levels of crime in various areas of a city might fluctuate in a similar manner. Thus, it was argued that the levels of crime between two areas might be highly correlated with one another. If the degree of association is high enough and the standard error of the estimate is within acceptable limits, it was believed that the level of crime within one area might be estimated as a function of the level within another area.

In order to test for the existence of crime-correlated areas, monthly Index crime levels were summarized over a thirty month period for each of the 360 reporting areas within Washington, D.C. Assuming a linear functional form, an exhaustive set of regressions was performed in which monthly Index crimes for each reporting area were correlated with those of each of the remaining 359 reporting areas. The results seemed to confirm the theory that the crime levels between many areas of a city are significantly related to one another. Results also substantiated the secondary hypotheses that two areas could be highly correlated with one another even though they are (1) spatially separated by a considerable distance, (2) dissimilar with regard to average level of crime, and (3) dissimilar with regard to socioeconomic and demographic characteristics.

Multiple Predictor Areas - Although the results supported the hypothesis concerning the existence of crime-correlated areas, the degree of correlation was not believed to be sufficiently high enough for prediction purposes. It was believed, and later demonstrated, that the use of more than one predictor area improves the degree of correlation. The feeling was that a better estimate of the level of crime in a given area might be achieved if it is based upon the experiences of several other reporting areas. Stepwise, linear multiple regression was employed to develop crime estimation models for a set of control areas. Indeed, the degree of correlation was improved, and the standard error term associated with the crime estimates was judged to be small enough for purposes of evaluative studies.

A problem did arise, though, in the process of validating the multiple predictor area technique. In some instances, models were developed which contained a large number of predictor variables (independent variables). These models were characterized by very high multiple coefficients of correlation, very low standard error terms, but poor predictive performance. It was concluded that the process of fitting the regression equations had, in certain cases, resulted in the phenomenon of overfitting. An excellent fit to the sample data points was achieved, but the addition of more independent variables than necessary resulted in a contaminated model. Consequently, these models were not useful in extrapolation for prediction purposes.

Several decision rules were examined which purported to resolve the overfitting problem. Comparison of these with several heuristics resulted in the selection of a decision rule based upon the manipulation of the partial-F criterion for entrance and removal of independent variables. The rule seemed to be successful in preventing overfitting in this particular application of a multiple regression model.

Comparative Analysis - In order to determine the relative performance of the crime-correlated area model, it was compared with three of the more popular crime-estimation techniques. Monthly crime estimates were made by each of the four models for twenty reporting areas over a one-year period. Predictive accuracy was based upon the mean absolute deviation between the actual and estimated crime levels.

The crime-correlated area model and the exponential smoothing model were judged to be the best models, from the standpoint of predictive accuracy. The crime-correlated area model outperformed the exponential smoothing model on the basis of lowest mean absolute deviation for the 240 crime estimates. But further analysis revealed that the two models were very close to one another in their performance. In fact, the exponential smoothing model was the better predictor in seven of the twelve months studied. When results were compared on a reporting area basis, the exponential smoothing model performed best over the twelve-month period for ten of the twenty reporting areas; the crime-correlated area model performed best for the remaining ten reporting areas. A further comparison seemed to indicate that the crime-correlated area model had greater success than the exponential smoothing model in those reporting areas having a high variance in the level of crime.

Further analysis of the crime-correlated area model revealed that the relative accuracy of predictions improves as the level of crime being estimated increases in magnitude. In addition, as might be expected, it was concluded that the relative uncertainty of crime level estimates decreases as the magnitude of the estimate increases.

Performance Under Changing Parameters - The results derived from the comparative analysis implied that the relative performance of the crime-correlated area model is better when the magnitude of crime being estimated is large. In order to explore this further, area and time parameters were varied in the model, and performance was observed. The parameters were varied in three different configurations in order to increase the general magnitude of crime being estimated.

In the first case the size of an area was increased. Whereas in the earlier analysis areas were defined as individual reporting areas, in this variation the area parameter was redefined to represent clusters of contiguous reporting areas. Monthly estimates of Index offenses were made for each cluster over a six-month period. Estimates for any cluster were based upon the levels of Index offenses occurring in one or more of the other clusters. The results indicated that relative prediction error decreased as the actual level of crime increased. There was, however, considerable variability in the relative prediction error at certain levels of actual crime.

In the second change, the time parameter was increased while holding the area parameter the same. Monthly data for reporting areas was transformed into quarterly data and quarterly estimates were made for twenty selected reporting areas. As had been found with the increase in the area parameter, the degree of correlation was very high for the first variable to enter the model. Thus, the quarterly estimates for the twenty reporting areas were based only upon one independent variable. The same performance trends were observed, as had appeared with the twenty-three clusters. Although the relative accuracy was quite variable in a number of cases, this was attributed largely, to the very small sample size (between 7 and 9 quarters of data were used in developing the models).

The final parameter change involved increasing both the area and time parameters simultaneously. Thus, quarterly estimates were made for the previously identified twenty-three clusters. Correlations were even higher than in the previous quarterly estimates, and models were developed, again, with only one independent variable. Performance results were very similar to those in which only the time parameter had been increased.

