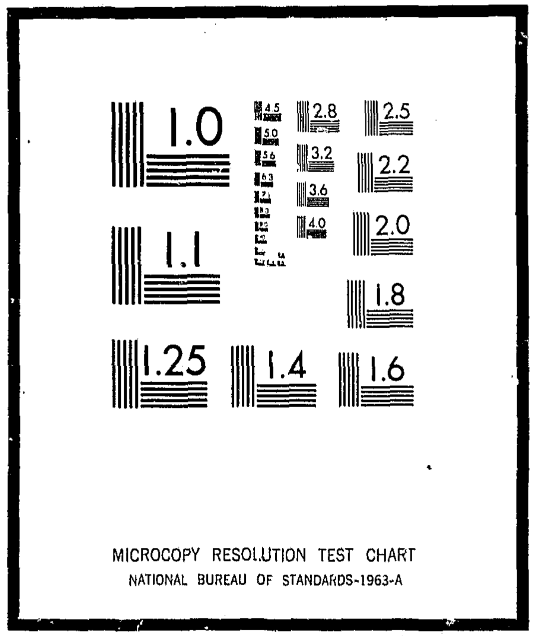

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ALPS (AUTOMATIC LICENSE PLATE SCANNING)
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COMPUTER AIDED OPERATIONS
COST BENEFIT ANALYSIS
EVALUATION
AUTO RELATED CRIMES
LICENSE CHECK
NYSIIS (NY STATE IDENT & INTELL SERV)
ANNOTATION:
ALPS IS A SYSTEM TO AUTOMATICALLY DETECT AUTOMOBILES THAT ARE WANTED BY LAW ENFORCEMENT AGENCIES.
ABSTRACT:
THE PURPOSE OF THIS STUDY WAS TO EVALUATE THE COST OF AN AUTOMATIC LICENSE PLATE SCANNING SYSTEM (ALPS). THE AUTOMATIC SYSTEM WAS ABOUT FIVE TIMES MORE EFFICIENT THAN THE NEXT BEST ALTERNATIVE. THE ANALYSIS SHOWED THAT THE SYSTEM COULD EFFECTIVELY IMPACT THE FOLLOWING PROBLEM AREAS - AUTO-RELATED CRIMES, AUTO THEFT, RECIDIVISM, STOLEN CAR, ACCIDENT DAMAGE, RECOVERY, NONRECOVERY, INSURANCE, AND CRIMINAL JUSTICE COSTS AND LOSSES, WARRANT SERVINGS, AUTO THEFT ACCOMPLICES, CIGARETTE SMUGGLING, STOLEN CAR FLOW PATTERNS. THE AREAS MOST SIGNIFICANTLY IMPACTED BY AUTO-RELATED CRIMES WERE SELECTED AND ANALYZED. A COST BENEFIT MODEL FOR THEIR DETERRENCE WAS CONSTRUCTED AND A PERFORMANCE AND COST EFFECTIVENESS MODEL FOR ALPS WAS DEVELOPED. THE SYSTEM APPEARS TO HAVE COST UTILITY FOR AREAS CORRESPONDING TO 95 PER CENT OF THE WANTED PLATE CRIMES. THE COST EFFECTIVENESS RATIOS DECLINE WITH THE DENSITY OF CRIME IN THE LOCATION.

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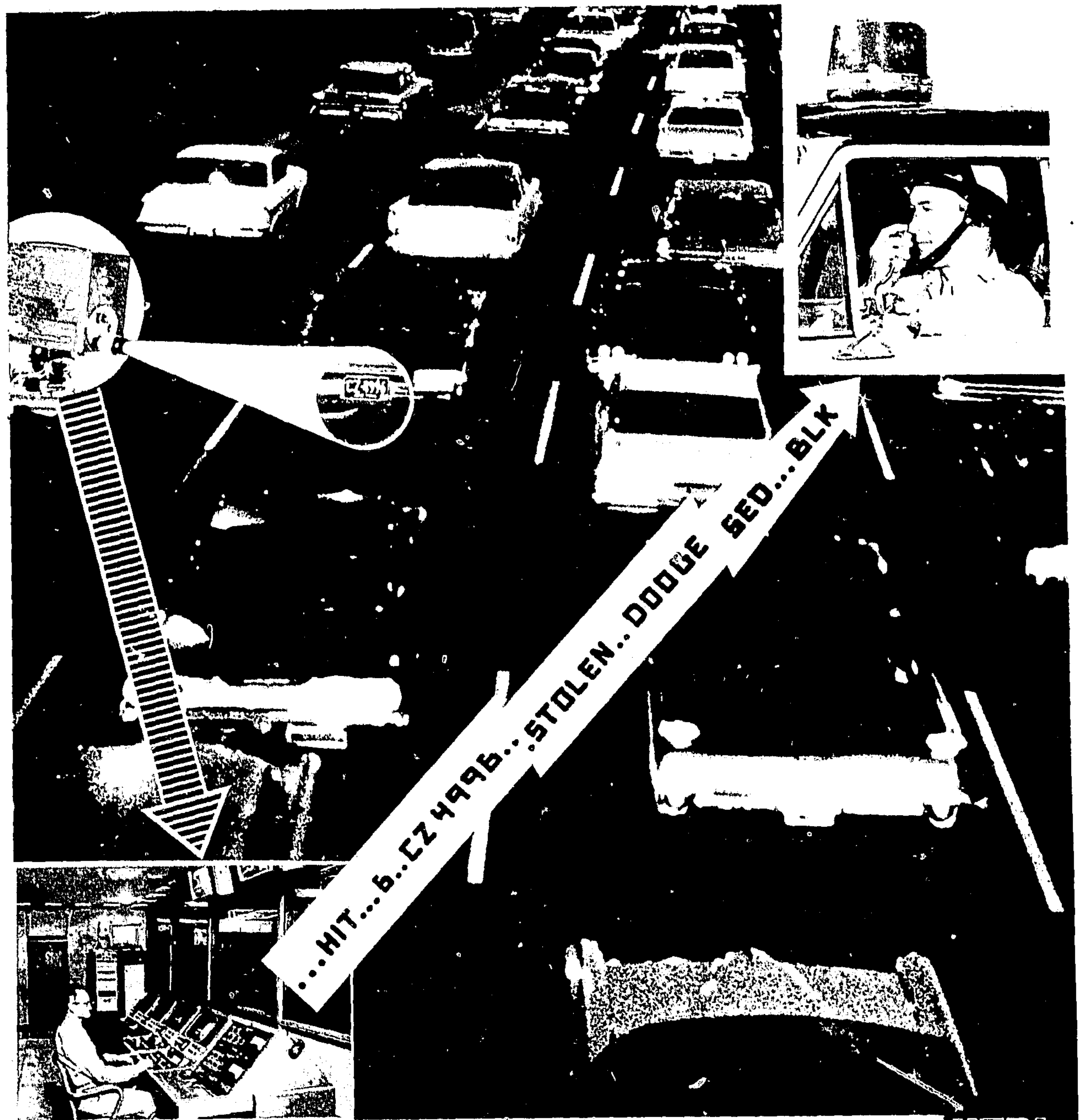
A SOCIO-ECONOMIC VALUATION STUDY FOR AUTOMATIC LICENSE PLATE SCANNING SYSTEM

NEW YORK STATE IDENTIFICATION INTELLIGENCE SYSTEM
NYSIIS



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A SOCIO-ECONOMIC VALUATION STUDY FOR AUTOMATIC LICENSE PLATE SCANNING SYSTEM

FINAL REPORT

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FOREWORD

This report is a presentation of the findings of a study to evaluate the cost-utility of an Automatic License Plate Scanning System. This study was contracted to the Systems Science Division of the IIT Research Institute (IITRI) by the State of New York Executive Department, Identification and Intelligence System (NYSIIS) commissioned under the auspices of Law Enforcement Assistance Administration, U.S. Department of Justice, Grant No. 040. Dr. Robert R. J. Gallati, Director of the New York State Identification and Intelligence System and Mr. Adam F. D'Alessandro, Deputy Director, were the principals responsible for the supervision and direction of the contract. The study was conducted by the Social Sciences and Technology Center of IITRI, in Annapolis, Maryland. Mr. Brian Keenan of IITRI served as the Project Manager. Dr. Edward J. DeFranco, Assistant Deputy Director of NYSIIS was responsible for all technical monitoring. The NYSIIS contract number is C 36276. The IITRI project number is X 6916.

The research necessary to complete this report was undertaken during the period from May 5, 1969 to December 31, 1969, and the final report submitted January 19, 1970.

Respectfully submitted,

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ABSTRACT

The primary purpose of this study was to evaluate the cost utility of an Automatic License Plate Scanning System (ALPS). The automatic system when compared with current operational systems and other mass scanning systems for detecting wanted plates was about five times more efficient than the next best alternative. The analysis showed that the system could effectively impact the following problem areas: auto-related crimes; auto theft; recidivism; stolen car accident damage, recovery, unrecovery, insurance, and criminal justice costs and losses; warrant servings; auto theft accomplices; cigarette smuggling and stolen car flow patterns.

The estimated 1972 forecasts for the penalties of these enumerated losses for that in New York State are as follows: 350 deaths, 1,000 jail years, 40,000 injuries, 100,000 days in the hospital, 285,000 victims, 86,000 family hardships, 150,000 non-auto theft crimes, 60,000 years of criminal activity, 4,000 boys admitted to criminal careers and 1.25 billion dollars.

In order to assess the degree of impact ALPS might have on the reduction of the above penalties, the areas most significantly impacted by auto-related crimes were selected and analyzed. A cost benefit model for the deterrence of these crimes was constructed and a performance and cost effectiveness model for ALPS was developed. The benefits calculated from the deployment of a small 10 unit network operating under certain conditions during the period between 1970 and 1974 were quantified as reductions in social penalties, increases in social services, direct dollar benefits and indirect dollar benefits. Theoretically, the ALPS system was credited with saving 190 lives, 22,000 injuries, 24,000 hospital days, 250,000 auto thefts, 66,000 hardships and 3,000 boys from a life of crime. In addition, the networks produced 76,000 arrests and served 114,000 warrants. Furthermore, the total direct and indirect dollar benefits were $377,000,000. The total procurement, operating and supporting costs of this system was a little over $10,000,000. Ninety percent of these costs were for police and operational manpower. The system appears to have cost utility for areas correspondent to 95% of the wanted plate crimes. However, the cost effectiveness ratios of the deployed systems decline with the density of crime in the location.

The study addressed factors concerning the users and systems requirements and the system's development, application and subscribers.

In conclusion, the analysis produced overwhelming evidence of the cost utility of the ALPS systems.

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PART I - INTRODUCTION

A. BACKGROUND AND INTRODUCTION

NYSIIS (New York State Identification and Intelligence System) by its legislative mandate, is charged with providing the 3,600 criminal justice agencies throughout New York State with access to timely and responsive information for identification and intelligence purposes in support of their functional activities.

To this end NYSIIS is implementing a computer based system wherein several sub systems (called modules), each comprising related type information (for example fraudulent check data, fingerprint data, summary criminal history data, organized crime intelligence, etc.), will be integrated. Telecommunication systems will also be employed.

During the NYSIIS definitional studies, it was pointed out that New York State did not have an operational state-wide "wanted plate" information file. Accordingly, it was included as part of a motor vehicle information module which had previously been identified as a desirable future capability that might be developed. (Since that time and since the initiation of the ALPS program, the New York State Police have developed such a file in conjunction with their message switching computer).

The "wanted plate" arises in connection with several law enforcement functions. It has been reported by some segments of the law enforcement community, that motor vehicles are involved in 75 to 80 percent of crimes reported to them. Automobiles are also the object of criminal activity, in addition to their use in the commission of a crime. Scofflaws, uninsured vehicles and unregistered vehicles, stolen license plates, and wanted and missing persons constitute additional interests of law enforcement in the status of an automobile license plate.

The main problem of processing "wanted plate" information is the sheer volume involved. The number of auto thefts alone reported throughout the state in 1969 exceeds 135,000. In addition there were in excess of seven and one half million motor vehicles registered and on the road in New York State in 1969. Computer processing of motor vehicle and "wanted plate" information for law enforcement purposes is thus becoming almost mandatory.

In the conceptual phases of ALPS the question was put forth as to how to address the problem of "wanted plates." The decision was made to implement a research and development program directed toward demonstrating the feasibility and utility of an automatic inquiry device to permit search of a computer based "wanted automobile license plate" file.

Feasibility of ALPS

The ALPS project has the overall objective of developing a system to automatically detect automobiles that are wanted by law enforcement agencies. To accomplish this objective, scanners located at appropriate roadside positions will view passing vehicles in constrained motion and supply license plate data to a data processor, which will identify New York license plates and

determine the alphanumeric characters on the plate. The character data will be transmitted via telephone lines to a central computer, where it will be compared with a stored file of wanted plates. If an incoming plate is found to match a wanted plate, an appropriate message will be transmitted to a police vehicle, where a law enforcement officer can initiate action to apprehend the wanted vehicle. The elapsed time from the instant of scanning the plate to response at the output station should be less than one or two seconds.

The ALPS program was planned in three successive phases, as follows:

Phase I - Program Definition Phase
Phase II - Prototype Development Phase
Phase III - Prototype Evaluation Phase

Phase I provided a detailed engineering analysis and design study of the ALPS system. An experimental scanner was set up in the laboratory and utilized to collect data on illumination requirements, effects of dirt, geometric distortion, contrast ratio, and other pertinent factors. These data were used to prepare the detailed design of a scanner for the prototype ALPS system to be constructed in Phase II. Methods of plate detection, plate identification, and character recognition were extensively investigated by means of computer simulations. Based on this work, specific techniques were selected and detailed logic design was completed for the prototype system. Also, investigations were made and recommendations generated for the data transmission and computer search portions of the ALPS system. This work was undertaken with Bendix Research Laboratories and ITEK Equipment Development Division. Since from a technical point of view, license-plate locating and character recognition are the two most challenging tasks, both contractors devoted the major part of their efforts toward establishing that their proposed schemes for handling these tasks were feasible, effective, and economically practical.

The results obtained by both contractors demonstrated that the system would be able to identify plate numbers even in the presence of an appreciable amount of "noise" (i.e., dirt or spurious reflections that would degrade the quality of the image). Both contractors felt that their Phase-I work clearly established the practicality of their respective engineering designs for an ALPS system, and both submitted detailed proposals to undertake the follow-on Phase-II development work.

Prior to the initiation of Phase-II, however, a decision was made to determine the utility of the ALPS program.

Utility of ALPS

The purpose of the Utility Study was to examine the "wanted plate" problem from a national, statewide, county and metropolitan view point. An attempt was made to learn as much as possible about the nature of the "wanted plate" environment such as current methodologies, statistics and advanced use of electronics and related costs. The preceding objectives were deemed a prerequisite step before attempting to answer the two basic questions as to

how effective can an ALPS system be and what benefit/cost relationships can be reasonably expected from its use. Beyond this, a socio-economic valuation study for ALPS with the objectives noted in the following section was deemed critical prior to Phase II development.

B. OBJECTIVES

The purpose of this study is to determine the exact worth or utility of the Automatic License Plate Scanning System under consideration. The specific objectives are to determine whether or not the societal and dollar benefits resulting from the services provided by this innovation are worth the costs, to assess the overall social and economic feasibility and utility of the system, and to ensure that ALPS is clearly the most cost effective of all the proposed alternative approaches.

Included as part of this expanded research is the provision of a more cogent evaluation of the project by determining the applicability of mass scanning and to evaluate the following four mass scanning techniques: (1) telephone, (2) radio, (3) radio teletype, and (4) optical scanning. Consequently, this study has evaluated in depth:

1. The economic feasibility of the concept of mass checking of license plates in an analysis of the wanted vehicle problem.
2. The manner in which mass checking will affect the following: automobile thieves, professional criminals, wanted plates, wanted (e.g., missing) persons, recidivism, stolen car accident loss, stolen vehicle damage, stolen vehicle recovery loss and unrecovery loss, stolen car insurance costs, figure of merit of ALPS, cost of stolen auto-related crimes, car theft accomplices, cigarette smuggling, stolen car

flow patterns, criminal justice costs, impact of incarceration, and loss valuations.

Also presented is an analysis of:

1. <u>Systems Synthesis and Identification of Operational Requirements</u>.

   (1) Man/resources of present methodologies at various levels of political subdivisions.

   (2) Response-times commensurate with various situations such as hot pursuit, surveillance, etc.

   (3) Identification of probable immediate subscribers and formulation of an extrapolation for system expansion.

   (4) Identify first and second order problems of a state-wide system.

2. <u>Interaction of Performance Evaluation and Cost Analysis</u>

   a. Delineation of alternative methods which might be used to implement a mass checking system.

   b. Development of cost, effectiveness and systems characteristics for those alternatives.

   c. A socio-economic evaluation of study findings.

As a final product, the study presents options for police jurisdictions, a systems development and growth plan and consideration of other applications.

C. HIGHLIGHTS AND SUMMARY

The objectives of this study require that a value be placed on a system for deterring auto-related crimes. In a sense these objectives have yet to be accomplished. For we were unable to measure the value of upholding man's right to be free of crime. Nor could we devise a metric that adequately expresses man's losses when these rights are violated. Our best efforts were able only to produce societal and economic indices, measurements of efficiencies and a recommendation concerning the allocation of resources.

However, despite the aforementioned limitations, those responsible for research must, with constancy, apply the best analytical techniques of the systems and social sciences to the reduction of uncertainty in the law enforcement decision-making process if the social institutions responsible for the maintenance of orderly and just patterns of behavior are to be effective in the supression of crime.

Toward this end we approached the case in question with the following logic:

1- Assess the scope of the penalties inflicted on the people of New York State by auto-related crimes.

2- Identify the most efficient system for the supression of this illegal activity.

3- Forecast the reduction of societal penalties that would result from the services of this system.

4- Calculate the cost, desirability, acceptability and feasibility of the system.

5- Conduct the cost utility analysis necessary for resource allocation decisions.

The results from the initial task were astounding. Hithertonow few of us had realized the extent of the spiraling inhumanities and costs that result from auto-related crimes and auto theft.

Auto-related crimes, exclusive of auto theft, now comprise more than half of the criminal offenses committed in the state and the statistics on auto theft have reached immense and frightening proportions. A ten year trend forecast from 1963 to 1972 shows that this crime will have increased by seven hundred percent during a single decade.

The consequences of motor vehicle larceny are severe: Of the crimes, it is the state's second biggest killer and third largest in the number of people victimized. Car stealing is one of the best training experiences for a criminal career. Auto theft is responsible for scores of thousands of injuries, days of pain and suffering, family hardships, and days in jail, and the cost penalties could exceed 1% of the total gross state product. To be specific, this last year, auto theft was responsible for 160 deaths, 850 jail years, 19,000 injuries, 30,000 days in the hospital, 135,000 victims, 40,000 hardships, 300,000 non-auto theft related unsolved crimes, 30,000 years of criminal activity and 2,000 boys being introduced to a lifetime of crime.

Aside from the inhumanities and injustices that result from unsolved rapes, murders, robberies and larcenies (if we exclude auto theft and stolen auto crimes), the value of the property losses and the law enforcement expenditures for these crimes was over 177 million dollars for this last year. By 1972 this loss will have climbed to over 300 million dollars. Also, these crimes will have cost the law enforcement functions more than just money; perhaps two lives and 400 injuries.

Sometimes the consequences of auto theft are insidious. For example, the mischievous but nonmalevolent act of a young lad appropriating a car for a few hours has foreboding consequences for all concerned. Joy riding hurts, kills, costs and spoils. In 1972 40,000 people will spend over 100,000 days in the hospital; 350 of these will die. The lost wages, lost potential earnings, funeral and medical bills and damages and expenses will cost over 52 million dollars. Joy riding is a major cause for one out of every 200 boys in the 15 to 17 year age bracket to step into a life of crime. For once a boy is arrested for auto theft the odds are 9 to 1 that he becomes a career criminal. We expect each of these illegal careers to be responsible for twenty auto thefts, five grand larcenies, ten burglaries, four robberies, four assaults and perhaps a rape or a murder. In 1972 these criminal careers will cost the state over one quarter of a billion dollars.

No matter who steals, it is the average family that usually suffers with the loss of its first or sometimes second major

investment. If the car is not recovered, the average family can expect to lose $1,450. If kids steal the car, the head of the household can expect to have his car returned either crashed, stripped, looted or vandalized for an average loss of $400.

By 1972 the New York car owners can expect to pay, one way or another, for over one quarter of a billion dollars of stolen vehicle losses. We say one way or another because even if some are insured, collectively the car owners still pay. In 1972 the insurance companies in New York will collect in the form of premiums 37 million dollars to cover their losses, costs and profits.

Included in the concept of auto related crimes are two other offenses: Failure to answer a summons and cigarette smuggling. About 300,000 of the New York State motorists have warrants out for their arrest. This cost the state about 20 million dollars and about half of the people get away. Cigarette smuggling is a significant loss area. Last year bootleggers cost New York State $60 million.

People steal cars for many reasons: thrills, transportation, money, and to commit evil. In 1967 about ten percent or 80,000 of the uncleared crimes involved a stolen auto. Aside from the toll in human misery these crimes cost the commonwealth another $47 million.

Because of the perpetrator's habitual tendency to repeat it is very likely that most of the thefts can be attributed to a very small but active minority. Our guess is that about eighteen or twenty thousand people were responsible for all the auto thefts committed in New York in 1967. However, auto theft is a crime of accomplices. And if we count those who assist, the ranks of the people involved in this illegal activity swell to about four times the original estimate. Unfortunately these accomplices are seldom arrested or charged.

So far we still have not accounted for all of the social and cost penalties inflicted by this crime, for example, the costs of maintaining a criminal justice system and the losses to the economy that results when people are jailed. Last year the economy lost the production of over 850 man years of effort because of jail sentences, and this cost another ten million dollars.

Auto theft also absorbs a large portion of the state's criminal justice system budget. The cost of auto theft enforcement, prosecution and correction functions were over $36 million last year. This crime will take more and more of the budget every year. In 1966 about 4.5% of the police budget went for auto theft. In 1972 the crime will require about 8.5% of the budget. At this date the criminal justice system costs for auto theft alone are expected to exceed one hundred million dollars.

Probably one of the most difficult outcomes to accept about auto theft is that it appears to be a very high payoff low risk activity. Theoretically one could expect to steal at least $1 million worth of property before spending one year in jail. Whoever said crime doesn't pay was not a statistician.

In summary, the total direct costs of auto theft, i.e. stolen car accident and damage losses and unrecovered vehicle losses and insurance and criminal justice costs are expected to be 206 million and 454 million dollars for 1969 and 1972 respectively. If we count the indirect costs of auto theft such as ecomonic impact and auto theft related crimes we must add another 77 million dollars and another 134 million dollars to the 1969 and 1972 respective subtotals. The addition of the costs of cigarette smuggling and auto related crimes will bring these totals over the one-half billion dollar mark for last year and slightly less than one billion dollar mark for 1972. However, if we consider the costs of a criminal career and the serving of warrants we would add another quarter of a billion dollars to this last total.

Comparisons between automatic scanning systems and the current traditional procedures and selected innovations in manual scanning systems left little doubt as to which was the dominant system.

An a fortiori cost utility analysis was used for efficiency comparisons between operational patrolmen, auto theft squad personnel, and telephone-radio, radio-teletype and optical systems for mass scanning. The former systems cost, respectively, $630 and $230 per hit; and while the latter semi-automatic scanning systems cost, respectively, $282, and $426 per hit, the optical system gave hits for less than $50. Hence even when all design, environmental and operational parameters are biased against ALPS and biased for the alternatives, ALPS is clearly the most cost efficient system.

Cost efficiency does not establish the system's utility. It still remains to be shown that ALPS can reduce the societal and dollar penalties of auto related criminal behavior to a level that more than justifies the investment costs.

To insure that the system's performance level of effectiveness would yield benefits worth much more than costs a theoretical simulation study was conducted. A model of stolen car behavioral patterns and the stolen auto environment was constructed to provide simulated target information and simulated operational conditions for a conceptual operational performance system.

An anaylsis of the state's stolen car flow patterns indicated that automatic scanning was ideally suited for this type of criminal activity. Eighty-five percent of all illegal traffic occurs in the New York City Standard Metropolitan Statistical Area (SMSA), and ninety percent of the state's unreturned vehicles are stolen within the city limits. There was also evidence of a large unrestricted flow of illegal cars from the waterfront and a significant but undetermined out-of-state flow. However, the major market place for these illegal goods appears to be New York City.

The recovery rate in the other SMSA's in the state ranged from eighty-five to ninety-five percent, while it was fifty percent for New York City and sixty-five percent for the New York City suburbs.

The probable disposal patterns of the unrecovered cars is as follows: 12% exported from the N.Y.C. docks; about 28% are either purposely abandoned, or are of junk value, or are lost

or picked up illegally under the guise of the derelict auto ordinance or were not picked up or accounted for in the police auto pounds; about 55% are either stripped, shipped out-of-state or resold under forged papers. A few are kept by the illegal owners. A greater portion of the unrecovered cars are the expensive G.M.C. makes that are stolen from wealthy neighborhoods.

The recovered cars are stolen from both poor and wealthy neighborhoods but a greater portion of the recoveries are made in the high crime areas.

Auto theft was not correlated with availability, lack of transportation, youth or income. It was correlated with crime and delinquency. The joyrider or looter or transportation thief preferred the lower priced G.M.C. cars. Neither group of thieves liked Fords.

Apparently, many of these were using the car for local transportation for a while before abandoning it. The amount of damage and stripping was directly correlated with the number of days gone.

The majority of cars were stolen from the street, outside of the owner's home in the evening hours. It usually took eight hours to detect the theft.

Stolen car traffic flow maps for each of the N.Y.C. precincts were drawn and they were used as a basis for deployment. It appeared that in a 10 unit system, each unit would get seven hits a day.

The performance of the ALPS system was dependent on the amount of illegal traffic. The amount of stolen cars on the road will be dependent on the growth of crime and on the deterrent rate of the system. We arbitrarily picked the four conditions for simulation: twelve, and twenty-four percent growth rates in crime, and a moderate effect and a no deterrent effect of ALPS.

The forecasting period was for a five year duration, from 1970 to 1974. The conditions, twelve percent growth with no deterrent effect, twenty-four percent growth with no deterrent, twelve percent growth with a deterrent effect, and twenty-four percent with a deterrent effect, represent environments which range from the least favorable to the expected operational situation. Under the least favorable situations the benefits were as follows: the reductions in the number of deaths, injuries, hospital days, hardships were 30, 3,480, 3,760, 16,600 respectively. In addition, the increased number of warrants served and arrests made were 114,000 and 68,000 in that order. The direct and indirect dollar benefits were $59 million.

Under the expected operational conditions, twenty-four percent growth with deterrent effect, the benefits are far in excess of those listed for the most severe conditions. We expect the final system to be credited with saving 190 deaths, 22,040 injuries, 23,750 days spent in the hospital, 249,249 auto theft victims, 65,870 hardship cases, and 3,000 boys from a life of crime. In addition, this small network should also be credited with 76,000 arrests and 114,000 warrants served. The total direct dollar

saving benefits are $339,000,000. The total direct and indirect benefits are $377,000,000.

Even though the benefit accounting looks encouraging, the system is still of little utility unless there is a users' need and demand and the costs are acceptable.

Although the equipment life is substantially longer, the system's cost estimates were based on ten ALPS installations operating on a 24-hour basis over a five year period. These estimates encompassed investment expenditures on scanners, computers, vans, spare parts, etc., depreciation, maintenance and repair, manpower requirements, and supportability operations.

Our best estimate of these expenditures required to fund the system for five years is $10,500,000; in excess of ninety percent of this total represents the cost of manpower needed to insure the system's effective operation.

From the simulation model there appears to be little doubt that the system is feasible and acceptable with respect to both cost and performance for New York City. From a survey of the major police jurisdictions that have wanted plate traffic, it appears that mass scanning is also applicable for all other New York State SMSA's and for some of the state's highway systems. However, for the smaller cities smaller and less expensive networks were planned. ALPS was justified on its primary role--to assist in the provision of law enforcement services rather than on its ancillary role of providing a profitable return on its capitalization investment.

The cost utility analysis showed that ALPS sufficiently reduced the societal penalties attributed to crime, to justify its cost for all areas of significant auto related offenses. And, in addition, the system yielded a very substantial return on the capital investment in terms of dollar benefits. Hence, ALPS was considered to be of significant cost utility with respect to both the social and economic criteria.

The data indicate that on the basis of economic benefits along ALPS easily meets the strictly economic criterion for deployment, i.e., $\frac{\$\ \text{Benefits}}{\$\ \text{Costs}} > 1$. These figures, however, represent only the performance of ALPS in New York City. The findings of the New York City analysis were generalized and applied to other populated areas of the state. The results showed that if ALPS produced a moderate crime deterrent effect, three other SMSA's, Buffalo, Rochester and Albany-Schenectady-Troy, would also meet the economic criteria for deployment. The extent of deployment in these three areas, however, would obviously be less extensive than in New York City.

Expanding the criteria for deployment to include the social aspects of ALPS will undoubtedly justify the system's use beyond the confines of the four SMSA's, as well as provide the rationale for increasing the deployment densities within these areas.

The justification of more extensive coverage, however, will depend upon the subjective valuations placed upon the social and public interest benefits by the general public, the state legislature and cognizant law enforcement officials.

D. Task Heuristics and Methodology

This section describes the heuristics and the methods used to evaluate the cost utility of the Automatic License Plate Scanning System. An enumeration of the tasks and the techniques used for task accomplishment follows:

1 - Compare ALPS with current methods and other candidate systems.

An a fortiori or worst-case type efficiency comparison was made between ALPS, the traditional methods and other leading candidate systems. In this analysis all systems' parameters that would effect the ALPS performance were deliberately chosen so as to inhibit the system's effectiveness. Conversely parameters that would effect the performance of the other systems were biased in favor of the performance of these systems. In spite of these unfavorable biases the performance data showed that ALPS was clearly the dominant system.

2 - Conduct a qualitative or quantitative demographic analysis of auto related crimes.

Major crimes involving the use of an auto, auto theft, stolen car related crimes, failure to answer summonses and cigarette smuggling were identified as the major auto related crimes.

National and state crime reports were used to plot the location and density of these crimes. Local police department reports and records provided the quantitative data. In certain cases local officials were interviewed for survey information, expert opinion and consensus judgments. A trend analysis was used to forecast the conditions at the time of the ALPS deployment.

3 - Develop a socio-economic accounting of the penalties that result from wanted plate activities.

The following factors were considered as cost penalties: auto related and recidivism related crime costs and the costs of the criminal justice system allocated to supress these crimes, stolen car accident losses, vehicle damage, recovery and unrecovery losses, insurance costs, warrant costs, cigarette smuggling revenue losses and incarceration costs. The social penalties were documented as life years lost, number of people victimized, number of hospital days experienced, the number of families suffering hardships, the number of auto related and stolen auto crimes committed, the number of man years of criminal activity, the number of boys admitted to a criminal career, and the number of jail years served.

The data was collected from an extensive processing of records and files in the various agencies, from interviews and questionnaire surveys of both agency officials and victims (over 4000 victims were surveyed), from state and local agency reports, from case studies documented in both primary and secondary sources, from expert opinions and consensus judgments, from national statistical budget reports, from typology and property space substructions and an input and output analysis, from inferences made from indicators and index predictors, from systems, statistical and accounting analysis, from on-site survey of locations which in aggregate supported 95% of the criminal activity in question and from interviews with spokesmen from relevant national and state agencies which might have knowledge or data on the selected parameters.

4 - Identify and assess the impact areas where ALPS might serve to reduce the cost, the societal and victim penalties.

Benefit assessments were made on the basis of the maximum number of hits that an ideal and conceptual system would make if deployed.

5 - Develop a formulation which relates the system's performance to costs and benefits.

A model expressing the relationships between the various cost savings benefits and the operational performance variables was developed. A similar model for the reduction in societal penalties was also constructed.

The figure of merit was then expressed by two indicators: the ratio of dollar benefits to cost and the ratio of the reduction in the amounts of the various indicators of societal penalties to cost.

6 - Describe the factors, the dynamics and the behavorial patterns of the various auto theft activities within a given environmental setting.

News releases, police department and concerned agency surveys were used to describe the inter-state car flow. On-site visits to the police agencies of all SMSAs were conducted to document the intra-state flows. A detailed analysis of the New York Waterfront Commission's investigation files and the New York City, Nassau County and Yonkers Police department records provided a thorough documentation of the New York City SMSA's recovered stolen car flow patterns. However, with the exception of the international exports, the quantification on the unrecovered stolen car flow patterns was very limited. The criminal typologies of auto thefts were substructed from a detailed survey of 1,500 auto theft victims and from an analysis of all stolen car canceled and uncanceled files for New York City for the last three years.

7 - Describe the factors, the dynamics, the behavorial patterns, the processes and the functions and the costs and the effectiveness of the components of the criminal justice system allocated to the suppression of auto related crimes.

Systems and input/output analyses of all relevant criminal justice functions were conducted with respect to services and costs.

The data were derived from department reports, on-site facility surveys, budget records, information files and national and state reports on the various criminal justice system functions and costs.

8 - Specify the system's operational requirements and constraints and capabilities.

The major political police jurisdictions were visited in an attempt to obtain the requirements of the various departments. Traffic flow maps, crime patterns and the various parameters likely to effect ALPS deployments were also studied. Quantitative data describing the ALPS system and its operational performance were obtained from two feasibility studies previously conducted by the Itek Corporation and the Bendix Corporation.

9 - Simulate the ALPS system deployed in operational environments under both realistic and unfavorable conditions and access the systems performance.

Several paper simulation exercises were conducted. On the basis of these studies, the operational productivities of ALPS was estimated by simulating the systems within the known context of a given geographic space and criminal behavior patterns. In the course of the study a total of four simulation results were generated, each under a different set of behavioral assumptions. In each instance the simulation model was sufficiently detailed so as to provide performance data as a function of the operational and environmental conditions and the assumptions on the behavior of the various types of auto thieves apprehended or deterred.

10 - Determine the cost of operating the system under these conditions.

The total system procurement operating and support costs were calculated over a five year period.

11 - Valuate the benefits derived from the services performed by the system.

The benefits derived from the system services were evaluated at three different levels of complexity. The simplest concept considered only direct dollar benefits. The more complicated iteration included all indirect dollar benefits. The most difficult reiteration identified and described the social benefits in quantifiable terms.

12 - Conduct a cost benefit analysis.

Subsequent to the simulation runs ALPS and its basic components were costed over a five year operational period. These costs, representing a five year undiscounted outlay of $10,500,000, were then related to the system's total quantifiable benefits, for each of the four simulations ranging from most unfavorable to most probable conditions. The results indicated that even under the most unfavorable set of assumptions the direct dollar benefits derived from ALPS exceeded the system's total cost by a factor of ten, and in each case the total five year costs were easily recouped in the first year of operation.

The total direct and indirect dollar benefits as well as the societal benefits for the most realistic set of conditions were documented and then compared against the system's costs.

13 - Discuss factors likely to effect subsequent deployment.

The various options for the local police jurisdictions, the systems applications and the systems demonstrations, and ultimate field operations were discussed.

PART II - TECHNICAL REPORT

A. Systems Effectiveness and Analysis of Auto Theft Factors

A-1. Current Methods versus Mass Scanning

The primary purpose of this task is to identify the most effective of the given alternatives for the deterrence of auto theft. Comparisons were made between current traditional procedures and selected innovations in mass scanning techniques that have recently become part of the state-of-the-art.

The systems selected for study are:

(a) Radio and/or Telephone,

(b) Teletype and/or Radio Teletype,

(c) Optical Scanning,

(d) Police Patrol, and

(e) Auto Theft Squad.

A fortiori cost utility type analysis technique was used for efficiency comparisons between the various systems in the hope of locating the dominant system early in the study.

This analysis does not evaluate performance with respect to the required level of effectiveness, but it does serve to identify the most efficient alternative.

Since the optical scanning technique was selected for valuation, the analyst purposely chose the high range of all the cost estimates used to price the system. Conversely the pricings of the other alternatives were underestimated. The theory being that if the optical scanning system is the better choice, it will demonstrate so, in spite of the bias.

With the exception of the operational systems, all alternative systems were configured to a specified level of operational performance and then priced. The performance criteria was arbitrarily chosen from a conceptual analysis of baseline systems. In reality, down stream design constraints or improvements may raise or lower this arbitrary comparison standard slightly. However, in this analysis the basic unit costed must scan four lanes of highway with 60% efficiency over a five year period. If deployed according to the guidelines established by subsequent analysis, this unit should yield 8,500 hits in five years or 1,700 hits per year. In other words, all systems were planned so as to give equal performance, hence the only parameter that varies is the cost of the baseline system. For example the basic optical scanner in the system will cover four lanes and give 1,700 hits per year. All other systems must be configured to achieve the same level of performance. If only cost is allowed to vary, the index of efficiency is then cost per hit.

These baseline considerations were not applied to the current or traditional systems. For those cases the cost per hit index was derived from estimates on the number of man hours spent on the detection of a stolen car by each of the two functional groups, the Auto Theft Squad and the Operational Patrol.

Diagrams of the three scanning concepts are presented in Figures A-1-1, A-1-2 and A-1-3. Figure A-1-1 shows the man scanner/radio or telephone system. One diagram was used

to show both alternatives because as presented they are very similar in concept, performance and cost. Neither the expense of the radio nor the expense of the telephone were considered for the following reasons: the police already have capitalized the radios and the fare for the telephones is relatively small. Therefore, Figure A-1-1 shows that the cost of radio or telephone system which will provide 8,500 hits in five years is $2,400,000 and that the basic cost per hit is $282.00. Similarly, Figure A-1-2 shows the five year charge for a man scanner/teletype or radio teletype system to be $3,624,000 for 8,500 hits or $426.00 per hit. Figure A-1-3 sets the appraisement for the automatic optical scanner over the same time frame at $426,100.00 or $50.00 per hit.

The quotations for the value amounts for the radio or telephone system and the teletype or radio teletype system were deliberately underestimated. For example, the pricing of the former did not consider the procurement, operating and maintenance and supportability or rental costs of the voice control system. Similarly in the radio teletype system, only the direct cost of the teletype were counted. The expenses of the radios were left out.

Conversely, the automatic optical scanner was priced high. The valuation included the outlay for training, total procurement, operations, maintenance and supportability and these charges were probably overestimated by an order of magnitude. The equipment was capitalized over a five year period when the actual capitalization time is likely to be 15 years and no credit was taken for salvage value after the capitalization period.

The same philosophy applied to performance considerations. The man scanners were credited with 60% efficiency while their rated performance is at 50%. (In the Project Corral study one man was able to scan only 25% of the traffic in one lane.)[A-1-1] The automatic system was also rated at 60% efficiency; however, this is the value for the 24 hour worst case condition of scanning.