Conclusions

The results of this analysis indicate that the multiple prediction concept may prove very useful in making ex post facto estimates of expected crime levels within an area. Thus, it can be quite helpful in evaluating crime-control programs such as manpower studies, helicopter patrol programs, and high intensity street lighting programs. The model, in its current form, does not make futuristic estimates of crime. Whereas many other time dependent modeling techniques allow for inclusion of information leading up to the experimental period, a virtue of the crime-correlated area concept is that it allows for causal forces to operate during the test period and for information related to their operation to be included in the estimating procedure.

The data also indicates that the relative performance of the model improves when the expected level of crime is large. Since most studies are concerned with higher crime areas, the model would seem to lend itself very well to such applications.

In comparison with other popular crime estimation techniques, the model resulted in better performance. But, since the exponential smoothing model performed almost as well, one might argue for its selection on the basis of computational efficiency. This is indeed a major advantage of exponential smoothing. However, it is believed that the crime-correlated area concept has potential benefits which can offset its more burdensome operational aspects. The contention is that the model has value not only for the purpose of crime estimation, but also for attempts to identify and relate causal forces to the incidence of crime. Since the concept assumes that there are universal influences which operate upon a ciy in such a way as to influence general crime levels, it is conceivable that upon identification of two areas which have similar rates of change in crime level, an examination of socioeconomic, demographic, and other crime related factors within the two areas might lead to an explanation of the differential which exists between the two areas. This, in turn, could enhance the identification and improved understanding of the causal determinants of crime.

Considerations for Future Research

On the basis of a rather obvious and simplistic assumption, the crime-correlated area concept presents some interesting results and prospects for future research. One operational problem involves identification of atypical data points for potential predictor areas. Multivariate techniques, such as cluster analysis, might be examined to determine their usefulness in identifying the obvious, as well as the not so obvious, atypical data points. In considering these techniques, the improved effectiveness in identifying such points should be weighted against the additional effort required for the analysis.

The problem of "overfitting" the sample data should also receive greater attention. Apparently this problem has not been resolved satisfactorily by statisticians. In attempting to determine the point at which model contamination begins, experimental heuristics, such as developed for this particular application, might be developed and tested.

It might also prove worthwhile to examine, further, the implications of using functional forms other than a linear model. This was done on an exploratory basis to a limited extent in this study, but additional efforts might prove fruitful.

This application worked with reported Index offenses as the primary measure of crime. Models were developed for aggregate Index offenses, as well as for specific Index offense categories. Future efforts might apply this concept to other crime classifications. In addition, an attempt might be made to identify clusters of crime categories which have similar response behavior to crime influences.

As mentioned at the end of the previous section, one might consider extending the concept of universal and local (or macro and micro) crime influences. This model hypothesized a set of universal or macro influences which would help to explain a considerable portion of the variation in the rate of change in crime between two areas. It might be assumed that the residual variation can be explained in large part by local differentials of socioeconomic and demographic characteristics between the two areas. An effort to identify measures of these local influences and to incorporate them in the model could be quite beneficial.

THE MANPOWER EXPERIMENT

This study was concerned with three one-month periods during 1970 in which the Special Operations Division of the Washington Metropolitan Police Department conducted high intensity police patrol activities within selected areas of the city. The effect, in each instance, was to increase the level of police visibility within these areas, as well as the level of preventive patrol activity.

Summary of Experiences and Conclusions

The analyses of the three experimental areas were conducted in order to evaluate the impact of the increase in manpower upon crime.

Deterrent Effect within the Experimental Areas - Index offenses were used as a measure of the general level of crime for purposes of this study. In the August study, there was no evidence of a general decrease in aggregate Index offenses within the test area. Although point estimates of expected crime levels reflected decreases in five reporting areas, only two of the eight test areas registered statistically significant decreases. One reporting area showed a significant increase. An examination of the impact upon four selected Index offenses revealed no significant changes within the test area as a whole.

In the September experiment, indications of a more general impact were apparent. In eight of the twelve test reporting areas, point estimates indicated a decline in crime; five of which were significantly lower than expected. Of the four areas in which point estimates indicated increases in crime, only one area showed a significant increase. The examination of the impact upon four selected Index offenses revealed that actual levels were less than the point estimates of expected levels in three of four instances; only one of the three categories reflected a significant decrease. On the other hand, the aggravated assault category showed a significant increase during the test period. One possible explanation for the reversal in this category relates to reporting. Aggravated assault is a crime very often involving persons who are not strangers. Due to prior knowledge of the other party, and the fact that many aggravated assaults are of a minor nature, this category is perhaps under-reported more so than other categories of crime. The presence of additional police officers within an area is often believed to result in a greater likelihood of reporting by citizens. It is possible that the increased reporting in this category was disproportionately greater than in other categories.

In the November experiment, results suggested the possibility of a general deterrent effect. For the fourteen reporting areas involved in the test during the entire month, expected levels of crime were greater than actual levels in ten instances. Four of these ten areas registered significant decreases. Of the four areas in which point estimates were less than actual levels, only one recorded a significant increase. For the three selected Index offense categories examined, all recorded decreases in crime levels; one of these was significant.

It is apparent from the results that the effectiveness of the increase in manpower was different during the three months. The least amount of impact seemed to occur during the August experiment. There was little evidence of any general deterrent influence. This was true not only with regard to aggregate Index offenses within individual reporting areas, but also in specific crime categories within the overall test area. Conversations with officials from the Fifth District revealed their disappointment and belief that the experiment had the opposite effect of that intended.

Evidence of a more general deterrent effect was found in the other two months. This was reflected not only in the larger percentage of reporting areas having significant decreases in aggregate Index offenses, but also in the differences between actual and expected levels for specific crime categories. Observation of these two months, on a reporting area basis, seems to indicate that the September experiment was most successful with regard to general deterrent influence.

Examination of the manpower estimates reveals that the relative increases in police visibility and preventive patrol time were considerably higher for the September experiment than for the other two months. And, one might attribute the greater deterrent influence for this month primarily to the larger relative increases in manpower.

Although the relative increases in manpower for August and November were very similar, the relative success during these two months was quite different. Apparently similar changes in visibility levels (the experimental condition) have resulted in different responses in crime levels. The inference in this case is that other factors, aside from the experimental condition, have influenced the response of crime within each area. And, as many people in the area of law enforcement realize, the success of most-crime-control programs is different, depending upon the environment in which the program is conducted.

An attempt to explain the variations in success for each month is a difficult task. Information is lacking concerning the identity of factors which influence crime. And, there is little understanding of how these factors interrelate with one another to influence crime. The 1970 Census data, presented in Appendix A, may offer some insights into the variations from the standpoint of target characteristics. Nothing in this study allows for discussion of offender characteristics.

It should be kept in mind that the objective is not trying to determine why these areas are high crime areas. Rather, the interest is in trying to distinguish those characteristics which would make the crime-control program more effective in one area than in another.

Casual observation of the Census data indicates the following relative differences between the three test areas. Combined with approximations of the square area for each test zone, the August test zone also had the lowest unemployment rate among males and the largest percentage of housing units owner-occupied. Conversely, September's test zone had the lowest population density, the highest percentage of families with female or other than husband male head (with children under 18 years old), a considerably lower educational level than the other areas, and a significantly larger percentage of male unemployment and poverty stricken families. November's test zone is characterized by high population density, a significantly larger percentage of white inhabitants, an age distribution which is older than the other two areas, significantly smaller family sizes, and the lowest percentage of owner-occupied housing units. It can be seen that even within the two areas experiencing relative success, the characteristics of the population are different.

Perhaps the most significant difference between the August test zone and the other two is one which can be seen visually. As mentioned in Chapter II, the August test zone is an area characterized by narrow streets, high density of dwellings and buildings, and a general absence of open spaces. The area does not have many high rise buildings or apartments, as is so with the other two areas. And it may be that an environment characterized by narrow streets, back alleys, and a multitude of nooks and crannies between physical structures restricts the visibility and preserves the anonymity of the potential offender. Even though the program increased police visibility and preventive patrol, it is likely that offenders were better able to adapt in this type of environment.

In this type of evaluative study, it would be of great benefit to have reporting area boundaries coincide with census boundaries. Such data would be very useful in reaching conclusions concerning the relative success or lack of success in each test reporting area.

Examination for Spatial Displacement Effects - The first layer of reporting areas surrounding each experimental zone was examined in order to determine whether displacement effects had occurred. Aggregate Index offense levels were compared with expected levels for each peripheral reporting area. And, experiences with selected Index categories were examined for the entire peripheral zone.

Results for the August experiment offered only a suggestion of displacement in one cluster of reporting areas. Otherwise, there was no evidence of a general displacement effect. In half of the reporting areas, actual crime levels were greater than expected levels; in only one instance was the difference significant. Of those reporting areas in which crime levels were less than expected, two areas experienced significant decreases. Observation of selected Index offenses revealed that in two categories actual levels were greater than expected. In the categories of robbery and auto theft, actual levels were significantly less than expected.

Results for the September experiment presented even less evidence of displacement. Of the seventeen peripheral areas, thirteen areas recorded actual crime levels less than expected. Ten of these differences were significant. Observation of four Index offenses revealed that actual levels were less than expected for each category. The difference was significant for robbery.

CONTINUED

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In the November experiment, there were suggestions of isolated displacement effects. In nine of the twenty-three peripheral areas, actual levels were greater than expected. In two of these nine, the differences were significant. Of the fourteen areas indicating a decrease in crime, six of the areas registered significant decreases. As indicated in the results, other reasons than the experimental condition were offered to explain the significant decrease in reporting area 410. As with the September experiment, the four Index offense categories all reflected decreases within the total periperhal zone. The decrease was significant in the case of auto theft.

There was little evidence to substantiate the existence of widespread spatial displacement effects. For the three months, only three peripheral reporting areas registered significant increases in Index offense levels. Eighteen areas showed significant decreases. But, for the three areas having significant increases, especially those associated with the November experiment, the indications are that displacement was indeed possible. This conclusion is based upon the significant decreases apparent within neighboring test areas. It might be mentioned that the second layer of peripheral areas was observed on a less formal basis, and observations did not suggest any greater likelihood of displacement effects. The conclusion is that the intensive police patrol activities seemed to result in a pervasive deterrent effect which extended beyond the immediate boundaries of the experiment. On the other hand, isolated instances of displacement were likely for certain peripheral reporting areas.