The two conventional systems for auto theft deterrence, Police Patrol and the Auto Theft Squad, were costed differently. For example in New York City, it is estimated that 4.7% of the police manpower (exclusive of the Auto Theft Squad) is given to the auto theft problem. If 10% of this is taken up by arrests, then 90% or 4.2% is allocated for the detection of stolen autos. If credit is given to the patrol force for all recovered vehicles except those found by the auto theft squad and those cars recovered by other agencies or the owners of the car (30%), then this 4.2% of manpower was responsible for the recovery of 29,050 vehicles in 1968. Oddly enough, this comes out to 1 recovery per man on the force per year. From the above we calculate that it takes 75 man hours or $630.00 to get a hit. If the assumption that the Auto Theft Squad spends 45% of its time on stolen car detection and 55% of its time on thief apprehension and arrest is correct and if we credit the 30 man squad with 847 hits in 1968, then it follows that the auto theft squad gets 29.2% hits per man per year or one hit for every 27.7 man hours. This figures to $230.00 per hit.

The cost values presented in all the above systems represent only the cost for detection. The resources necessary for arrest

were considered common to all and were not part of the subtotals since this task addresses only the problem of detection system relative to cost efficiency.

Table A-1-1 shows the cost per hit index for all systems. Note, that the automatic optical scanner is clearly the most cost efficient. The noncompetive costs of the other configurations reflect the fact that manpower is the single most expensive item. To cut costs you must cut manpower. It is also interesting to see that the Auto Theft Squad's performance compares favorably with the manual scanning systems. Furthermore, note that those detection systems which require a radio might be rejected because of the unavailability of frequencies.

Footnotes

A-1-1. In 1965 the New York City Police Department tested a new technique for the apprehension of offenders connected with a wanted plate. The project was called Operation Corral. The tested concept was essentially a manual scanning system. A police officer stationed in a parked patrol car visually read, and radioed the license plate numbers of passing vehicles to a teletype operator. These number inquiries were sent via the teletype link to another system which contained a computer file of all wanted plate numbers. If the computer search yielded a hit, then arresting officers stationed down the road were notified for the purposes of intercepting the vehicle.

TABLE A-1-1

ALTERNATIVE SYSTEM'S COST EFFICIENCY

(Table A-1-1 presents the cost of all alternative systems considered. If the systems are rated in accordance to a cost per hit index, then the optical system is clearly the dominant system. Systems diagrams and cost component data and pricing techniques are presented both in the text and in Figures A-1-1, A-1-2 and A-1-3.)

	Type of System	Cost/Hit
Mass Scanning Detection	Automatic Optical Scanner	$ 50.00
	Man Scanner/ Radio or Telephone	$282.00
	Man Scanner/Teletype or Radio Teletype	$426.00
Conventional Detection	Police Patrol	$630.00
	Auto Theft Squad	$230.00

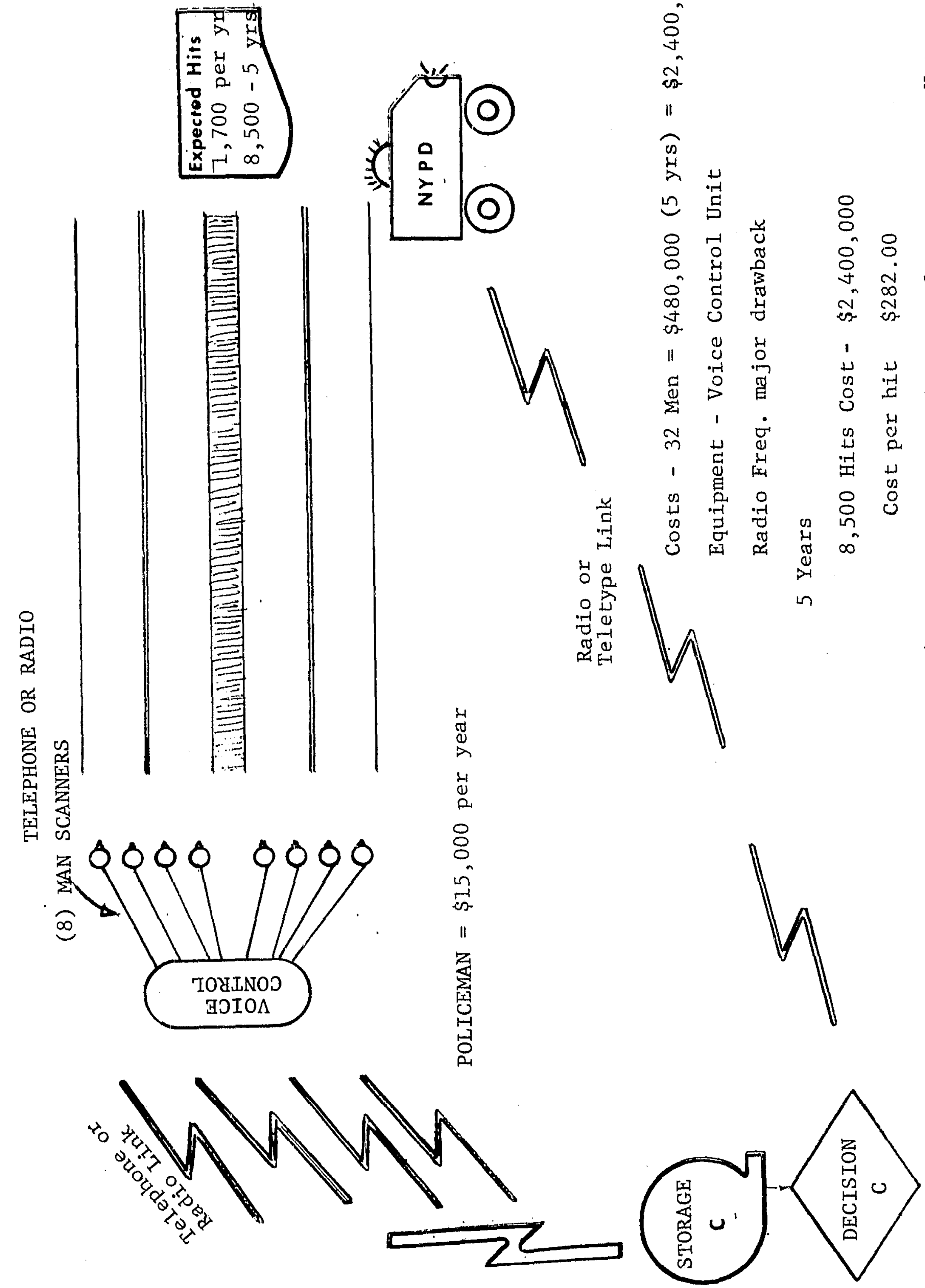
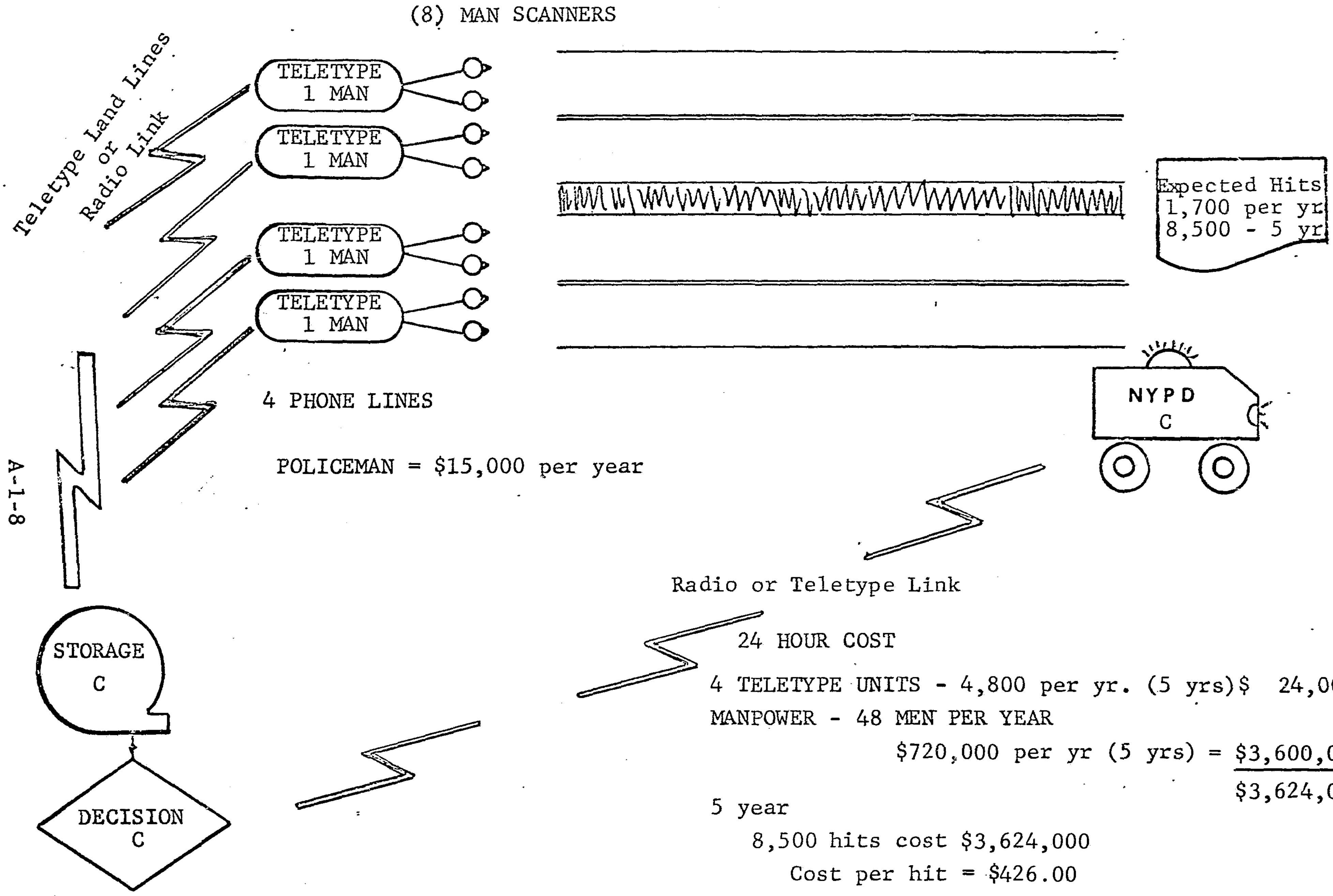


Figure A-1-1 shows a diagram of a man/radio or telephone license plate scanner. Note, the voice control system is necessary to encode the voice signals and address the computer.



24 HOUR COST

4 TELETYPE UNITS - 4,800 per yr. (5 yrs) $ 24,000

MANPOWER - 48 MEN PER YEAR

$720,000 per yr (5 yrs) = $3,600,000

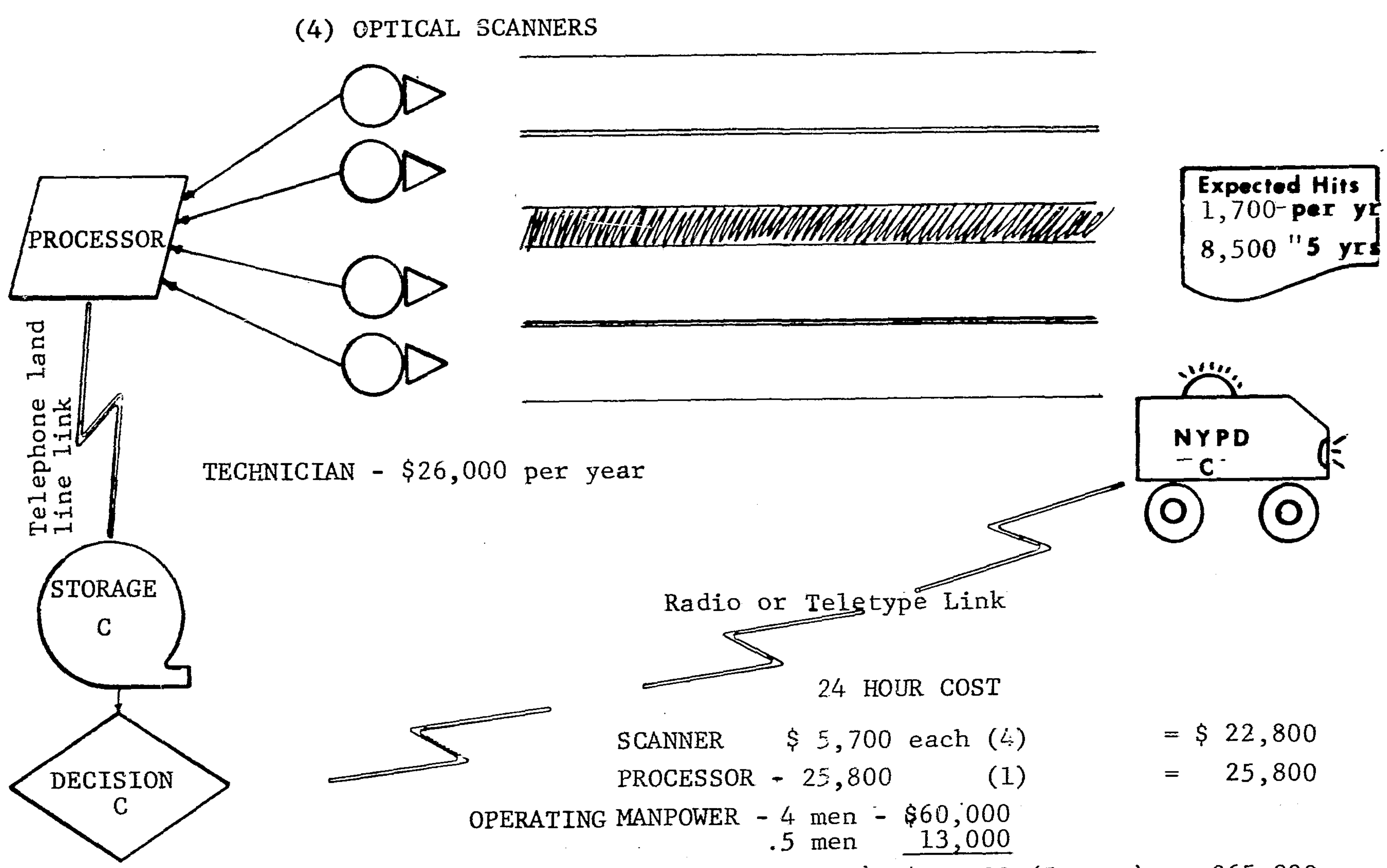
$3,624,000

5 year

8,500 hits cost $3,624,000

Cost per hit = $426.00

Figure A-1-2 shows a diagram of a manned scanner/teletype or radio teletype license plate scanner. The cost schedules represent the costs necessary to obtain a given level of performance.



24 HOUR COST

SCANNER $ 5,700 each (4) = $ 22,800

PROCESSOR - 25,800 (1) = 25,800

OPERATING MANPOWER - 4 men - $60,000
.5 men 13,000

$73,000 (5 yrs.) = 365,000

SUPPORTABILITY AND MAINTENANCE - 5 yrs. 12,500

5 years $426,100

8,500 hits cost - $426,100

cost per hit - $50.00

Figure A-1-3 shows a diagram of an automatic optical scanner. The cost schedule represents the costs necessary to obtain a given level of performance.

A-2. The Impact of ALPS on Auto Related Crime

The first topic to be considered in the task of quantifying areas where an automatic license plate scanning system will have the greatest impact is the subject of auto related crime. This topic includes all crimes which involve an automobile, exclusive of auto theft and auto theft related crimes. The exclusion was necessary to avoid double accounting since auto theft and auto theft related crimes will be treated in the subsequent pages.

Although there appears to be no empirical evidence which identifies the exact proportions of crime which involve the use of an automobile, it is very likely that this proportion represents the majority. Most of the cleared cases are solved because either there is a suspect involved or because a patrol was able to get to the scene of the crime in timely fashion. In the uncleared cases the perpetrators are frequently strangers to the victim. And when one considers where most crimes happen (residence, businesses, public places, street, tavern, school or transport property) it is logical to assume that in more than half the cases the criminals use a car to travel to and from the area, to haul away their loot, to transport or conceal their equipment, to make good a get-away or to plan their work.

However, before attempting to assess the cost penalties of auto related crime these writers found it necessary to delineate the scope of the problem by making the following assumptions: the analysis considered only the three biggest property crimes of robbery, burglary and grand larceny. The data reviewed was limited to the F.B.I. statistics for the Four Standard Metropolitan Areas of Albany-Schenectady-Troy, Rochester, Buffalo and New York. These SMSA's represent 94 or 95 percent of the state's crime. The consensus of this research staff is that about 50 or 60 percent of all of the 335,000 uncleared crimes involved the use of an automobile. Auto theft was excluded from this total since it is being covered elsewhere.

From the Crime Commission's report and from a review of the data provided by the Office of the District Attorney in Queens County on this matter we estimated that from 9 to 10 percent of these property crimes were committed with a stolen auto. Since the losses attributed to stolen auto-related crimes are treated in Section A-10, we reduced our estimate on the number of uncleared auto-related crimes involving property losses by 9% to avoid double accounting. Hence, our projections will be derived by taking 43% of the losses sustained by the three major property crimes.

In 1967 the Annual F.B.I. Index Crime Reports showed that the victims of these crimes in the four referenced SMSA's sustained a property loss of over $86 million. By adjusting this figure down by 57% in accordance to the minimal assumptions stated in the above paragraph we estimate that auto-related crime was responsible for a property loss of $37 million in 1967. Although figures from the Crime Commission's report show the average cost of these three property crimes to the criminal justice system to be $853 per incident, we used a lower estimate

because New York State may spend less per crime than the national figures show. From the New York City Annual Report we determine that the average index crime cost the police $485 and this was the figure used in the following calculation. (100% of the detective force and 25% of the uniformed force are usually allocated to index crimes.) The 1967 F.B.I. Uniform Crime Reports show that there were about 384,000 such property crimes in the four SMSA's. Therefore the three index property crimes probably cost the State of New York's law enforcement agencies over $186 million in 1967. Again if the same delineating assumptions are applied to this value the proportionate estimate is $80 million. Therefore the total cost of the property loss and the police services to the commonwealth is at least $117.5 million for auto-related crime in 1967. Forecasts from this data and the 1968 New York State and national rate increases in crime yield the following loss totals in millions of dollars for the years 1968 through 1972: 145.0, 177.5, 219.0, 267.5 and 309.0.

An automatic license plate scanning system can impact auto related crime in three ways. First of all it speeds up the process of apprehending suspects, for, in many of the cases, one will have a plate number. Second, it can help identify additional suspects for the hitherto uncleared cases. Third, it can provide an arresting officer with prior information on the nature of the alarm.

Without ALPS the plate number of a suspect can be used only to identify the name and address of the wanted person. Apprehension usually follows from an arrest call, a stake-out or an investigation to or in that area. If the suspect's plate number is on the ALPS wanted file the arresting officers have an additional chance to pick up the suspect while he is in transit.

With a small modification the scanning system could be equipped with a one or two-day memory system. This system will have stored information on the coming and going of traffic near the scene of the crime about 2 percent of the time. (ALPS scans about 2% of all traffic) Hence, in about 2 percent of the cases the police will be furnished with a list of car license plates near the scene of the crime at the time the crime was committed. By interrogating the drivers of these cars the police may identify the offenders or witnesses that can provide additional information. Also since about 90 percent of the crime will be committed by a person with a criminal record one can check this list of plates that were in the area against a list of plates of cars known to be operated by suspected offenders.

The 2 percent figure was derived from a deployment simulation study in Section C-2 which assumed a completely random deployment. However if the system were deployed with prior knowledge of the auto related crime patterns the surveillance units would pick up the traffic at the scene of the crime about 4 percent of the time. From the estimates of the cost penalties of auto related crime we can see that a mass scanning

system would save the commonwealth an additional two to four million dollars a year in police time and recovered stolen property.

From a review of the 1967 New York City Police Department Annual Report we see that the municipal police sustained a loss of eight deaths and 1,771 injuries. At least one and perhaps two of these deaths and nearly two hundred of these injuries were sustained while conducting activities related to wanted plates. These injuries probably cost the police at least 1,771 man days of work. Some of these unfortunate experiences would have undoubtedly been avoided had the police been forewarned of a dangerous situation.

Footnotes

A-2-1 The Challenge of Crime in a Free Society, A report by the President's Commission on Law Enforcement and Administration of Justice. 1967, U.S. Government Printing Office, Washington, D.C.

A-3. Auto Theft and Recidivism

While we will probably never know the true cost of recidivism, there is little doubt that this is the single biggest expense to society. Once a boy is arrested for stealing a car the odds are nine to one that he will enter into a career of crime. The profile of this career is well documented in the 1967 and 1968 Uniform Crime Reports. The perpetrator will have seven arrests over a seven year period. His second arrest is more likely to be for auto theft; successive arrests will show a transition through the more serious property crimes to crimes of violence. He will spend at least two years in jail.

Although the real costs of this career have never been measured, predictions made from the Blumstein and Larson model and other consensus data presented in the Crime Commission Report indicate that the arrests will be for two auto thefts, one grand larceny, two burglaries, one assault and either another assault, a forcible rape or homicide. The costs of the arrests and jail are in excess of $30 thousand. And this is just the cost for the criminal justice system alone.

Arrests, of course, represent only the number of times the felon was caught. For repeaters almost always commit several times the number of crimes they are arrested for. For example, extrapolations from the data on crime clearance rates for New York show that the recidivist might very well have committed twenty auto thefts, five grand larcenies, ten burglaries, four robberies, four assaults and maybe a rape or murder, over his seven year criminal career. The price of these crimes to the law enforcement agencies is another $20,000. The victim property loss is $19,000. The total sum of all direct costs of this one recidivist to society is almost $70,000 or $10,000 for every year of his criminal career.

In 1967 there were about 9,000 arrests for auto theft in New York State. With a 90% recidivism rate we calculate that there were probably about eight thousand of these repeaters abroad. The total seven year cost of these criminal careers initiated in 1967 is then probably about 3/4 of a billion dollars.

The total 1967 annual costs attributed to recidivism may have exceeded 80 million dollars. Forecasts for 1968, 1969, 1970, 1971 and 1972 show this yearly criminal career cost to be 100 million, 122 million, 154 million, 198 million and 253 million dollars for each respective year.

This, of course, is only an estimate since these predictions were derived from the Blumstein and Larson probability model. The model did not account for the repeaters successive changes in disposition to commit more serious crimes. That is to say the model was based on the overall frequency with which repeaters committed certain types of crimes. It did not account for the fact that certain criminal careers existed and that the experience of committing a crime increased the felon's tendency

to commit a more serious crime next time.

However, these severe cost burdens are all but dwarfed by the social penalities. For auto theft appears to be one of the major critical incidents towards an extended period of criminal activity and anti-social behavior. And how can you put a value on the loss of crime-free youth years?

In an attempt to make some quantitative estimates on the number of boys caught up in this seemingly irresistable process to produce outcasts, we first attempted to substruct some characteristics about the population of the young people who commit these auto thefts.

Initially these boys do not appear to be predisposed toward delinquency. Surveys conducted by Erwin Schepses[A-3-1] The Department of Justice[A-3-2] and Fritz and Storch[A-3-3] show the primary motivation for the crime was not criminal intent, malice or personal gain but rather to have a good time.

Erickson and Empey,[A-3-4] while studying the effects of undetected delinquency, selected a control group of sixteen and seventeen year olds who were judged as non-delinquent. None of these boys had had any previous encounters with the law and none were noted for misconduct. While the sample was small it showed that one out of fifty of these boys had been involved in a few auto thefts. If there is a relationship between the number of cars a boy steals, the possibility of arrest and a start of a criminal career, then we estimate that one out of every fifty non-delinquent high school boys has a twenty-five percent chance of developing a criminal career. In 1967 there were about 250,000 boys entering into the 16 - 17 year age bracket of which 5000 may have had perhaps four exposures to the auto theft experience. From the statistics on repeaters we might hazard a guess that twenty-five percent, or 1,250 of these youths might become professional law breakers. These estimates are further supported by the statistics on recidivism. In 1967, ninety percent of the 7,500 non-juvenile arrests for auto thefts had previous records. The remaining 750, mostly seventeen and eighteen year olds, were classified as new criminal career admissions. Also of the 1,500 juveniles arrested in 1967, 40% or 600 had had no previous offenses. Hence by this logic a total of 1,350 boys are thought to have entered the auto theft criminal career in 1967. Both of the above methods of estimation appear to yield comparable results. The total loss attributed to the criminal career of those 1967 novitiates is perhaps 9,000 crime-free years.

After considering the increase in crime and the differential increase in the population of the auto theft career age group, we forecast the number of new boys introduced into a career of crime through auto larceny to be about 1,500, 2,000, 2,500, 3,200, and 4,100 for the respective years of 1968, 1969, 1970, 1971 and 1972. This means that there is likely to be just as many so-called man years of new criminal activity added to the labor pool of illegal occupations each year. And auto theft is undoubtedly one of the major critical incidences involved in this recruitment.

Speculation as to the population of people who commit crimes is subject to many uncertainties. However, because of the tendency to repeat, the tally of stolen autos is much larger than the population of perpetrators. These habitual tendencies are greater in some subgroups than others. For example, some professional law breakers or delinquents may steal up to ten or more cars a year. While the transportation, the borrower, the joy rider type thieves may steal only two, three or four cars each year. Therefore the population of motor vehicle thieves is likely to be small. Just how small? We do not know for sure, but we think about 18,000 people were responsible for the 83,000 auto thefts in 1967. We also expect this population to increase with the crime rate. We predict the population of auto thieves to be 21,000, 28,000, 36,000, 44,000, and 60,000 for the years 1968, 1969, 1970, 1971 and 1972. These predictions refer only to those actually responsible for the removal of the automobile from its owner. No attempt was made in this section to account for all possible persons who may have been involved. This topic is addressed in Section 11 which deals with auto theft accomplices.

We must of course caution against the use of these auto theft crime population estimates. The forecasts were based on very limited and uncertain observations and data, which was recorded during a time period of much change. Hence, these forecasts are offered only as an early attempt to get some scope and perspective on the problem rather than to provide the state-of-the-art with definitive evidence. Table A-3-1 shows an attempt to develop a hypothetical substruction of the said population for New York State in 1967. In addition to questions concerning accuracy and realism of assumptions the model may be further limited by recent changes in criminal behavior. For example, the rise in professional criminal trade in illegal cars and the prevalence of auto theft as an addict-related crime. The concepts of criminal careers and professional thieves are mentioned throughout this paper. They refer to people who have a period in their lives which is marked by repeated arrests. The criminal careers refer to the time between the criminal's first and last arrests and the number and types of crimes that occurred between the initial and final crime committed This, of course, does not mean that a criminal career that started with auto theft is the exclusive domain for this offense. All offenses are common to all types of criminal careers. The typologies vary with respect to duration of career, age of the offender, and the frequency of occurrence of certain types of offenses.

Knowledge of the population is important to any assessment of deterrent effects. If the estimates of 25 to 30 percent deterrent effect is not unrealistic then one can very well imagine that the suppressive effects will be differentially greater on the younger, inexperienced thieves and the joy rider--perhaps 30 to 50 percent. This will choke off the system's supply of new recruits and the criminal population will eventually decay no matter how persistent the veterans may be. Auto theft will then be a manageable crime.

TABLE A-3-1

POPULATION OF PEOPLE WHO STEAL CARS

Number of People in the Population	Type of People in the Population	Numbers of Cars Stolen
800 [1]	Juvenile delinquents or young offenders	8,000 [2]
4,000 [3]	Professional criminal stealing the car to commit other crimes	8,000 [4]
2,800 [5]	Professional career criminals specializing in stolen autos	28,000 [6]
2,000 [7]	Professional career criminals not specializing in auto theft	2,000 [8]
7,000 [9]	Joy riders	21,000 [10]
1,500 [11]	Borrower or transportation driver	6,000 [12]
18,000		73,000

(Table A-3-1 is a theoretical attempt to substruct the population of people who stole cars in N.Y. State in 1967.)

Note: There were actually about 83,000 cars stolen in N.Y. in 1967 but 10,000 of these vehicles may have been either purposely abandoned or not claimed or accounted for in the police pounds. The footnotes describe the various information sources used to derive the estimates in the column cells.

1.) This population estimate was derived from field trips to all N.Y. SMSA Police Departments, the F.B.I. crime report, the Crime Commission report, the N.Y C.P.D Annual Report, N.Y.C. court records and the Erickson & Empey study. 2.) The number of cars stolen by individuals in this population was extrapolated from the Erickson & Empey study. 3.) Number of people and the frequency of occurrence were arbitrary estimates. 4.) The number of cars stolen for this purpose was extrapolated from data in the D A.'s office, Queens Co., N.Y. 5.) The enumeration of this population was based on arbitrary estimates made after reviewing the files of several such cases[A-3-5] and after conducting an analysis of unrecovered stolen car flow patterns. 6.) (Same as 5). 7.) This data was extrapolated from the Blumstein & Larson model[A-3-6]. 8.) (Same as 7.). 9) The estimates on the number of possible joy riders and the number of crimes they are likely to commit was based on extrapolations from the 1960 census and the Erickson & Empey study. 10.) These numbers were derived from an analysis of recovered stolen car flow patterns presented in this report. 11.) (Same as 10 and arbitrary estimates.) 12.) (Same as 11).

Footnotes

A-3-1 Schepses, Erwin, "Boys Who Steal Cars," Federal Probation, December 1960.

A-3-2 Braun, Richard, Auto Theft Survey, United States Department of Justice, Washington, D.C., 1967.

A-3-3 Fritz, G. and Storch, S. An Examination of Physical Characteristics, Interpersonal Relationships, and Personality Traits of Multiple Adolescent Car Thieves Who Were Under Supervision of the New York State Division of Parole Between September 1, 1967 and March 31, 1966. Masters Thesis, Syracuse University Library, 1966.

A-3-4 Erickson, M.L., and Empey, L.T., "Court Records, Undetected Delinquency and Decision-Making," The Journal of Criminal Law, Criminology and Political Science. 1963, 54 (4), P. 456-467.

A-3-5 Criminal Career recidivists model predicts two auto theft arrests in two years. For this arrest rate it is highly probable that the perpetrator is stealing perhaps ten or more cars a year. Some of the cases documented by the files of the WaterfrontCommission showed that some professionals were stealing a car a day.

A-3-6 Blumstein, A. and Larson, R.C. "A Systems Approach to the Study of Crime and Criminal Justice." P.M. Morse (Ed.), Operation Research for Public Systems. Cambridge:MIT Press, 1967. P. 159-180.

A-4. Stolen Car Accident Loss

Auto theft is undoubtedly one of New York State's costliest, fastest growing crimes. Instances of theft have nearly tripled in the last decade and may triple again in the next five years (see Figure A-4-1). In 1972 over 1/3 of the 250 to 300 thousand auto theft victims will be visited with death, injury or hardship (see Figure A-4-2); thousands of young men will be started in a criminal career and the cost to the commonwealth and its people could be in excess of a billion and a half dollars. A stolen car is frequently an instrument in the commission of other crimes, the cause of a serious accident, the booty of youth's first offense, the loss of a family's biggest single investment, and/or a significant cost to the criminal justice and social systems. The purpose of this task is to quantify these losses. The first cost analysis will deal with stolen vehicle accident losses exclusive of vehicle damage. Stolen vehicle damage and recovery losses, insurance and criminal justice costs and additional indirect costs will be documented in subsequent analysis.

The cost accounting of auto theft stolen car accident losses considers only the private and public disbenefits that result from a stolen car accident. The factors to be studied under private losses are death, personal injury, and private property losses, i.e., medical and funeral costs, loss of potential earning power, private property damage and the owners "out of pocket" expenses such as transportation costs and possible

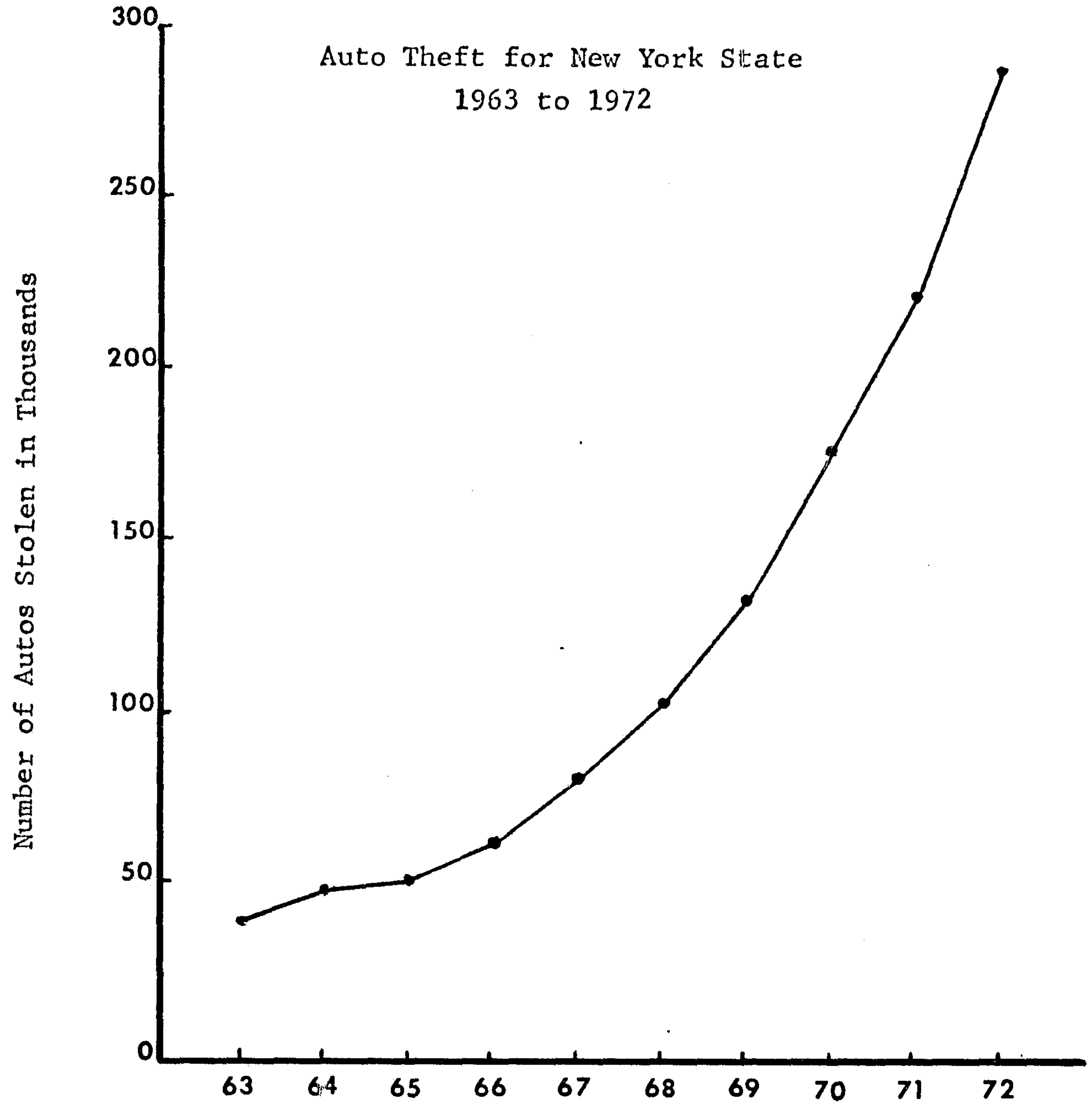


Figure A-4-1 Auto theft is shown as a function of time over the last decade, for New York State. The data for the years 1963 through 1968 were taken from the FBI Uniform Crime Reports. The forecasts for 1969 through 1972 were derived from extrapolation based on the survey analysis conducted by this study. Note the exponential increase from 1969 to 1972. This is partially alarming when one considers the fact that these forecasts were dampened to account for population and physical constraints.

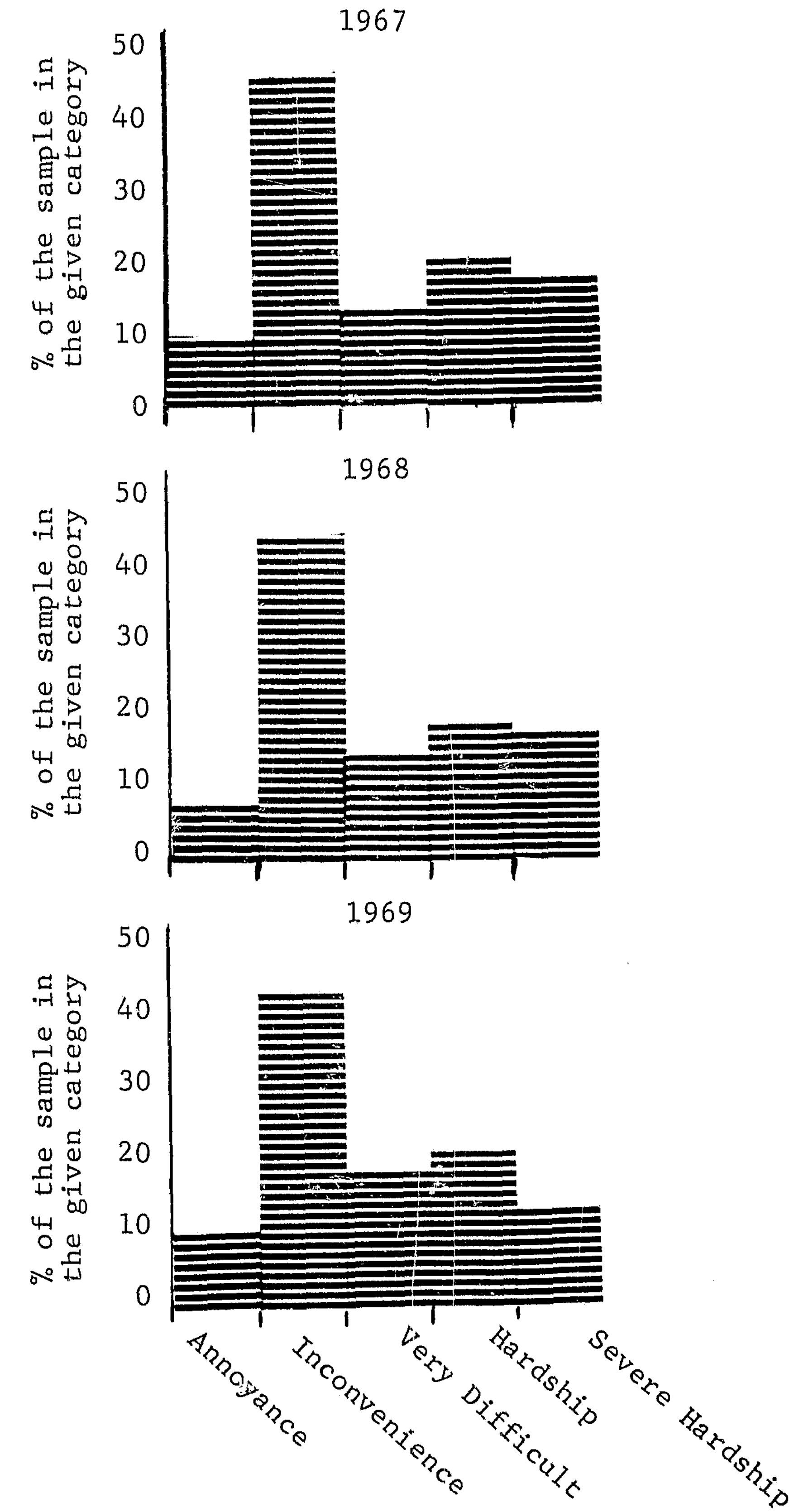


Figure A-4-2 shows the distribution of the various suffering experiences as rated by the New York City auto theft victims over the last three years. That data was tabulated from a survey conducted by this study in 1969. The ordinate shows the percent of the sample population, 1200, that rated the loss of their car as an annoyance, an inconvenience, a very difficult time, a hardship or a severe hardship, respectively.

loss of wages. The most costly private loss item, actual motor vehicle damage, will be treated in detail in Section A-5.