As indicated earlier, there were certain areas within the test zones which incurred significant increases in crime. One might suggest that these represent possible evidence of internal displacement within the test zone. An interesting observation, though, is that for each reporting area (test and peripheral) which registered a significant increase in Index offenses, there was at least one neighboring reporting area which incurred a significant decrease in crime. This lends even greater credibility to the suggestion that these significant increases may be explained, at least in part, by the displacement phenomenon.

The analysis by type of Index offense offered no evidence that particular categories of crime are more susceptible to the displacement phenomenon than others. On the other hand, the categories auto theft and robbery within the peripheral zones seemed to be especially affected, in terms of a pervasive deterrent effect.

Examination for Temporal Displacement - Since the high intensity patrol effort was not in effect between 12:00 a.m. - 8:00 a.m., the time distribution of Index offenses was examined for possible shifts. For both the August and September experiments, there were no significant changes in the time distribution of offenses for any of the experimental reporting areas, nor for the test zone as a whole.

For the November experiment, only one reporting area (503) was found to have incurred a significant change. The change was in a direction opposite of that expected. Area 503, which incurred a significant increase during the period, showed a significantly larger percentage of crimes occurring during the period of increased patrol.

Therefore, no evidence was indicated by the results which would substantiate that there was temporal displacement of Index offenses to the normal manpower shift. For those areas which registered a significant decrease in crime, having no significant change in the time distribution of offenses might suggest a pervasive deterrent effect into the normal manpower period.

Crime Trend - By examining a seven-day moving average of Index offenses for each experimental zone, the hope was to identify trend effects. For the August experiment, there was no significant downward trend during the test period. There were indications of a slight downward response during the first eleven days, followed by an upward movement during the middle of the month. But, no particular signs of a deterrent effect were apparent.

During September, there was a definite downward trend during the first twenty days. Beyond this period, the trend reversed, climbing toward but never attaining levels which existed prior to the initiation of the experiment.

During November, there was a downward movement in crime during the first thirteen days. This was followed by a rather dramatic reversal for the following week in which the moving average climbed to levels higher than had existed prior to the beginning of the experiment. This was followed by a leveling off for the remainder of the month.

An examination of the crime trend resulted in a few conclusions. First, for those months in which a deterrent influence was noticeable (September and November), there were definite indications of downturns in crime levels early in the experimental periods. These downturns were not necessarily immediate, but due to the sporadic nature of the plot, it is difficult to determine precisely when they began. Thus, it is a little difficult to determine what the exact lead time was between initiation of the program and a response in crime levels.

Second, during the two months in which there was a distinct downturn, the crime trend reversed itself at some point in time and began to climb toward previous levels. In the November experiment, the trend moved above those levels which existed prior to initiation of the experiment. The conclusion suggested in this instance is that although the additional police presence resulted in a downturn in crime, the offender community learned to adapt to the changed environment. This type of behavior has been suggested in high intensity street lighting programs. If these programs are not accompanied by some additional active deterrent, such as additional policemen, the offender learns to operate within the changed setting.

Another possible explanation for this behavior could relate to the continuity and intensity of the experimental influence. Patrolling within small geographic areas over long periods of time might eventually result in lower motivation levels on the part of participating officers. And, the levels of enthusiasm which perhaps exist at the beginning of a new assignment, might diminish at some point in the experiment. This, of course, could not be measured in the current study, but it is suggested as a consideration for future studies.

Lastly, there was little indication of a lag or residual deterrent effect upon termination of the experimental period. The only evidence which might suggest such a possibility is reflected in the September trend. For this month, the crime trend did return toward, but never quite attained, previous levels toward the end of September. In the following month, the trend did not increase upon cessation of the experiment. Rather, it maintained the level which had existed at the end of the month. And, it would be difficult to attribute the maintenance in the level of crime trend solely to a residual effect.

Limitations of the Study

The fact that the study was conducted ex post facto is responsible for many of the problems experienced. Having to rely upon data sources which were not adapted to the needs of the study, created a major problem. One of the most obvious examples of this relates to gathering data on manpower deployments. The modification of data gathering procedures can lead to much improved control in measuring and describing the experimental manipulation.

Another limitation is related to the criteria for evaluation of the study. In this study, the manpower experiment was judged on the basis of the impact upon Index offenses. This proxy for actual crime levels is subject to certain limitations. For example, reported crime levels are used as a substitute for actual crime levels. The discrepancy between reported and actual levels of crime has been well documented, but not satisfactorily resolved.[1]

In this study, as with others, there is the possibility of errors in the reporting of crime by the police department. Resources did not allow for an audit of Washington's crime reporting procedures. And, there is reason to suspect that in many department the documentation of offenses can result in errors such as misclassification of offenses and the incorrect recording of the time and location of offenses.

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[1]See the President's Commission on Law Enforcement and Administration of Justice, The Challenge of Crime in a Free Society, 1967, pp. 20-22.