Public loss with respect to the hours and money spent by police and criminal justice agencies in the apprehension of thieves and the processing of auto theft cases will be discussed in detail in Section A-14. Damage to public property and public administration costs will be presented later in this section.

The most important and far reaching private loss is death or personal injury resulting from a stolen vehicle accident. Both the thief, usually a youth, and the innocent victim can be affected by this most serious of consequences to auto theft in loss of life years, in medical expenses, and funeral costs. The seriously injured victim can be deprived of wages if he is unable to work due to his injuries. Serious accident injuries which require extensive medical treatment or long term care, or which leave the patient physically impaired permanently or for a substantial duration, result in staggering medical bills not always covered by insurance.

Property damage is the second area of private loss due to stolen car accidents. Extensive damage to vehicles, grounds, buildings and other objects is done by the reckless or frightened auto thief who loses control of the vehicle he steals.

Finally, consider the "out of pocket" expenses of the owner of the stolen vehicle such as his additional transportation costs and other inconveniences. He may be forced to

rent a car or use public transit systems, necessitating spending which may not be reimbursed to him. Inconveniences such as business and social delays and schedule rearrangements might result in additional expenditures.

Public property damage in regard to such items as telephone poles, fire hydrants and guard rails also sustain a high incidence of loss, much of which results from the recklessness of the stolen car thief. Each taxpayer is affected by the public bill for property damage that results from stolen auto accidents. These theft collisions also increase the cost of record keeping and information gathering that is necessarily done by the Department of Motor Vehicles in such cases.

Before considering the above factors in detail, note that the base year, used to provide a framework for discussion, is 1968.

The trends presented in the tables of Loss Protection were established either from historical or empirical data for 1968 and all prior years and on whatever data was available for the first six months of 1969. The forecast for the 1969 and 1972 years were based on the rates established by these trends. These yearly trend figures show the rate increase for stolen vehicle accidents and the resulting deaths, funeral costs, injuries, life years lost, hospital day costs, medical costs, lost wages, out-of-pocket expenses, public property damage and public administration costs.

The FBI Uniform Crime Report indicates that 103,577 motor vehicles were stolen in the State of New York in 1968. We shall examine the effect of this statistic on the above mentioned factors in regard to loss, both monetarily and sociologically.

Accident Deaths & Injuries:

A Department of Justice survey[A-4-1*] of past offenders, nationwide, indicates that 18.2% of all stolen cars are in accidents sometime within 48 hours after they are stolen. However, a survey of auto theft victims in New York City, conducted for this report, established that 20% of the City's recovered stolen cars were involved in collisions in 1967. This figure increased to 22% in 1968 and 26% in 1969. However, the statewide figure is about 25% in 1969.

The statewide recovery rate for stolen cars decreases from 70% in 1967 to 58% in 1969. In the City, the recovery rate has decreased from 67% in 1967 to 50 or less percent in 1969. For the purpose of this analysis we have assumed that the City recovery rate will stabilize at 50%, although in actuality it could go lower. If we attribute most of the accidents to the

*See end of Section.

recovered vehicles on the assumption that the unrecovered vehicles are stolen by professionals who wish to maintain the value of their theft, then from the above accident rates we calculate that about 16,825 stolen cars were involved in collisions in 1968. This figure represents about 4% of all New York State traffic accidents for that year. From these figures we can determine that auto theft has a significant effect on the traffic accident rate, a fact which, hitherto now, has been overlooked. Statistics derived from the State Department of Motor Vehicles's published figures underestimate the stolen car accident rate by twelve orders of magnitude. This error is attributed to the fact that usually the New York state law requires only the driver of the motor vehicle to file (however, in special cases, e.g., when the driver is unable to file, the owner may be required to file) and thieves seldom file unless they are caught.

The tally, state-wide, for motor vehicle accident deaths for 1968 was 3,114.[A-4-2] In New York State approximately 1 out of every 132 accidents are fatal. From this ratio we can predict that 127 people were killed in 1968 by stolen autos. The sad part of this story is that perhaps more than 60% of these mortalities are innocent victims. The estimated age of the typical traffic accident death victim is 19.5 years. Hence, the resulting life expectancy remaining for the victim is estimated to be 54.7 years.[A-4-3] From the above 127 traffic deaths, 6,946 life years were lost. While the economic benefits of a life year lost are rendered in the following exercise, the actual cost to society is beyond valuation.

In each case, the death represents a substantial loss in potential earning power of about $175,000 per person.[A-4-4] The total for the 76 persons who are workers (60% of the mortality population are estimated to be in the labor force) is $13,300,000.[A-4-5] Also, funeral costs for 127 people could amount, conservatively, to another $171,450 loss.[A-4-6] Our subtotal, therefore, for losses due to stolen vehicle deaths is $13,471,450.

An even larger cost in dollars and cents, is the number of injuries sustained in stolen vehicle accidents. For New York State in 1968, 355,799 traffic accident injuries were recorded.[A-4-7] In this year about 87% of all New York State traffic accidents resulted in some form of personal injury. If stolen car accidents are no more serious than other traffic accidents, we can conclude that 87% of the 16,825 estimated stolen car accidents resulted in an injury. This calculation shows that 14,638 people were probably injured in this way.

These accidents cause pain, hardship and suffering and cost the victim a great deal of money. An ambulance ride and a checkup and one day in the hospital is likely to cost $216.00. An itemized listing of these costs is as follows: ambulance, $8.50; emergency room, $13.00; one hospital day, $50.00; clinical tests, $47.00; X-rays, $31.00; pharmacy costs, $17.00; physician's fees, $47.50. If the injury is serious the victim is likely to incur additional hospital day costs of $150.00 and additional medical costs, such as, $175.00 for surgery; $72.00 for an operating room; $30.00 for anesthesia; $42.00 for appliances; $52.00 for rehabilitation expenses; $16.00 for out-patient clinic costs; $75.00 additional physician fees and $50.00 added pharmacy costs.[A-4-8]

Just how much of these costs should be allocated to each accident? The heuristics of this cost accounting problem was composed of three basic steps. First, classify the seriousness of the various accidents. Second, determine the range of injuries likely to occur in the various types of accidents. Third, allocate costs to the injuries.

The New York State Dept. of Motor Vehicles has three classifications of accident injuries which rate the victims state of health. The most serious, Type A, is classified by unconsciousness, serious bleeding, distorted or lost members, incapacitation, etc. Type B, an intermediate injury, is classified by bleeding, bruises, painful movements, signs of fractures, and no obvious sign of serious danger. Type C, the least injurious classification, is characterized by momentary unconsciousness, complaints of pain, slight bleeding and bruises and few visible signs of injury. The New York State accident figure also shows that in 1968 15% of the injured were classified as Type A and 26% and 59% were classified as Type B and Type C. From a review of the literature on automobile impact injury,[A-4-9] it is estimated that the Type C or minor injury classification would require the basic injury expenses required for transportation , examination and minor treatment, e.g., ambulance, emergency room, tests, X-rays, pharmacy and physician's fees. The cost of this treatment was estimated to be $166.00. The Type B or substantially injured patient is likely to incur these costs plus the costs of one hospital day, $50.00, and as well as a few of more serious additional medical costs, e.g., surgery, operating room and anesthesia, appliances, rehabilitation, out-patient clinical and added physician and pharmacy fees. The average cost of this additional treatment is expected to be about 90 dollars. The Type A or serious injury is expected to pay the basic accident costs plus $163.00 in extra medical expense and $350.00 for several days in the hospital. From these figures it was estimated that the 2,196 Type A accidents plus the 3,806 Type B accidents and the 1,597 Type C accidents cost the State of New York $1,491,084, $1,164,636 and $1,433,576 respectively in the year 1968. These are probably very conservative estimates. Comparisons between the above calculated figures and those derived by updating a 1963 National Safety Council estimation study show our figures to be low by about 30 percent.[A-4-10]

Forecasts for accidents, accident deaths, injuries, costs and losses for the period between 1967 and 1972 are shown in Figures A-4-2 through A-4-10 as well as in Tables A-4-1 through A-4-10 and Tables A-4-12, A-4-15, A-4-16 and A-4-17.

The number of hospital days necessitated by these injuries was computed in the following way. The most serious Type A requires 1 week of hospitalization and comprise 15% of the total number injured. Those less seriously injured but still requiring 1 day of hospitalization, Type B, comprise 26% of those injured. The remaining 59% in Type C complain of injuries and are treated and released and require no hospitalization. The total number of hospital days required to treat both Type A and B injuries in 1968 for New York State is 19,178. A Projection Table for this source of loss for 1967 through 1972 is presented in Table A-4-10.

The cost for the 1968 hospital days (19,178 days) alone constitute a $1,035,612 loss. If each one of the injured auto theft accident victims had the estimated amount of medical treatment, the resulting total loss to the victims would be $4,089,296.

Next to be determined is the lost time from work due to injuries or impairment. Each worker who is injured loses approximately $21.85 per day in time from work, accounting for weekends and holidays.[A-4-11] The working force injured in 1968, 60% of the total, numbers to 8,783 men and women.[A-4-12] Fifteen percent of these are hospitalized for one week and lose one month of wages or about $8,626,635. The 25% who are hospitalized for one day lose about one week of wages or $349,299. The remaining 59% lose at least one day of work or $113,226. The total amount of wages lost is $1,325,160.[A-4-13]

To sum up the total loss for death and injury arising from stolen vehicle accidents is $19,921,518.

Private Property Damage

Private property damage is the next item to be considered in the tabulation of stolen car accident loss. Such items as lawns, trees, fences, building fronts and other vehicles show a high incidence of loss, due to stolen auto accidents. We can obtain some indication of the private citizens annual loss by the same method we used in determining the injury and fatality rate. New York State experienced 186,191 incidents of property damage due to auto accidents in 1968.[A-4-14] The ratio of property damage incidents to accidents is 45%. From this percentage and from the incidents of property damage, we calculate that about 7,577 incidents were caused by stolen cars that year. Insurance company estimates indicate that each property damage claim averages about $100.00. In this case, the private property damage loss due to stolen car accidents would be $757,700.

Finally the "out-of-pocket" expenses of the 16,825 owners of stolen vehicles involved in accidents must be considered.

The victim has lost the use of his car, which may necessitate several additional expenses. He may find it necessary to rent a car or use a public transit system to get to work. He may have

to fly or take the train or bus for business trips he would ordinarily have driven to. His wife has to use public conveyance or a taxi for grocery shopping, etc. His insurance company may help defray the rented car cost, but not until 48 hours after the vehicle is reported stolen. Their maximum reimbursement is $10.00 a day for 30 days.

The most frequently quoted fee on a rented car from the recognized agency is $12.00 per day and 12¢ a mile.[A-4-15] The usual total trip public transportation costs range between 20 and 40 cents one way. If the victim rents a car for a month and is reimbursed by his insurance company to the maximum, he spends $60.00 of his own money. If he travels 20 miles to work and back every day for 22 working days that's $52.80; the total loss is $112.80 a month just to go to work. Even if the unfortunate owner can take the transit system, at 60¢ a day, his monthly loss is $13.20.

The average time a vehicle is gone after theft is about 10 days. This includes police recovery time, owner location, notification and recovery time. The total cost for the collision victims is 168,250 rental days. Of those stolen vehicles which will be returned after a collision, 36% or 6,057 were not driveable. This information was obtained from a survey of 1967, 1968 and 1969 auto theft victims conducted by these authors. When one accounts for an average of 5 days of repair time, add another 30,285 rental days to the total. Of the 64% (10,768) returned in driveable condition, 70% (7,537) needed some type of repair. This factor adds another 7,537 more rental days to the total. The final estimate is the cost of 206,072 rental days for the year of 1968. At a twelve dollar a day rental charge and at a 10 mile a day average mileage at a 12¢ a mile charge, the total daily charge is $13.20 for the average vehicle. The resulting costs total to $2,720,150.

The above survey also indicates that 36% of these car renters loses an average of $72.00 on transportation cost, either because they are not fully reimbursed by their insurance companies or they are not insured for theft. The personal loss then for these 6,057 people totals to $436,104.

It is difficult to estimate what additional inconveniences and expenses are incurred by the stolen car owner while he is without his car during its repair. But certainly additional costs result from rescheduling business and social trips and the solving of transportation emergencies. Clearly then, although "out of pocket" expense is a nebulous and highly fluctuating factor and a dollar value cannot be placed on inconvenience, it is an item to be considered both monetarily and sociologically.

Public Property Damage:

Turning now to public loss we must consider property damage to such items as telephone poles, fire hydrants, guard rails and the like. A large quantity of these articles are damaged yearly and an appropriate estimate should be made with regard to the loss due to stolen car accidents.

Our calculations indicate that approximately 3,788 incidents of public property damage due to stolen cars occurred in New York State in 1968, or about half of the number of private property damage accidents. The estimated cost of maintenance on these damaged items is about $100 per incident, therefore, we have established a figure for the public property damage bill from stolen cars at around $378,550.

Cost of Public Administration

The final item in this section concerns the cost of public administration of records and information by the DMV for stolen car cases. Vehicle and traffic laws for New York State require the driver of a vehicle involved in an accident to make a report to the DMV. The owner of the car is not always required to report this accident. Therefore, in the case of stolen car accidents, the DMV receives reports on only a fraction of the occurrences. Some of these were made by owners who volunteered or were required to file because the driver was not able to file. In some cases the police filed. Sometimes the thief who was caught at the scene of the accident was required to submit a report.

We can verify this assumption by noting that only 1,236 stolen car accidents were reported to the New York State Department of Motor Vehicles in 1968. Our survey indicated that in the same year there were 16,825 stolen vehicle accidents. The DMV, therefore, has very few stolen vehicle accident claims to process. According to the administrative offices of the DMV, an accident report can be completely processed for $2.80 bringing the cost of public administration of stolen vehicle accident reports to $3,463. Hence, this is a minor cost factor.

Calculations from the IITRI 1969 Auto Theft Survey also indicated that the grand total, statewide, in 1968 for stolen car accident loss is 20,461,123 dollars. A breakout of relevant component subtotals is presented in Table A-4-1. Table A-4-2 shows a comparable breakout for New York City.

Table A-4-3 shows the frequency of stolen car accidents predicted for the years 1967 through 1972 for both New York City and New York State. Similarly, Table A-4-4 lists the State and City accident deaths for the years 1967 through 1972. Table A-4-5 lists the stolen car accident death funeral costs for the years 1967 through 1972. Table A-4-6 shows the frequency of stolen car accident injuries that have occurred or will occur for the years between 1967 and 1972. Tables A-4-7, A-4-8 shows the actual and forecasted annual medical and hospital day costs that result from these injuries. Tables A-4-9 and A-4-10 show the annual number of life years lost and the number of days victims spend in hospitals because of stolen car accidents. Table A-4-11, A-4-12, and A-4-13 show the annual costs for each year in question of stolen auto private property loss, out of pocket expenses, public property damage and public administration costs. Table A-4-15 shows the dollar amount of the wages lost because of the accident. Tables A-4-15 and A-4-16 sum up the total of direct stolen vehicle accident dollar value losses for the years 1968 through 1972.

The final tabulation shows that stolen vehicles will cause 46,149 accidents, 350 deaths, 40,610 injuries, 109,948 days in the hospital, and 19,122 life years to be lost in 1972. The direct cost of these accidents total to $56,800,142.

TABLE A-4-1

1968 NEW YORK STATE STOLEN CAR ACCIDENT LOSS

Lost life years	6,946 years	
Potential earning power		$13,300,000
Funeral costs		127,000
Hospital days sustained	19,178 days	
Medical costs		4,089,296
Lost wages		1,325,160
Private property damage		757,100
Out-of-pocket expense		436,104
Public property damage		378,550
Administrative costs, DMV		3,463
		$20,416,673

TABLE A-4-2

1968 NEW YORK CITY STOLEN CAR ACCIDENT LOSS

Lost life years	2,516 years	
Potential earning power		$4,900,000
Funeral costs		46,000
Hospital days sustained	10,985 days	
Medical costs		2,379,923
Lost wages		764,807
Private property damage		529,970
Out-of-pocket expense		248,913
Public property damage		264,985
Administrative costs, DMV		1,929
		$ 9,136,527

TABLE A-4-3

ANNUAL TOTALS OF STOLEN VEHICLE ACCIDENTS

	New York State	New York City
1967	13,200	7,212
1968	16,825	9,603
1969	21,448	12,389
1970	27,689	16,005
1971	35,747	20,663
1972	46,149	26,676

TABLE A-4-4

ANNUAL TOTALS OF STOLEN VEHICLE ACCIDENT DEATHS

	New York State	New York City
1967	100	34
1968	127	46
1969	162	59
1970	209	76
1971	270	98
1972	350	127

TABLE A-4-5

ANNUAL FUNERAL COST TOTALS FOR STOLEN CAR ACCIDENT DEATHS

	New York State	New York City
1967	$ 100,000	$ 34,100
1968	$ 171,450	$ 61,101
1969	$ 295,893	$ 106,186
1970	$ 515,406	$ 185,999
1971	$ 836,388	$ 323,071
1972	$1,566,208	$ 563,853

TABLE A-4-6

ANNUAL TOTALS OF STOLEN VEHICLE ACCIDENT INJURIES

	New York State		New York City	
1967	11,616	Injuries	6,347	Injuries
1968	14,638	"	8,451	"
1969	18,873	"	10,965	"
1970	24,366	"	14,085	"
1971	31,457	"	18,183	"
1972	40,610	"	23,474	"

TABLE A-4-7

ANNUAL STOLEN CAR ACCIDENT MEDICAL COSTS

	New York State	New York City
1967	$ 3,534,804	$ 1,999,135
1968	4,089,296	2,379,923
1969	5,682,093	3,284,499
1970	7,927,608	4,683,464
1971	11,035,915	6,379,127
1972	15,430,324	8,919,561

TABLE A-4-8

ANNUAL STOLEN CAR ACCIDENT HOSPITAL DAY COSTS

	New York State	New York City
1967	$ 627,240	$ 342,705
1968	1,035,612	593,216
1969	1,712,189	994,676
1970	2,895,389	1,658,075
1971	4,790,165	2,768,941
1972	8,026,233	4,639,379

TABLE A-4-9

ANNUAL STOLEN AUTO ACCIDENT LIFE YEARS LOST

	New York State		New York City	
1967	5,469	Years	1,864	Years
1968	6,946	"	2,516	"
1969	8,883	"	3,187	"
1970	11,464	"	4,137	"
1971	13,784	"	5,324	"
1972	19,122	"	6,884	"

TABLE A-4-10

ANNUAL NUMBER OF HOSPITAL DAYS ATTRIBUTED TO STOLEN AUTO ACCIDENTS

	New York State		New York City	
1967	12,545	Days	6,854	Days
1968	19,178	"	10,985	"
1969	29,520	"	17,149	"
1970	46,699	"	26,743	"
1971	71,495	"	41,327	"
1972	109,948	"	63,553	"

TABLE A-4-11

ANNUAL STOLEN AUTO ACCIDENT PRIVATE PROPERTY DAMAGE LOSS

	New York State	New York City
1967	$ 584,470	$ 402,770
1968	757,100	529,970
1969	929,716	657,160
1970	1,134,253	801,735
1971	1,383,787	978,116
1972	1,688,219	1,193,301

TABLE A-4-12

ANNUAL STOLEN VEHICLE ACCIDENT VICTIM "OUT OF POCKET" EXPENSES

	New York State	New York City
1967	$ 342,144	$ 186,952
1968	436,104	248,913
1969	555,932	321,134
1970	717,714	414,873
1971	926,567	535,593
1972	1,196,176	691,444

TABLE A-4-13

ANNUAL STOLEN VEHICLE ACCIDENT COSTS DUE TO PUBLIC PROPERTY DAMAGE

	New York State	New York City
1967	$ 292,235	$ 201,385
1968	378,550	264,985
1969	464,858	328,580
1970	567,126	400,867
1971	691,893	489,058
1972	844,109	596,650

TABLE A-4-14

ANNUAL STOLEN VEHICLE ACCIDENT REPORT RECORDING COSTS

	New York State	New York City
1967	$ 3,267	$ 1,820
1968	$ 3,463	$ 1,929
1969	$ 3,670	$ 2,044
1970	$ 3,890	$ 2,166
1971	$ 4,123	$ 2,295
1972	$ 4,370	$ 2,432

TABLE A-4-15

ANNUAL STOLEN VEHICLE ACCIDENT COSTS RESULTING VICTIMS' LOST WAGES

	New York State	New York City
1967	$1,020,373	$ 588,901
1968	1,325,160	764,807
1969	1,708,605	992,914
1970	2,101,584	1,221,284
1971	2,584,948	1,502,179
1972	3,179,486	1,847,680

TABLE A-4-16

ANNUAL NEW YORK CITY STOLEN VEHICLE ACCIDENT TOTAL LOSS PROJECTIONS

(Each cell entry is the dollar amount of the loss incurred. The row by column classification shows the loss categories for each successive year.)

	1968	1969	1970	1971	1972
Potential Earning Power	$4,900,000	$ 5,955,005	$ 7,612,816	$ 9,498,587	$11,903,500
Funeral Costs	61,101	106,186	185,999	323,071	563,853
Medical Costs	2,379,923	3,284,499	4,683,464	6,379,127	8,919,561
Lost Wages	764,807	992,914	1,221,284	1,502,179	1,847,680
Private Property Damage	529,970	657,160	801,735	978,116	1,193,301
Out of Pocket Expenses	248,913	321,134	414,873	535,593	691,444
Public Property Damage	264,985	328,580	400,867	489,058	596,650
Administrative Costs	1,929	2,044	2,166	2,295	2,432
Total	$9,151,628	$11,647,572	$15,323,204	$19,708,026	$25,718,421

TABLE A-4-17

ANNUAL NEW YORK STATE STOLEN VEHICLE ACCIDENT TOTAL LOSS PROJECTIONS

(Each cell entry is the dollar amount of the loss incurred. The row by column heading classification shows the loss categories for each successive year.)

	1968	1969	1970	1971	1972
Potential Earning Power	$13,300,000	$16,503,871	$20,687,000	$24,148,950	$32,891,250
Funeral Costs	171,450	295,893	515,406	836,388	1,566,208
Medical Costs	4,089,296	5,682,093	7,927,608	11,035,915	15,430,324
Lost Wages	1,325,160	1,708,605	2,101,584	2,584,948	3,179,486
Private Property Damage	757,100	929,716	1,134,253	1,383,787	1,688,219
Out of Pocket Expenses	436,104	555,932	717,714	926,567	1,196,176
Public Property Damage	378,550	464,858	567,126	691,893	844,109
Administrative Costs, DMV	3,463	3,670	3,890	4,123	4,370
Total	$20,461,123	$26,144,538	$33,654,581	$41,612,571	$56,800,142

FOOTNOTES

A-4-1: "Accident and Injury Rates" One of the most startling and significant results of the survey was the high percentage of stolen cars which become involved in accidents. Of the total sample, 18.2% of cars stolen became involved in accidents. Many studies have established that most stolen cars are recovered within a period of 24 to 48 hours after theft. When this fact is considered in light of the most frequent purposes of theft (joy-riding and transportation), it is apparent that the great majority of stolen cars are utilized by thieves for only a few hours after their theft. Thus it is a reasonable estimate that most of the accidents occurred within 24 hours after the car had been stolen.

In determining the validity of this figure as an accurate sample of the general accident rate for stolen cars, the probability was considered that many thefts resulting in apprehension might involve wrecked vehicles. Put another way, car thieves whose joyrides ended with a crash would probably be caught more often than others. Thus, the "1st offense" category might show a higher accident rate, since all offenses in this group had resulted in apprehension. To avoid possible bias from this factor, the accident rate was broken down into the last offense and other offenses. A bias was in fact demonstrated, although the difference was not great. Thefts in the last offense only category turned out to have a 20.1% accident rate. Those involving other offenses had an accident rate of 16.8%, with the composite figure of 18.2%. Because of the bias, it was decided to accept the lowest figure -- that of 16.8% -- for other offenses. Since these offenses did not necessarily result in apprehension, it can reasonably be concluded that the accident rate reported by the car thieves who were interviewed should be reliable. (Department of Justice Survey, August 28, 1967.)

A-4-2: New York State Department of Motor Vehicles, Computer printout, 1967, 1968.

A-4-3: World Almanac, 1969.

A-4-4: Derived from the Statistical Abstract of the United States, Department of Commerce, Bureau of Census.

A-4-5: Special Labor Force Report No. 80, Derived from Department of Labor, Bureau of Labor Statistics.

A-4-6: The Community Funeral Society, 40 East 25th Street, New York, New York.

A-4-7: op. cit.,New York State Department of Motor Vehicles; A-4-2.

A-4-8: Hospital Rate Directory; prepared by United Hospital Fund of New York, January, 1969.

A-4-9: New York State Department of Motor Vehicles; op. cit., A-4-2.

A-4-10: Haddon, William, Jr., Accident Research; Harper & Row Publishing Co., New York, 1964.

A-4-11: Derived from the United States Census of Population and Housing, for New York, New York; U.S. Department of Commerce, Bureau of Census.

A-4-12: op. cit., A-4-5.

A-4-13: op. cit., New York State Department of Motor Vehicles, A-4-2.

A-4-14: op. cit., New York State Department of Motor Vehicles, A-4-2.

A-4-15: Hertz-Rent-a-Car; Annapolis, Maryland.

A-5. Recovered Vehicle Damage

This section is concerned with estimating the cost of stolen vehicle damage caused by collisions, looting, stripping, and vandalism. Collision damage is that loss of property resulting from accidents, which in most cases is sustained by the body and the interior of the vehicle. Looting is the theft of articles from within the vehicle which are not considered part of the car. Stripping is the removal of any or all parts of the vehicle body, interior, etc. Finally, vandalism is the simple destruction of all or any part of the car including hard usage. The owner, who has already been deprived of the use of his car for the time it takes to recover, process and transfer the possession of the vehicle, must now wait and pay for the repair of his vehicle. The average transportation cost loss is in excess of $75 for each stolen vehicle. This loss item will be documented below under the topic of "Additional Expenses".

The average real loss per stolen car collision is $430. This figure was derived from a 1967, 1968 and 1969 survey of New York City auto theft victims. This study showed that in 1967, twenty percent of the stolen cars which were recovered were involved in collisions. In 1968 and 1969 this figure increased to twenty-two percent and twenty-six percent respectively. The state wide figure remains at 20 percent. The empirical results are consistent with national statistics that indicate 18.2 percent of all stolen vehicles are in collisions within 48 hours after their theft. A weighted average for New York City and State was used to obtain a state wide figure of 25% for this study.

The referenced survey also provided the following facts: six percent of these vehicles were completely unrepairable and eighteen percent had damages in excess of $500. The repair and total loss estimates ranged from $40 to $1500. The average loss was $430 per incident. Hence, we concluded that twenty-five percent of the 67,300 recovered stolen cars in New York State in 1968 sustained a collision loss of $430 each. Therefore, the stolen car collision loss to the state was $7,234,750 for that year.

The unfortunate part of this evidence is that a great portion of this loss was not covered by insurance. In the cited survey, less than 15% of the people had total coverage and many were completely uninsured for theft. Most of those insured carried only $100 deductible. Consequently, the average loss not covered by insurance was $285 per incident. This figure seems consistent with the New York Insurance Rating Board estimate, which quotes an average collision damage claim of $200.00. Adding a $50 or $100 deductible to this figure brings it up to the survey's total. The final state total valuation of the stolen vehicle body damage loss not covered by insurance is $3,260,685 or 45 percent of the total collision damage loss in 1968.

The cost of collision damage is increasing at a rapid rate. By 1972 the total loss will be $19,844,070, (see Table A-5-1).

Table A-5-1

This table indicates the loss projection for accident damage costs for New York City and State for the years 1967 to 1972.

Collision Damage Loss

	New York State	New York City
1967	$ 6,235,000	$ 4,189,060
1968	$ 7,234,750	$ 4,745,480
1969	$ 9,222,640	$ 5,588,710
1970	$11,906,485	$ 6,938,050
1971	$15,371,210	$ 8,959,050
1972	$19,844,070	$11,565,710

Table A-5-2

This table indicates the loss projection from looting for New York City and State for the period 1967 to 1972.

Looting

	New York State	New York City
1967	$ 2,462,000	$ 1,636,740
1968	$ 2,826,000	$ 1,854,090
1969	$ 3,603,306	$ 2,183,580
1970	$ 4,651,836	$ 2,710,680
1971	$ 6,005,538	$ 3,499,440
1972	$ 7,753,116	$ 4,517,940

Looting:

Theft of personal articles from stolen vehicles also becomes a costly item, particularly when the articles stolen are not covered under the owner's automobile policy. Such items as golf clubs, tape decks, cameras, tools and clothing fall into this category and usually must be replaced from the owner's own pocket.

Empirical data from this study's survey indicates that 21 percent of the stolen car owners in 1968 had vehicles which were looted of personal possessions while the car was in the hands of the thief. The average loss per looting incident was about $200 bringing the total loss evaluation from the looting of stolen autos to $2,826,000. This figure is perhaps a high estimate since some of the questionnaire respondents may have considered stripping loss under this category. However, the above figure will be used for valuation purposes since this same error source would have provided a counterbalancing low estimate for the stripping losses. From Table A-5-2 we can see that the looting losses are likely to exceed $7,753,116 for New York State in 1972.

Stripping:

Of course, the most lucrative field for the car thief, outside of actually selling the vehicle in its entirety, is to sell it in parts. Many items such as tires, transmissions, radios, bucket seats, tape decks and engines can be disposed of quickly and profitably by the thief. The perpetrator takes

a relatively small chance and the owner seldom recovers his lost items. Many of the parts are not numbered or traceable in any way that is applicable for police use and once the item is installed in a legally licensed vehicle the property is usually hidden from suspicion.

In 1966, an empirical study conducted by the New York Police Department Crime Analysis Section indicated that 23 percent of all stolen cars are stripped of some or all of their parts. Questionnaires sent to 1967, 1968 and 1969 auto theft victims by these authors indicate the stripping rates to be 22, 23 and 29 percent for each respective year. From the above consensus of data points these researchers chose a 25 percent stripping rate to be the best estimate.

Stripping, however, has become an increasingly professional operation. Large rings have been uncovered where professionals take orders for parts and will steal a particular car because they have a buyer for its engine or its front end or rear quarter panel. That particular part is sold and the rest of the car's parts are stripped and stored according to their category and sold whenever a buyer comes along. Of course, this car represents a total loss to the owner. The research conducted by this study staff indicates that fifteen percent of the stolen recovered car stripping can be attributed to professionals. Estimates of the value of the removed articles of cars stripped down to the frame showed this to be a business with a $3,084,300 volume in 1968. In addition, at least another fourteen percent of these stripped recovered cars sustained a loss of over $500 each. The total for this loss percent is at least $1,177,750. Over and above the expense of the removed articles, the owner of the recovered car with stripping loss usually has to pay for the damage done to the car during the illicit component removal. In some cases this can be well over $500.

The total cost of the removed articles and the damage that was done to the car during the stripping was $8,782,650 for New York State in 1968. Table A-5-3 shows that this loss figure will increase to $24,090,039 in 1972.

Vandalism Damage:

The fourth area of damage to be analyzed is vandalism, the willful destruction of any or all parts of the vehicle. Favorite items are: windshield, $100; aerial, $5; tires slashed, $75; interior damaged, $200.

Those surveyed indicated that 28 percent of all stolen cars are vandalized in some way. The average loss attributed to vandalism is $195. From these figures we are able to compile a loss figure of $3,673,800 for vandalism of recovered cars. Again from Table A-5-4, we can see that this loss will increase to $10,079,050 during the year 1972.

Additional Expenses:

Among the host of additional expenses that are incurred when a vehicle is stolen, the most obvious are transportation

CONTINUED

1 OF 4

Table A-5-3

This table indicates the loss projection from stripping for New York City and New York State for the year 1967 to 1972.

Stripping Loss

	New York State	New York City
1967	$ 7,569,000	$ 5,085,585
1968	$ 8,782,650	$ 5,760,922
1969	$11,195,986	$ 6,784,695
1970	$14,453,919	$ 8,422,470
1971	$18,660,064	$10,874,565
1972	$24,090,039	$14,037,885

Table A-5-4

This table indicates the loss projection from vandalism for New York City and New York State for the years 1967 to 1972.

Vandalism Loss

	New York State	New York City
1967	$ 3,166,800	$2,127,762
1968	$ 3,673,800	$2,410,317
1969	$ 4,684,297	$2,838,654
1970	$ 6,047,387	$3,523,884
1971	$ 7,807,199	$4,549,272
1972	$10,079,050	$5,873,322

costs, lost wages and the price of the gas in the tank. Of course such things as rearranged business and living schedules and the cancellation of insurance policies and the number of other inconveniences that result from an auto theft cost money; but unfortunately we have not been able to document these losses.

This study survey showed that 48 percent of the victims rented a car for an estimated 5.4 days. The remaining 52 percent either used public transportation or made other arrangements. The total transportation costs were estimated to be in excess of $2,325,600 in 1968.

This same source also indicated that more than 30 percent of the people lost at least three days from work. The aggregate value of this loss is $1,332,540.

Gas is another item. The average thief used 8.3 gallons of the car owner's gas. The total loss for all stolen car owners was $174,980 for our base year.

In 1968 the total additional expenses were $3,833,120. By 1972 this figure will jump to $10,514,701. (See Table A-5-5).

In summary, the total value of the losses for New York State attributed to collision damage, stripping, looting, vandalism and additional expenses were $26,350,320 in 1968. By 1972 this figure will have increased over two and one half times. A summary of all stolen car damage losses and expenses for New York City for the years 1967 through 1972 is presented in Table A-5-6. A similar table for New York State is presented in Table A-5-7.

Table A-5-5

This table shows the documented and forecasted additional expenses for New York State and New York City for the year 1967 to 1972.

Additional Expenses

	New York State	New York City
1967	$ 3,303,680	$2,219,731
1968	$ 3,833,120	$2,514,499
1969	$ 4,886,769	$2,961,350
1970	$ 6,308,774	$3,676,198
1971	$ 8,144,653	$4,745,907
1972	$10,514,701	$6,127,187

Table A-5-6

Loss Projection Table

This table shows the progressive totals of stolen car loss due to damage and additional owner expenditure for New York City.

	1967	1968	1969	1970	1971	1972
Collision Damage	4,189,060	4,745,480	5,588,710	6,938,050	8,959,050	11,565,710
Looting	1,636,740	1,854,090	2,183,580	2,710,680	3,499,440	4,517,940
Stripping	5,085,585	5,760,922	6,784,695	8,422,470	10,874,565	14,037,885
Vandalism	2,127,762	2,410,317	2,838,654	3,523,884	4,549,272	5,873,322
Damage Total	13,039,147	14,770,809	17,395,639	21,595,084	27,882,327	35,994,857
Added Expenses	2,219,731	2,514,499	2,961,350	3,676,198	4,745,907	6,127,182
Grand Total	15,258,878	17,285,308	20,356,989	25,271,282	32,628,234	42,122,039

Table A-5-7

Loss Projection Table

This table shows the progressive totals of stolen car loss due to damage and additional owner expenditures for New York State for the years 1967 to 1972.

	1967	1968	1969	1970	1971	1972
Collision Damage	6,235,000	7,234,750	9,222,640	11,906,485	15,371,210	19,844,070
Looting	2,462,000	2,826,000	3,603,306	4,651,836	6,005,538	7,753,116
Stripping	7,569,000	8,782,650	11,195,986	14,453,919	18,660,064	24,090,039
Vandalism	3,166,800	3,673,800	4,684,297	6,047,387	7,807,199	10,079,050
Damage Total	19,432,800	22,517,200	28,706,229	37,059,627	47,844,011	61,766,275
Added Expenses	3,303,680	3,833,120	4,886,769	6,308,774	8,144,653	10,514,701
Grand Total	22,736,480	26,350,320	33,592,998	43,368,401	55,958,664	72,280,976

A-6. Stolen Vehicle Recovery and Unrecovery Loss

This section attempts to fix a cost value to both stolen cars recovered and unrecovered vehicles. The loss value derived deals only with those costs associated with the vehicle. It does not include accident death or injury, insurance or criminal justice costs. It does include the cost of the unrecovered car, the owner's transportation expenses for thirty days and the articles in that vehicle. This section also documents the out-of-pocket expense, vandalism, looting, damage and transportation losses for the owner of recovered cars. These valuation figures are concerned only with the total loss and do not differentiate out the losses suffered by the owners and the insurance companies.

Unrecovered Vehicle Loss:

A cost accounting exercise for all unrecovered vehicles listed in the New York City police stolen auto files for the years 1967, 1968 and 1969 shows the average value of the unrecovered cars to be $1,312, $1,222 and $1,217 for those respective years. From an analysis of the distribution of cars stolen it is apparent that there is a slight preference for older model cars in 1968 and 1969. This may be a result of the new locking devices. In 1968, 36,260 cars valued at $1,222 each were unrecovered in New York State. This loss is $44,309,720. If we are permitted to assume that unrecovered car owners are no different than recovered car owners, then 48% of these victims will rent a car. If we assume a 30 day period, the total rental costs are (44.30)(.48)(13.20)(30) = $6,892,300. Again, if the recovered car owners are no different than the unrecovered car owners, then they will have lost $200,000 worth of personal property with each looting incident. The total loss attributed to this factor is $1,522,920. The final loss for all unrecovered vehicles for New York State in 1968 is $52,724,940. Hence, when we divide this figure by the total number of unrecovered cars, we find that each unrecovered vehicle constitutes a loss of $1,454 in 1968.

The loss values for the recovered cars have already been tabulated in Section A-5. Comparable figures from this section show that the loss for recovered cars was $26,350,320 in 1968. This is a loss of $391.00 for each stolen car that was recovered in 1968.

However, there is also direct relationship between the loss value and the length of time a car is missing. From Figure A-6-1 we can see that the initial loss is $220.00 and that each day a car remains unrecovered increases this loss by another $20.00. Hence, it is cost effective to recover these cars early.

A summary of both the recovered car and unrecovered car losses is presented in Table A-6-1.

Figure A-6-1 shows the total dollar loss per recovered auto as a function of days missing.