There is also the possibility that the experimental condition itself may result in biased measures of crime. Awareness of experimental conditions may cause officers to perform differently than otherwise. They may be more conscientious in identifying crime, reporting crime, and making arrests. There is also the possibility of citizen initiated bias. Being aware of greater police presence, citizens may be more likely to report an offense which they normally would not report. Concurrent victimization studies and surveys of community awareness of police presence may aid in accounting for this type of citizen initiated bias.

Another difficulty with the current study is the inability to generalize results beyond the experimental area and conditions. There are a multitude of factors which influence crime levels. Many of these factors are unknown. For those factors which have been identified, the interrelationships with crime are often not understood. It is hoped that the documentation of this study and the characteristics of the experimental environment will be of eventual use in identifying general crime response patterns. Ultimately, as additional well-documented studies are reported, it is hoped that the implications of manpower policies will begin to emerge.

Suggestions for Future Research

The following are suggestions which may facilitate the conduct of future research in the area of crime control.

(1) In the design of experiments, police departments should be willing to commit portions of their resources to a research posture for periods of time sufficient to generate meaningful results.

(2) Efforts to improve upon police information systems should continue. Although the introduction of computer technology has resulted in the redesign of such systems, efforts should continue to provide more meaningful information at the time and place it is needed most.

(3) Police department personnel should attempt to develop an awareness of the types of information which can be most meaningful in current and future research studies. Open communication between police department personnel and scientists can allow for anticipation of the types of studies, and thus the types of data which may be most useful. Such anticipation would even allow for more meaningful studies on an ex post facto basis. For example, selective gathering of data during one experiment may provide inputs for secondary or peripheral experiments not of most immediate interest at the time of the experiment.

(4) Police departments should continue to improve their auditing and review procedures in order to minimize crime reporting errors.

(5) Concerning the difficulties which were encountered in accounting for manpower data, police departments and scientists should explore improved means of accounting for an officer's activities. The challenge lies in improving accountability while at the same time attempting to reduce the amount of paperwork which currently exists for both administrators and patrol officers.

(6) Cities should examine their reporting systems in an effort to take advantage of socioeconomic and demographic data which is routinely gathered. For example, standard reporting area boundaries might be shifted in such a way as to coincide with census area boundaries. In conducting experiments in crime control, the availability of this type of data could help provide explanations to many of the questions which arise. And as mentioned earlier, this added description of the experimental environment will perhaps hasten the overall understanding of crime control programs and their effectiveness, or lack thereof.

(7) Finally, as individual cities conduct experiments in the area of crime control, results and derived knowledge should be shared with other cities. A forum for the mutual exchange of experiences can be extremely helpful in improving research designs and thus, enriching our understanding of law enforcement effectiveness.

APPENDIX A

CENSUS DATA FOR TEST ZONES

The following data was taken from the results of the 1970 U.S. Census.[1] The data represents composite information for each monthly test zone. The data is not precise in the sense that data was aggregated for the set of census tracts which corresponded most closely to the boundaries of the test zone.

[1]1970 Census of Population and Housing: Census Tracts, Washington, D.C.--Md.--Va., Standard Metropolitan Statistical Area, PHC(1)-226, U.S. Government Printing Office, 1972.

		August	September	November
I.	Population-All Persons	40,782	16,056	56,701
II.	% of Population, Negro	96.93	98.25	69.32
III.	Age Distribution-Males			
	a. All Males-Total	19,662	7,584	27,197
	b. Nine or Under	3,810-19.38%	1,548-20.42%	3,305-12.15%
	c. 10-14 Yrs.	2,444-12.43%	961-12.68%	1,488- 5.47%
	d. 15-19 Yrs.	2,110-10.74%	797-10.50%	1,692- 6.22%
	e. 20-24 Yrs.	1,432- 7.28%	456- 6.02%	2,975-10.93%
	f. 25-44 Yrs.	4,463-22.70%	1,487-19.60%	8,883-32.66%
	g. Over 45 Yrs.	5,403-27.47%	2,335-30.78%	8,854-32.57%
IV.	Persons/Household	3.61	3.41	2.03
V.	% of Families with Female or Other than Husband Male Head, With Children Under 18 Yrs. Old	34.94	50.71	42.10
VI.	% of Persons 16-21 Yrs. Old, Not High School Graduate and Not Enrolled in School	25.25	35.73	24.40

		August	September	November
VII.	Years of School Completed	(Persons 25 Yrs. or Older)		
	a. 0 Yrs.	376	248	599
	b. Elementary, 1-4 Yrs.	1,707	855	1,913
	c. Elementary, 5-7 Yrs.	4,046	1,897	5,060
	d. Elementary, 8 Yrs.	2,297	945	3,149
	e. High School, 1-3 Yrs.	6,432	2,508	8,208
	f. High School, 4 Yrs.	4,702	1,368	8,145
	g. College, 1-3 Yrs.	1,054	222	3,834
	h. College, 4 or More Yrs.	659	184	4,512
	i. % High School Graduates	30.15	21.56	45.28
VIII.	% of Male Civilian Labor Force Unemployed	4.82%	6.87%	5.53%
IX.	Mean Family Income	$8,625	$6,074	$8,809
X.	Familes with Income Below Poverty Level	1,244	1,196	2,059
XI.	% of Familes with Income Below Poverty Level	14.40%	37.08%	19.35%
XII.	% of Housing Units Owner Occupied	32.90%	12.08%	7.36%

APPENDIX B

MODELING DISPLACEMENT EFFECTS

One of the original expectations in this research was to identify and confirm the existence of spatial displacement effects arising from the saturation program. Having done so, it was hoped that a model would be developed which would be useful in predicting characteristics of displacement. This model could then be tested in situations where displacement had been identified. Unfortunately, this study did not confirm the existence of displacement effects. Although there were hints of its presence, these were difficult to confirm.