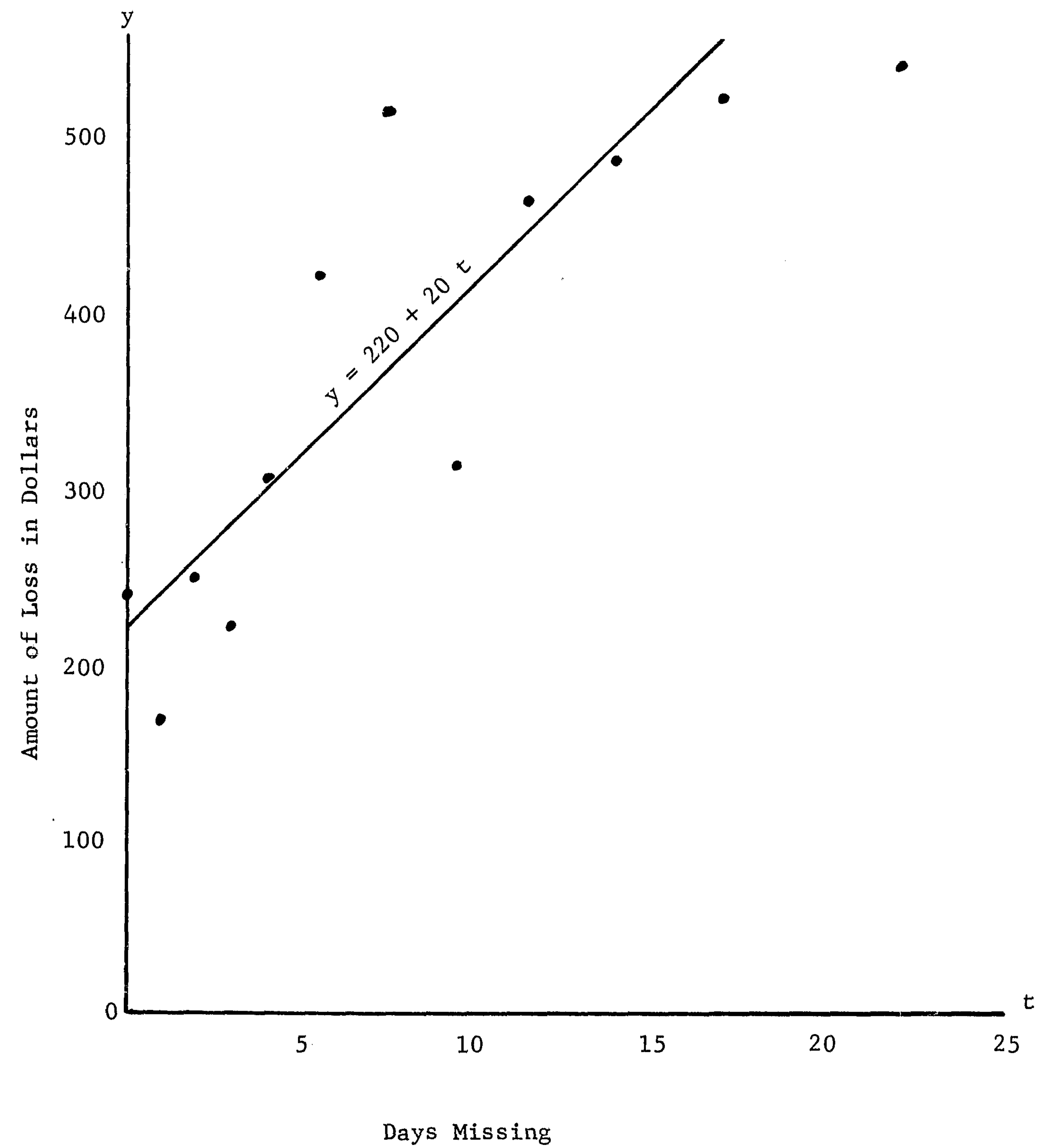


TABLE A-6-1

STOLEN VEHICLE LOSSES, RECOVERED AND UNRECOVERED

(This Table shows the total losses for recovered and unrecovered vehicles for New York State for the years 1968 - 1972.)

	1968	1969	1970	1971	1972
Recovered Car Damage Loss	$ 26,350,320	$ 33,592,998	$ 43,368,401	$ 55,958,664	$ 72,280,976
Unrecovered Car Loss	$ 52,724,940	$ 77,702,346	$112,854,350	$145,690,503	$188,081,889
Total	$ 79,075,260	$111,295,344	$156,213,751	$201,649,167	$260,362,865

Note 1

Both Table A-6-1 and A-6-2 are concerned only with the loss of the vehicle itself and the totals do not contain such items as public loss and administrative expenses.

TABLE A-6-2

PER CAR STOLEN VEHICLE LOSSES FOR RECOVERED AND UNRECOVERED VEHICLES

(This Table shows the loss per car for recovered versus unrecovered vehicles from 1966 through 1972 for both New York City and New York State.

Annual Loss Per Car

	1968	1969	1970	1971	1972
Loss per Recovered Car	$391.00	$391.00	$391.00	$391.00	$391.00
Loss/Unrecovered Car	$1,449	$1,449	$1,449	$1,449	$1,449

Note 1

Both Table A-6-1 and A-6-2 are concerned only with the loss of the vehicle itself and the totals do not contain such items as public loss and administrative expenses.

A-7. Stolen Car Insurance Costs

The valuation of stolen car insurance costs presented in this section was derived by indirect means since these authors were unable to obtain any actual cost data. All of the available auto theft claim payment statistics were components of the aggregate comprehensive premium and claim payment values and could not be separated out.

However, if we assume that the premiums paid into the system are equivalent to the sum of the theft claim payments, the underwriting profits and the administrative expenses for handling these payments, we may be able to derive the insurance costs from this effort's survey data. This study documents both the total amount of the auto theft loss and that part of the loss not covered by insurance. In addition the 1969 Senate Antitrust Subcommittee Hearing conducted by Chairman Philip A. Hart of Michigan may provide some bench marks for estimating the other parameters.

From the valuation study in sections A-4 and A-5, we can see that the 1968 losses which could be claim categories totaled to $22,016,800. However, the insurance companies did not reimburse the total amount of losses and not all people were insured. Data from the Insurance Rating Board on private passenger auto theft losses cite claims paid of $13.2 million. The IRB members pay about 75% of the state's comprehensive insurance claims. From these figures we can estimate the auto theft claim payments to be $17.3 million.

From the above referenced Senate Hearing's data we see that the auto insurance industry averaged a slightly less than 10% profit over the last decade. This same source estimates that administrative costs are about 69% of the payment benefits. However, since 15% of these administrative costs went for defense lawyers, an expense not frequently incurred in auto theft cases, the administrative costs are probably closer to 59% of the claimant disbursements. A breakout of the administrative costs is as follows: agents commission, 34%; adjustment expenses, 16%: selling expenses, 15%; overhead, 13%; and taxes, 7%.

Hence, given the formula:

$$P_r = C + P_f + A$$

where P_r = Premiums,

C = Claim Payments,

A = Administrative Costs and

P_f = Profit.

And as C is known to be \$17.3 million and A is known to be \$10.2 million and P_f is known to be 10% of P_r, then P_r is

(\$17.3 million + \$10.2 million) 1.1

or \$30.25 million. If the premiums are about \$30.25 million then the profit is about \$3.025 million.

In calculating the insurance cost losses, we need only consider the administrative and profit costs, since all the claimant costs have been accounted for in Section A-4 and A-5 of this paper. Therefore, the total 1968 New York State insurance losses is likely to be about 13.2 million dollars.

It is also interesting to note that insurance companies may not experience significant losses from auto thefts. For example, the 30.25 million dollars in premiums paid-in during 1968 invested over the time the insurance company was able to hold the money, probably yielded an additional profit, after taxes, of 4%. This sum is 1.21 million dollars. Since premium rates are adjusted upward to match claim payments, theoretically, there is a direct proportional relationship between an increase in claim pay-outs, rates, premiums, and premium investment yields. However, these theoretical inferences may not hold true for the auto theft insurance businesses. In fact, spokesmen from both insurance institutions and the regulating agencies indicated that the underwriters do little better than break even on auto theft insurance. And it may well be that the rate increases do not always cover the "pay-outs". If this is the case, then the additional profit from the premium reinvestments are needed to cover this erosion in the initial underwriting profits. The result is that any further increases in losses or loss payments would further decrease the underwriting profit margin. Hence, high auto theft rates could drive the auto theft insurance operations out of business.

If we disregard the premium reinvestment factor, Table A-7-1 can be used to show the forecasts for costs attributed to stolen car insurance losses for New York State for the Years 1967 through 1972.

TABLE A-7-1

STOLEN CAR INSURANCE LOSSES

(This Table shows the stolen car insurance loss for New York State for the year 1967 through 1972 in millions of dollars)

	1967	1968	1969	1970	1971	1972
Stolen Car Insurance Costs	$8.8	$13.2	$16.9	$21.5	$27.5	$36.8

A-8. Wanted Plates

So far, this study has been concerned only with the problem of stolen auto plates. In a system such as ALPS, effectiveness is directly related to the size of the wanted plate file. From Table A-1-1 we can see that if we consider warrants, missing persons, and crime related cars we would expand our data bank by another 420,000. If we include scofflaw violators the file would have over three quarters of a million entries.

With a data base of this size on scope a 10 unit deployment of ALPS could produce each day something approximating the following variety of hits: recover 40 stolen vehicles and in most cases apprehend the thief, serve 125 warrants, collar 75 scofflaws, pick up 4 wanted criminals, and locate one missing person. This productivity demonstrates both the versatility of ALPS as a law enforcement tool and its ability to score hits in areas, such as auto theft and warrants, where conventional techniques have been least effective.

The biggest loophole in any scanning system is the problem of cold plates. If a thief replaces hot plates with a set of out-of-state or legally registered plates (which do not belong to the stolen car) he has a very good chance of escaping ALPS detection. If he steals another set of plates the perpetrator will very likely delay the alarm time by six to eight hours. However, if he trades plates it is possible that an alarm will not be issued until the loss is noticed. The time delay in this case may extend a week or more. If the thief drives the hot plated car

TABLE A-1-1

WANTED PLATE DATA BASE FOR STATE OF NEW YORK

(This chart is based on 1968 data and reflects an estimate of the number of wanted plates on the file over a one year period. The information was derived from court records, F.B.I. Crime index and an analysis of major police department's annual reports. State and New York City wide car ownership to population indicators were used to extrapolate values for the number of wanted persons who could be traced to a plate.)

1.	Stolen Vehicles - State of New York.	103,557
2.	Missing Persons statewide with registered vehicles (1/8 of total).	3,000
3.	Approximate number of warrants with registered vehicles	330,000
4.	Crimes having a direct correlation with a known wanted vehicle (except auto theft) (875,000 crimes could be auto related throughout New York State).	87,500
5.	Emergency/non criminal wanted "plates"*	Unknown
		420,500
	Plus Auto Theft -	103,557
	Expected Number of Wanted Plates -	524,057

* Denotes individuals who are on the road and need to be located because of emergencies at home, etc.

away from the scene of the theft, for subsequent cold plating he must get the vehicle under cover before the ALPS alarm is issued.

Such cold plating practices have not been widespread in the past because they unnecessarily increase the thief's risk. Numerous re-registrations and illegal attempts to get cold plates attract the attention of the Department of Motor Vehicle authorities and the auto theft squad detectives. License plate changes conducted on or near the scene of the crime take time and are often noticed by neighbors, passersby, the victims or patrol officers. However once ALPS is operational it is very likely that the thieves will consider these and other types of evasive tactics. But it is also very likely that many of the advantages gained by ALPS detection counter-measure schemes will be offset by the increased risk of detection by traditional police practices and by new police counter-counter-measure innovations. In any case, the freedom of the thief to steal, almost without detection, will be severely curtailed.

We must exclude from this discussion the current and widespread practice of using illegal means to obtain an official registration for the stolen car under the name of an illegal owner. To accomplish this the thief must have already stolen and stored the car. Strong title laws are needed to discourage such counterfeit registrations.

A-9 Figure of Merit

The figure of merit developed in this section can perform a two-fold function: it can be used to compare the ALPS system with alternative systems of license plate scanning, and it can be used to determine if the level of effectiveness achieved by ALPS is sufficient to justify the costs of deploying and operating the system. However, in this study the figure of merit formulation is used only in the latter application. The Fortiori analysis in section A-1 entitled "Current Methods versus A.L.P.S.", demonstrated that ALPS was clearly the dominant alternative. Therefore, the figure of merit concept will serve to evaluate the utility of the system.

The figure of merit selected for this study is the ratio of the aggregate dollar and social benefits gained by society to the total system cost, i.e., $\frac{\$\text{ Benefits}}{\text{System Cost}}$. The system with the greatest ratio of benefits to costs will be preferred over all alternative candidates. In addition, the system will be deemed economically feasible to deploy if $\frac{\$\text{ Benefits}}{\text{System Cost}} > 1$.

In order to circumvent some of the complex problems associated with the quantification of the benefits into the common metric, dollars, the benefits are valuated at three different levels of complexity. The simplest concept considers only the direct dollar savings. The more complicated iteration also includes the indirect costs. The most difficult reiteration tries to put dollar values on the social benefits in an attempt to expand the scope of the analysis.

Both the scope of costs and the concept of benefits used in this figure of merit calculation are discussed in the succeeding paragraphs.

Costs

Costs will include all expenditures required to purchase, install, man, support, operate and maintain the mass scanning system.

Since both costs and system effectiveness are subject to economies and diseconomies of scale, the magnitude of the deployment effort must be specified within the model framework. For purposes of analysis, the optimal deployment density will be derived from the minimal requirements necessary to check the explosive rate of auto theft.

Dollar Benefits

There are four categories of direct effects expected from the mass license plate scanning system. These are; theft deterrence, more rapid recovery of stolen vehicles, recovery of vehicles not currently being returned and criminal apprehension ... each of these effects results in direct as well as indirect benefits to potential theft victims, society in general and to state and local governments. Each of these four effects has secondary and tertiary ramifications as well. For example, deterrence and early apprehension affect recidivism; and deterrence together with rapid vehicle recovery affects the commission rate of auto related crimes. The four categories of system effectiveness are estimated through the use of simulation techniques. System benefits are then predicted by relating the simulated levels of effectiveness to the dollar savings they engender to the three segments of society identified above.

The benefits portion of the figure of merit is related to effectiveness through the following general equation:

$$\text{Benefits} = F_1 (C_{1I} + C_{1s} + C_{1g}) + F_2 (C_{2I} + C_{2s} + C_{2_G}) + F_3 (C_{3I} + C_{3s} + C_{3G}) + F_4 (C_{4I} + C_{4s} + C_{4G})$$

which condenses to the form

$$B = \sum_{i=1}^{4} F_i (C_{iI} + C_{is} + C_{ig})$$

where F_1 is the expected number of auto thieves deterred through the deployment of ALPS.

F_2 is the expected reduction in the time lag between theft and recovery.

F_3 is the expected increase in the number of vehicles recovered.

F_4 is the expected increase in the rate of apprehending auto thieves.

C_{iI} is the cost savings to potential auto theft victims from each of the 4 categories of effectiveness.

C_{is} is the cost savings to society, other than individual savings, due to improvements in each of the four effectiveness categories.

C_{iG} is the cost savings accruing to state and local governments from a system of mass scanning.

Specific values for each C_{ij} are derived and presented in Tasks 2 through 16. While the specific mathematical form of the benefit equation is the essence of Section C-2

A-10. Cost of Stolen Auto-Related Crimes

Auto theft is often an antecedent to other serious crimes. Burglars and bank robbers, kidnappers and murderers frequently steal cars for use in the commission of these crimes. Statistics shown in the Crime Commission Report indicate that approximately 10% of the automobiles stolen are used in the commission of other crimes. The car is usually stolen a few days before the planned crime is executed. This allows the thief the opportunity to check the vehicle and prepare it for use. However, by this time, the stolen car plate number will be in the ALPS File. The thief will either have to risk stealing new plates shortly before the planned crime or risk apprehension by the system. The risk is probably about 1 in 20 for the former alternative and 1 in 50 for the latter.

Table A-10-1 shows the estimated number of uncleared auto-related crimes for New York City in 1967. If one excludes the auto theft crimes and then increases the figure by 30% to reflect the state total, one is left with an estimate of 79,000 auto theft related crimes for New York State in 1967. Estimates, based on the New York City 1967 Budget, fix the average cost for crimes like these at $458.00. The resultant multiplication provides a total estimated cost to the law enforcement systems of 36.2 million dollars. Similar calculations derived from the 1967 Uniform Crime Report Statistics for the areas in question show that the victims of these crimes sustained a loss of an additional 10.9 million dollars. The total loss to the commonwealth is then $47.1 million.

TABLE A-10-1

ESTIMATED NUMBER OF UNCLEARED AUTO-THEFT-RELATED CRIMES FOR NEW YORK CITY IN 1967

(The values represent 10% of the total number of crimes. These crimes were selected because they frequently involve an automobile. The data source was the New York City Police Department's 1967 Annual Report.)

Felonies	
Rape	108
Robbery	2,860
Assault	1,331
Burglary	12,925
G.L. except M.V.	7,579
G.L. Motor M.V.	46,239
Criminal possession	1
Fraud-except forgery	7
Arson	172
Dangerous Drug Offenses	297
Dangerous Weapon Offenses	102
Abandonment of Child	21
Criminal Mischief	143
All other felonies	42
	71,826
Serious Misdemeanors and Violations	
Unlawful entering building	29
Sex offenses	151
Dangerous drug offenses	190
Dangerous Weapon	3
Aiding escape from prison	2
	374
Other Misdemeanors and Violations	
Petit larceny	9,946
Unauthorized uses of vehicle	51
Assault	1,452
Motor law offenses	23,774
Criminal mischief	9,548
	44,771

GRAND TOTAL 116,971

Projections based on the increase in crime rate for these areas show that, for the years 1968, 1969, 1970, 1971 and 1972, the state's loss will be $57.9, $71.2, $87.5, $107.0 and $123.5 million respectively.

The mass scanning system could save New York State about 2 and 1/2 million dollars in 1972 simply by picking up the perpetrators using stolen cars before they have a chance to commit the crime. The savings is even greater if we consider the possible deterrent effect.

A-11. Car Theft Accomplices

To describe the population of car thieves as we have done in Section A-3 without addressing the topic of criminal accomplices is like describing an iceburg without eluding to its submerged masses. Accounting for accomplices increases the size of the population involved in this illegal activity by three or four orders of magnitude. And in most cases the accomplice is causal to the continuation of these crimes. They provide the incentive and the help necessary for the maintenance of the illegal operation. Hence any assessment of impact of a crime deterrent system is incomplete without considering the role of those who aid and abet in the crime.

From the analysis in Sections A-3 and A-13 it appears that there are about six classes of violators and each type may have different support needs. The joy rider or thrill seeker needs someone to share in the excitement, the delinquent seeks peer status and illegal parts outlets, the criminal seeking a getaway car has his partners in collusion, the thief specializing in crime other than auto theft needs an outlet, and the professional specializing in large volume operations needs perhaps the most complex of support operations. It is only the borrower or transportation thief who is perhaps the least dependent on his accomplices.

The transportation thief appropriates the car for trips. Sometimes the trip is a short one and the car is found the next day near the law breaker's destination. However, usually this type of thief keeps the car for a few days and perhaps weeks and makes several trips. When this unauthorized driver finally decides to abandon the car he may strip the vehicle of some of its marketable parts. The distance traveled and the extent of the stripping operation are directly proportional to the time the car was under the illegal owner's custody. From the number of trips taken and the type of stripping operation conducted, our guess is that every other one of this type of thief may have one accomplice.