Nonetheless, this researcher feels strongly that the phenomenon is real. This chapter, first, briefly reviews the concept and its implications. This is followed by a discussion of considerations related to modeling the phenomenon. A hypothetical model is presented which can be discussed at present only in a theoretical sense. This is followed by some suggested modeling techniques which may be of interim benefit in exploratory research within this area.

Some Implications of Displacement

Chapter I discussed spatial displacement as a possible consequence of crime prevention programs. This spillover effect was suggested as a possible consequence of crime prevention measures. It was also suggested that certain types of offenders are more likely to be displaced by a crime prevention program than others. The inference in Chapter I was that individuals who commit crimes out of either an economic or pathological need are more likely than others to seek an alternative target. Offenders in this category include the professional criminal, the drug addict, and other habitual offenders.

It was also suggested that these types of offenders are likely to plan, or at least anticipate, an offense. One might reason that in a planned offense, an offender selects his original target based upon a number of factors. These factors might include location, potential payoff, risk, crime opportunities, and familiarity with the area. It might be argued that he has subjectively ranked all possible areas according to these factors and has determined subjective estimates of the likelihood of success, or perhaps what might be called a probability of goal achievement. It might be logical to assume, therefore, that the primary target has been assigned the highest probability of goal achievement.

If you deflect the prospective offender from his primary target, it could be argued that you will force him to an alternate site which was originally assigned a lower probability. In a sense, you might be moving the potential offender down his ordered list of alternatives. Moving an offender to a secondary target might place him in an environment which is less familiar and characterized by greater risk. Thus, from the standpoint of tactical strategies, deflection of offenders may increase the likelihood of apprehension.

If one had greater understanding of the nature of the deflection phenomenon, counter tactics might be developed which could prove very useful to law enforcement agencies. Preventive efforts might be instituted which anticipate alternative target areas and plan supplemental prevention activities within these areas. This <u>layering</u> of prevention programs would be likely to place the potential offender in situations of greater risk, decreasing his chances of a successful crime. It might also lead to higher-ordered deflection, in which the offender is moved further down his list of target alternatives.

Considerations in Testing for Displacement

Little research has been conducted concerning the concept of spatial displacement of crime. Many people have intuitive feelings about its existence and its nature. But, few studies are known which have examined the concept.

The initial need is to test for its existence. Well-designed and controlled studies are needed which examine the effects of various crime-control programs. As with this study, crime levels need to be studied in areas surrounding the experimental area. Sufficient controls should be established to enable the researcher to identify any increases in crime which can be attributed to displacement effects.

It is believed by many persons that crime-control programs influence different types of crime, depending upon the nature of the program. For example, a program of helicopter patrol is not likely to have a significant deterrent impact upon many categories of petty larceny, nor upon vice offenses. By the same token, a program which increases the design standards on household and business locking devices is not likely to have a significant deterrent impact upon street robbery or auto theft. Consequently, when examining for displacement effects, intuition would first suggest focusing upon the type of crime at which the crime-control program is directed. The assumption in this instance is that potential offenders are specialists in one type of offense. If an offender is displaced from a primary target to a secondary target, you can anticipate a decrease in the level of this type of crime within the primary target area and an increase in the level of the same type of crime within the secondary area.

But, the assumption that offenders specialize in one type of crime may be unrealistic. This would be especially true for offenders who are economically motivated in the manner of the drug addict. These types of offenders are likely to become involved in the phenomenon of "crime-switching."[1] This phenomenon, as related to the discussion of this appendix, is one in which the potential offender selects not only an alternative target area, but also an alternative type of offense. For example, encountering a police officer as he is ready to attempt the robbery of a liquor store, an offender might move to a new area where he chooses to burglarize a residence. Therefore, the crime-switching phenomenon introduces added complexity in testing for the existence of displacement effects. Research into crime-switching may reveal that offenders specialize not in one type of offense, but in a group of offenses. For example, it might be found that those offenders who primarily commit street robbery, when switching crimes, will have a high propensity to commit residential burglary. Consequently, in examining for displacement effects, groups of related offenses may have to be observed in order to reasonably determine that displacement has or has not occurred.

[1]Marvin Wolfgang has conducted, perhaps, the most extensive research related to the phenomenon of crime-switching.

PREDICTIVE MODELING

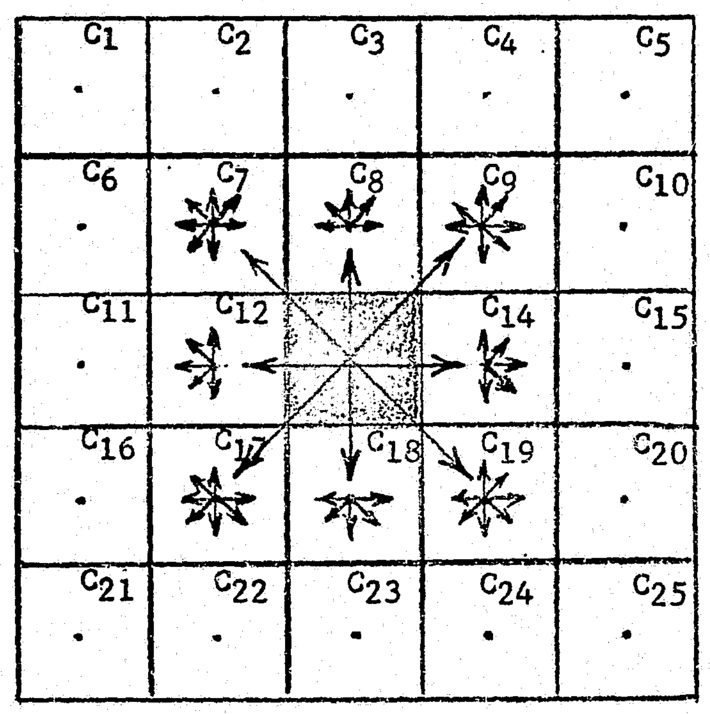
Until such a time when better data is generated concerning the existence of spatial deflection, one can only hypothesize model designs which may be useful in describing the phenomenon.

A Hypothetical Model

The following discussion presents a somewhat simple and idealistic model for predicting displacement effects. The model is a first-order Markovian model. Figure B-1 depicts a central, shaded area which is presumed to experience a special crime prevention program (such as a saturation effort). Arrows emanating from the experimental area reflect possible movements of crime. Notice that the deflection phenomenon is not depicted as necessarily being outward-oriented (directed away from the "hardened" area). The movement vectors allow for possible lateral deflection between peripheral areas. This infers that the net change in the incidence of crime for a peripheral area might not be solely the result of overflow from the test area. The net changes would be indicative of possible outflows from the peripheral area, itself, as well as inflows from other neighboring areas.

FIGURE B-1

HYPOTHETICAL TEST AREA AND CRIME SHIFT VECTORS



The model is based upon the matrix, **P**, which is a matrix of transition probabilities reflecting the likelihood of crime shifts

$$\mathbf{P} = \begin{pmatrix} P_{11} & P_{12} & \cdots & P_{1n} & P_{1,n+1} \\ P_{21} & P_{22} & \cdots & P_{2n} & P_{2,n+1} \\ \vdots & \vdots & & \vdots & \vdots \\ P_{n1} & P_{n2} & \cdots & P_{nn} & P_{n,n+1} \\ P_{n+1,1} & & \cdots & & P_{n+1,n+1} \end{pmatrix} \quad \text{(B.1)}$$

where: P_{ij} represents the likelihood that a potential offender will be displaced from area j to area i during a crime prevention program.

between n geographic areas. The values in the j^{th} column of the matrix represent all retention and loss probabilities for the j^{th} geographic area. The transition probabilities, P_{ij} (where i=j), reflect the proportion of expected crimes which will be retained in the area. The other P_{ij} values in a column reflect the percentages of expected crimes anticipated to be displaced to the other areas. The (n+1) dimension is necessary in order to reflect the percentage of expected crimes suppressed as a result of the crime prevention program. This means that the last probability in any column represents the proportion of crimes expected to be suppressed within the area as a result of the program. Notice that this allows for the possibility that the preventive influence may extend beyond the geographic boundaries of the program. $P_{n+1,j}$ values for areas geographically not a part of the program would represent this likelihood. Thus, the sum of the probabilities in any column must total to one. The figures in any row, i, of the matrix represent the probabilities that area i will retain expected levels of crime or gain increases from other areas as a result of displacement.

Column (n+1) would have all P_{ij} values equal to zero, with the exception of $P_{n=1,\ n+1}$, which would equal one. The zeros simply imply that crime that is suppressed as a result of the crime prevention program will not be transferred to any geographic area.

In order to predict the levels of crime expected in each area as a result of the crime preventive influence, matrix **P** would be multiplied times an expected crime vector. This vector would contain estimates of the level of crime expected in each area, in the absence of the program. The new estimates would be computed as below.

$$\mathbf{P}\mathbf{C} = \mathbf{C}' \qquad (B.2)$$

or,

$$\begin{pmatrix} P_{11} & P_{12} & \cdots & P_{1n} & P_{1,n+1} \\ P_{21} & P_{22} & \cdots & P_{2n} & P_{2,n+1} \\ \vdots & \vdots & & \vdots & \vdots \\ P_{n1} & P_{n2} & \cdots & P_{nn} & P_{n,n+1} \\ P_{n+1,1} & \cdots & \cdots & \cdots & P_{n+1,n+1} \end{pmatrix} \begin{pmatrix} c_1 \\ c_2 \\ \vdots \\ c_n \\ c_{n+1} \end{pmatrix} = \begin{pmatrix} c_1' \\ c_2' \\ \vdots \\ c_n' \\ c_{n+1}' \end{pmatrix} \qquad (B.3)$$

where: c_i = Predicted number of crimes for area i during the experimental period (assuming no impact due to the crime-control program)

c_i' = Predicted number of crimes for area i during the experimental period (accounting for deflection effects).

This type of model might be used for particular types of offenses, or for aggregate crime data. The model would obviously require a means of predicting expected levels of crime for any area (to provide c_i values). Although much work is needed in crime prediction, reasonable techniques are beginning to emerge for this purpose. It is the transition probabilities which pose the greatest problems. These would have to reflect such factors as the nature of the crime prevention program, the degree and duration of the crime prevention influence, the type of crime being predicted and its response to the type of prevention program, the relative crime opportunities within each area, a measure of the distance separating two areas, and some relative measure of normal crime prevention levels between areas (reflecting relative risk). Information on these factors and the way in which they interrelate with one another is currently not available. It would take time and carefully controlled studies to develop a sufficient understanding of these complex interrelationships to reduce their nature to a simple set of transition probabilities.

In the Meantime

The above model is somewhat of an ideal at this time. It potentially could provide rather complete information concerning displacement effects. Given some crime preventive influence, it could predict expected levels of crime for surrounding areas during the period of the program. In the meantime, though, models will have to be developed at somewhat lower level of abstraction. Perhaps initial models should try to answer broader questions concerning the general direction of deflection and the magnitude of deflection. This latter characteristic might involve not only considerations of the volume of crime deflected, but also the aspect of distance of the displacement. For example, it might be hypothesized that the probability of a peripheral area absorbing any spillover of crime is inversely related to the distance separating it from the "hardened" area.

In terms of developing a model to predict the general direction of deflection, a number of possibilities exist. It is suspected that, depending upon the nature of the specific offense, each neighboring area may be characterized by a degree of attractiveness. Therefore it might be possible to develop an index of relative offense attractiveness by evaluating certain attributes of each area. A very simple measure of the appeal that an area holds for committing a particular offense is the historical crime level within the area. Certainly the frequency with which the offense has been committed provides some measure of the way in which the offender population evaluates the area. Given any area in which a crime-control program is initiated, peripheral areas might be examined with regard to previous levels of the particular crime of interest. Combining this measure of attractiveness with other variables, such as the centroidal distance separating the two areas, areas might be ranked according to likelihood of being selected as an alternative target. An oversimplified index might be computed as below for m peripheral areas.

$$A_i = \frac{c_i}{\sum_{i=1}^{m} c_i \Big/ m} \cdot \frac{k}{d_{ik}} \qquad i = 1,\ldots m \qquad (B.4)$$

where: A_i = relative likelihood that area i would be selected

c_i = level of particular offenses occurring in area i during some historical period

k = constant term

d_{ik} = measure of distance separating area i and the test area (k)

A_i is a multiplicative index, computed as a function of relative crime experience and distance between the test and peripheral areas. Relative crime experience is represented as the ratio of the level of offenses occurring in area i to the average level occurring in all m peripheral areas.

This model assumes the size of the peripheral areas is the same. If the areas are not of the same size, the variable portraying the historical crime level should perhaps be a crime density variable. The c_i variable might be redefined to represent the number of offenses having occurred per square mile within area i.

As another variation, the experiences of this manpower study indicated that the deterrent influence pervaded beyond the geographical boundaries of the experiment. The author has termed this a corona effect. This implies that within a narrow band surrounding the experimental area, the deterrent influence of certain crime-control programs is experienced. The implication for equation (B.4) is that this formula might have to be conditionalized as valid only for values of $d_{ik} > d_c$, where d_c is the hypothesized width of the corona effect.

As an alternative approach in developing a measure of appeal, it might be contended that for a particular crime (e.g., commercial robbery or commercial burglary), there exists a set of target characteristics which are closely associated with the incidence of crime. These characteristics might include various demographic factors as well as physical factors associated with the target.[2] The offender may or may not be consciously aware of these factors in selecting a target. The idea, though, is that rather than look at the causal nature of an offense, or the motivational aspects of the offender, one should examine the end product of his decision process — the target he has selected and its characteristics.

[2]Such a study is Crime and the Physical City, A Pilot Study Prepared for the National Institute of Law Enforcement and Criminal Justice, by Gerald Luedtke and Associates, Detroit, Grant No. NI-078, 1970.

Utilizing a technique similar to multiple discriminate analysis, a victimization study might reveal the combination of factors which seems to differentiate between victims and non-victims. Upon identification of such favors, peripheral areas might be sampled to determine the relative content of the discriminating variables. This, in turn, could be transformed into a measure of relative appeal for each area.

CONCLUSIONS

The obvious conclusion is that much needs to be learned about the deflection phenomenon. The most immediate need is to identify the phenomenon in well designed research studies. When it is identified, thorough documentation of the experimental environment is essential. Gradually, as more is learned regarding the existence of the phenomenon, efforts can be made to predict the probable effects resulting from crime-control programs. This, in turn, can be quite helpful in the development of counter-tactics on the part of law enforcement agencies.

Although a few hypothetical models have been discussed, they are in some respects oversimplifed and premature. But, they do indicate the types of considerations which must be made, and will hopefully stimulate creative thinking with regard to phenomenon.

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