Auto theft is not limited to professional criminals and rings who specialize in this activity. In fact from the auto theft arrest and clearance rates, the F.B.I. Uniform Crime Report and the Blumstein and Larson model, we calculate that each major type of professional criminal can be expected to steal at least one car for each year of his criminal career. We suspect that the career type's familiarity with the underworld connection affords him these occasional opportunities. These same connections probably provide him with at least one accomplice to help dispose of the booty.

The professional who specializes in theft for either the resale of the vehicle or its components needs considerable support. He must store or dispose of the car quickly. If he exports abroad he must have a receiver. Out-of-state shipments will need both a shipper, a receiver and a wholesaler or retailer. Intra-state transactions need paper forgers and sales outlets. If he is part of a stripping operation, garages and

skilled mechanics are required. If the "pro" is really an operator he will employ spotters and lookouts. It is difficult to see how these volume operators can get by with less than three accomplices.

From surveys like the Erickson & Empey paper[A-11-1] and the Spergle study[A-11-2] we can see that the juvenile delinquent or young offender does a heavy traffic in stolen autos. And each act may employ at least one or two peers. At first he steals mainly for status. Auto larceny is perhaps one of the most frequent methods used by the delinquent to gain respect or a reputation in the so-called theft culture. Encouraged by his peers and driven by his continued need to maintain his status he steals again and again. After a while repeated production of this act usually leads to more sophisticated operations dealing with the sale of illegal parts. Up to this point the delinquent or youthful offender will work with one or two accomplices. However once he starts trading in illegal parts he may limit his confidants in order to avoid detection.

From a criminalistic point of view joy riding is perhaps the most serious problem. This crime involves more people, it is the primary catalyst to a life of crime, and it costs more lives than any other type of auto theft. The joy rider rivals the career specialist in the number of people they victimize and they are responsible for most of the body damage and vandalism and a good part of the looting.

The joy rider thief, usually aged 15 to 17 and initially a good boy, steals a car often with four or more accomplices and drives it a few hours before abandoning it near the scene of the theft. This boy's natural instinct to seek thrills has disastrous consequences. These boys, obsessed with speed, race around town often playing sport with games that skirt the outcome of a severe collision. The result is a hundred or more deaths, several thousand injuries and over a hundred million dollars worth of body damage and accident loss. After a few experiences at joy riding (provided the boy has escaped death, injury or the law), the young man adds vandalism, looting and stripping and then perhaps illegal trade to his initial crimes of unauthorized use and reckless driving. His joy riding experiences provide the opportunity to learn the skills and attitudes needed for the introduction into a career of adult crime in later life. In 1967 the joy riders and their accomplices numbered about 28,000 and that population has grown every year since then.

Table A-11-1 expands the concept presented in A-3-1 to include the number of accomplices. In each type of theft it is doubtful that all the accomplices will be involved in each crime. However since these accomplices probably serve several criminals, no attempt was made to account for this factor.

Auto theft accomplices play a key role in the maintenance of the criminal population. From the 1967 court records we can see that they are ten to twenty times less likely to be arrested. If the deterrent system is to make any headway it must also deter this population.

TABLE A-11-1

TOTAL POPULATION OF ACCOMPLICES AND CRIMINALS

(Table A-11-1 is a theoretical attempt to substruct the population of auto theft accomplices in N.Y. State in 1967. The data sources are discussed in the text and in the notes for Table A-3-1, "Population of Auto Thieves".)

Number of People in the Population	Types of People in the Population	Number of Crimes Committed	Number of Accomplices Per Crime	Total Number of Accomplices	Total Number of Thieves
800	Juvenile delinquents or young offenders	8,000	2	1,600	2,400
4,000	Professional criminal stealing the car to commit other crimes	8,000	1	4,000	8,000
2,800	Professional career criminals specializing in stolen autos	2,800	3	8,400	11,200
2,000	Professional career criminals not specializing in stolen autos	2,000	1	2,000	4,000
7,000	Joy riders	21,000	4	28,000	35,000
1,500	Borrower or transportation drivers	6,000	1/2	750	2,250
Total 18,100		73,000		44,750	62,850

Auto theft appears to be learned through repeated exposure as an accomplice and then through repeated undetected practice. The act is rewarded by the thrill of driving, by social interaction and encouragement of the group, by the thrill of avoiding detection, and by the thrill of possessing a coveted object. During the accomplice's apprenticeship the thief's peers are present and they carefully train him. The thief will probably commit auto theft and thusly be rewarded eight to ten times before experiencing punishment. By this time punishment is not an effective deterrent. For now his criminal behavior has been more reinforced than non-criminal behavior. The strength of this behavior is a direct function of the amount, frequency and probability of receiving reinforcement and of avoiding punishment. From the clearance rates we can well see that the youth in question is either a full fledged delinquent or youthful offender before his first apprehension. And by this time his motivation is no longer to seek a thrill. He now steals with criminal intent for personal gain and status in a theft culture.

A twenty-five to thirty percent increase in apprehension will have a far greater effect on these youngsters than adults. First because young people are less likely to take the chance on seeking thrills and they will have a far smaller number of accomplices if they know apprehension is more certain; and second, the learning process will be interrupted before the illegal behavior has been thoroughly conditioned. Auto theft

is one criminal act which is classic to learning situation. And this is probably the single most important reason for the high degree of habitualism among these violators. As things stand today it appears that the lesser offense of joy riding is in reality a grim precursor of a foreboding future, and the deterrent of this type of youthful exploration and expression would probably be one of the most significant advances in crime supression.

A-11-1. Maynard L. Erickson and Lamar T. Empey, "Court Records, Undetected Delinquency and Decision Making," Jour. of Criminal Law, Criminology and Police Science, 54, No. 4, Dec. 1963.

A-11-2. Spergle, I. Racketville, Slumtown and Haulsburg. Chicago: University of Chicago Press, 1964. Pp. 29-53.

A-12. Cigarette Smuggling

North Carolina, where there is low state tax on tobacco, is the starting point for the purchase of the most active form of contraband in the eastern part of the United States: cigarettes. The FBI report estimates that there is a million-dollar-a-day traffic in smuggled cigarettes. And, because of the high tax in New York, this state has become the prime target for the movement of these contraband cigarettes.

The variation in state and local taxes is the problem. In New York the State Tax is 10¢ per pack but New York City adds an additional local tax of 4¢ and a sales tax of 2¢, this brings the total to 16¢ per pack in the city. The transportation of cigarettes from a state with no tax, or even 2 and ½¢, like Virginia or Kentucky, makes it very easy to realize a profit of more than 100 percent.

Over 40,000 packs of cigarettes can be carried on a one ton panel truck. This small load alone is worth more than $6,000 to the runner. Hence, because of the high profits and low risks, a fine is treated by the bootlegger as a cost of doing business and is no deterrent. It can be recouped as quickly as can the cost of any cigarettes seized as contraband. It is very unlikely that this attitude will change unless significant advances in the surveilance system are made. While it was very difficult to pin down the dollar volume of this illicit trade, estimates from several sources ranged between 40 and 60 million dollars for 1968. For example, the Governor in his

1967 budget message, cited a cigarette bootlegging loss of 40 million dollars. Similar estimates were later published by the Director of Finance of N.Y.C. The District Attorney's office in Queens and in Brooklyn both provided comparable estimates of 60 million dollars for 1968. Extrapolations made by these authors from the 1966 FBI report on cigarette smuggling for the nation, put New York at the 25 million dollar mark for that year. Forecasts on cigarette consumption gave New York State about 1/6 of the national illegal market or 60 million dollars.

Unfortunately, the loss constitutes more than just the loss of revenue from the cigarette tax. The District Attorney's office in Queens County estimates that one out of every five packs of cigarettes are contraband. As a result the cigarette merchandising industry's sales in New York City was down 25% over the previous years average.

Most of the loss is sustained by New York City. The same above sources estimated the City's part of the State loss range between 20 and 30 million dollars.

Again, reports from the Assistant District Attorney's office in Queens attribute the greater part of the illegal traffic to organized criminal elements. However, the document was careful to point out that the independent operators still maintained a sizable share. The independents operate all over the city while the major distribution losses for the larger organizations are around Kennedy Airport, the flatlands of Brooklyn and downtown Manhattan.

In many cases the police are able to get information on the plates, time, direction and size of the load from sources outside the state. The informer is usually the seller, who gets 20% of the value of the confiscated items. However, even with the prior knowledge of the smugglers' plates, it is very difficult for the enforcement agency to cover the access routes. The high profit and low risks have been the major factors in the proliferation of this illegal business; and this illicit traffic is likely to continue unless a more severe system is implemented.

To satisfy the market demands for the contraband, the runners must make at least 25 or 30 trips a day. At least half of these go into New York City SMSA. While most of Brooklyn's cigarettes come in by truck, the District Attorney's office in Queens has evidence to indicate that there is also a small airlift for transporting these illegal goods. If we assume a 30% mass scanning cover of all major accesses to the known centers of distribution on a random basis and a 5% informer tip rate (not an unreasonable figure), a mass scanning system would probably pick up at least one or two illegal loads every other week. The confiscation and auction of this contraband would probably bring about a half a million a year. In addition, the deterrent effort of the publicized ALPS and the arrests made would probably save the State another million dollars in tax revenue.

Table A-12-1 shows the forecasted value of illegal tobacco expected to come into the State of New York during the period between 1967 and 1972.

Cigarettes happen to be the commodity now in demand; however, smuggling done on any scale with any product will be combatted by the ALPS system. The system will be a preventive or curtailing measure on any crime which utilized the state highway system.

TABLE A-12-1

THE COST OF CIGARETTE SMUGGLING

(This Table shows the estimated dollar volume in illegal cigarette trade to New York State for the period between 1967 and 1972. The estimates were derived from a consensus of data from the District Attorney's office in Brooklyn and Queens and the N.Y.C. Department of Finance and from the 1966 FBI report on cigarette smuggling. The values for 1969 through 1972 are forecasted. The forecasts were dampened to account for a possible market saturation).

	1967	1968	1969	1970	1971	1972
The Cost of Cigarette Smuggling in millions of dollars.	30.0	40.0	60.0	70.0	75.0	80.0

A-13. Stolen Car Flow Patterns

A comprehensive analysis of stolen car flow patterns and the complex factors which produce them was necessarily undertaken to provide a background of knowledge upon which an effective apprehension and deterrent system could be based.

Included in this topic is a discussion of the following factors: the various types of auto theft and their relationship to traffic flow patterns; a discussion of the state and out of state stolen car flow patterns; and a micro analysis of New York City stolen car flow patterns. Also discussed is the effect of flow patterns on design and usage of ALPS and the cost effectiveness of inter-city deployment. Finally the potential effects of ALPS on stolen car flow patterns is examined.

Types of Auto Theft:

In the State of New York, crimes are rated according to their seriousness as felony or misdemeanor and each of these two classifications is subdivided into five categories. The theft of an auto is classified in accordance with the intent or purpose behind the crime and the category of seriousness is determined by the monetary sum involved. The joy rider or transportation thief is usually charged with a misdemeanor, Unlawful Possession of Stolen Property, with a class A (the most serious) rating. His intent or purpose behind the theft was merely the temporary use and not permanent possession of the vehicle. The professional thief is charged with a felony, Criminal Possession of Stolen Property, because he intends "wholly to deprive" the owner of his automobile by permanent possession or resale of part or all of the vehicle. The difference in intent behind each of these thefts results in significant changes in the type of road usage each exhibits.

First, consider the professional thief. He steals a car from the street or a public place and brings it into one specific area, for short term storage and/or quick processing for either stripping or resale. About 40% of the cars are stolen in this manner. From here, about 6,000 of the cars are taken to the docks for shipment to South America; the rest are either stripped, driven out of state or equipped with false papers and resold in New York. We assume the professional spends as little time on the road as possible, drives carefully and attempts to keep himself inconspicuous to authorities. The car he steals joins the several thousand other unrecovered vehicles that disappear each year. His period of road travel, whether short or long, is probably a one shot deal. Consequently, his "availability" for apprehension by conventional methods was severely limited because of his ability to make himself invisible, until now. However, contrary to popular belief, at least 15% of these stolen vehicles are missed within 15 or 20 minutes. The simulation model in Section C-3 shows that we would pick up at least one or two "pro's" a day.

The transportation thief needs a car usually for a few days. He steals a car, drives it about 100 miles for four days, then abandons it - usually near his home.

The joy rider and one shot trip thief operate quite differently. The latter steals a car to make one trip, then deposits the car. The joy rider has a very similar modus operandi except that he tends to make a round trip with the same vehicle.

Another type of thief is the looter. His behavior is quite consistant. He drives the stolen car a few blocks away and there loots the contents of the glove compartment and the trunk. He is usually after the tires and tools.

There is also the amateur who goes in for easy to remove parts, like radios, tape decks, etc., as opposed to the professional stripper who can reduce a car to its frame.

The following pages contain a precinct by precinct study of stolen car statistics in New York City which have been correlated with traffic patterns for the area. In this way an optimum placement of the ALPS system can be determined.

A Micro Analysis of New York City:

In the three years from 1967 through 1969 the auto theft rate in New York City will have almost doubled. That city can move into the 70's with the knowledge that by mid decade the theft rate will have passed the four hundred thousand mark.

As Table A-13-1 shows, theft is increasing at an alarming rate in some precincts; 36% of New York City's precincts increased their theft rate by at least 50% from 1967 to 1968, the median

TABLE A-13-1

PERCENT INCREASE IN THEFT BY PRECINCT, 1967 TO 1968

(PRECINCTS RANKED WITHIN EACH BOROUGH)

MANHATTAN

PRECINCT	% INCREASE IN THEFT
18	108.9
5	97.2
20	69.6
30	66.5
34	61.4
24	51.9
14	47.8
32	37.4
19	34.7
10	34.6
26	32.3
13	29.6
NY CITY	26.3
7	25.9
4	21.8
28	20.1
1	19.3
9	19.3
25	16.7
17	8.7
6	8.0

RICHMOND

PRECINCT	% INCREASE IN THEFT
122	55.4
120	34.2
NY CITY	26.3
123	6.1

BRONX

PRECINCT	% INCREASE IN THEFT
42	81.8
44	79.7
46	74.1
45	72.9
50	59.0
40	53.3
48	48.1
47	47.9
43	47.7
41	47.3
52	43.2
NY CITY	26.3

QUEENS

PRECINCT	% INCREASE IN THEFT
111	90.3
109	76.4
100	66.1
110	64.8
107	59.9
112	57.9
101	53.5
102	53.3
114	51.1
106	44.8
104	36.8
NY CITY	26.3
108	21.3
103	6.1
105	-10.6

BROOKLYN

PRECINCT	% INCREASE IN THEFT
94	73.9
72	71.1
92	64.3
88	53.8
81	51.3
78	44.1
70	42.1
75	40.5
61	37.3
83	36.3
71	34.2
69	30.1
62	29.4
NY CITY	26.3
87	25.1
76	24.4
60	23.6
63	22.5
64	19.0
66	18.8
68	18.5
73	17.8
80	16.5
90	15.1
79	7.8
77	7.4
67	4.7
84	-(11.7)

TABLE A-13-2

This Table shows the % of cars stolen from various types of parking spots and the % of cars stolen from various parking location areas. The greater portion of the vehicles are stolen from the street outside the owners place of residence. The data was derived from a 1969 survey of N.Y.C. auto theft victims.

Location of Parking Spot	% of Cars Stolen from the Parking Location
Street	66%
Parking Lot	15%
Garage	5%
Service Station	3%
Driveway	2%
Other	8%

Description of the Parking Place Area	% of Cars Stolen from the Parking Place Area
Outside the Owner's Residence	45%
Near a Public Facility	17%
In a Business or Commercial Area	16%
In an Entertainment Area	3%
Other	15%

for the city being 26.3%. From this Table we can determine that the residential areas of Queens and the Bronx are sustaining the greatest impact. This statement is supported by Table A-13-2 which delineates the percent of cars stolen from various types of parking spots and the percent of cars stolen from various parking locations. Street parkers incur 66% of the thefts and 45% of those surveyed indicated that their car was parked outside their residence when stolen. However, it should be noted that a significant number indicated that at the time of theft, their vehicle was parked in a public parking lot or garage.

Those surveyed indicated also, that almost 30% of the thefts occur in the evening between 6 P.M. and 10 P.M. As Figure A-13-1 shows, the hours between 10 PM and 6 AM are also times favored by the thief. The reason behind this choice of time period may be twofold. Certainly under cover of darkness, the thief has less chance of detection; but an additional factor may be that public transportation is less frequent during the evening and early morning hours.

Once the car is stolen, a direct relationship exists between the number of days the vehicle is gone and the number of miles it is driven. As Figure A-13-2 shows, the number of miles driven increases the longer the car is unrecovered until about the 23rd day. After this period, the curve levels and we can assume that most of those cars which are recoverable will be abandoned by the thief with little additional mileage placed upon them.

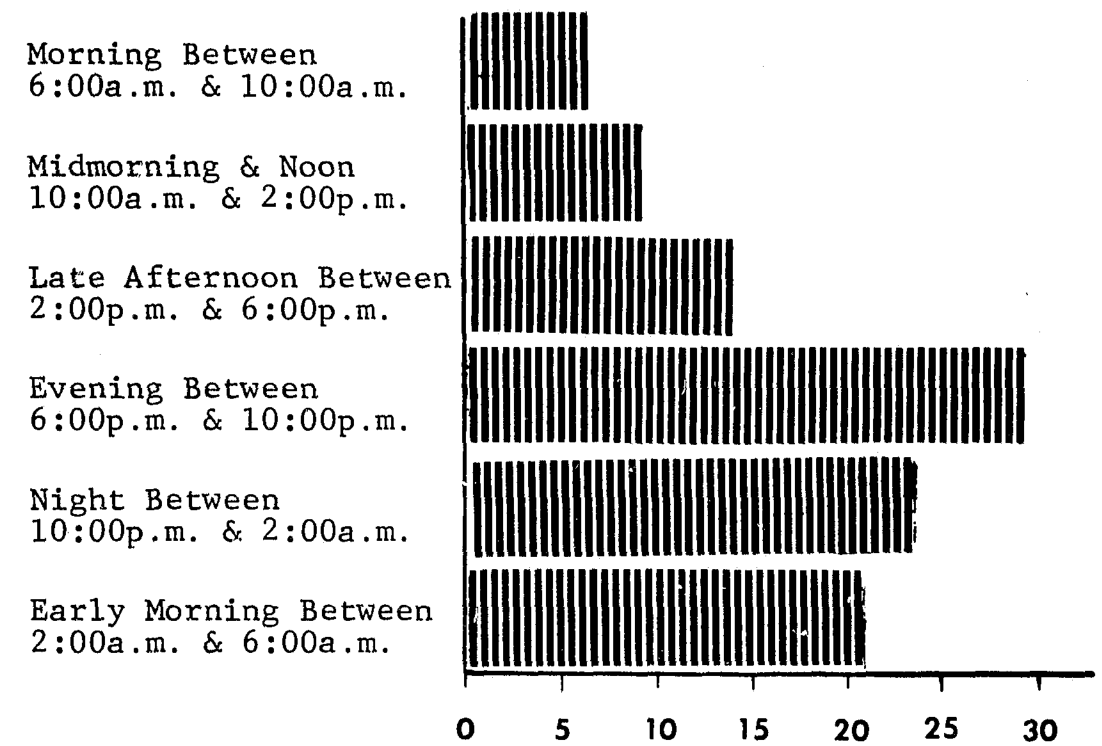


Figure A-13-1 shows the percent of the total cars stolen during the various periods of the day. Over 72% are stolen at night. The median time is about 9:00 p.m.

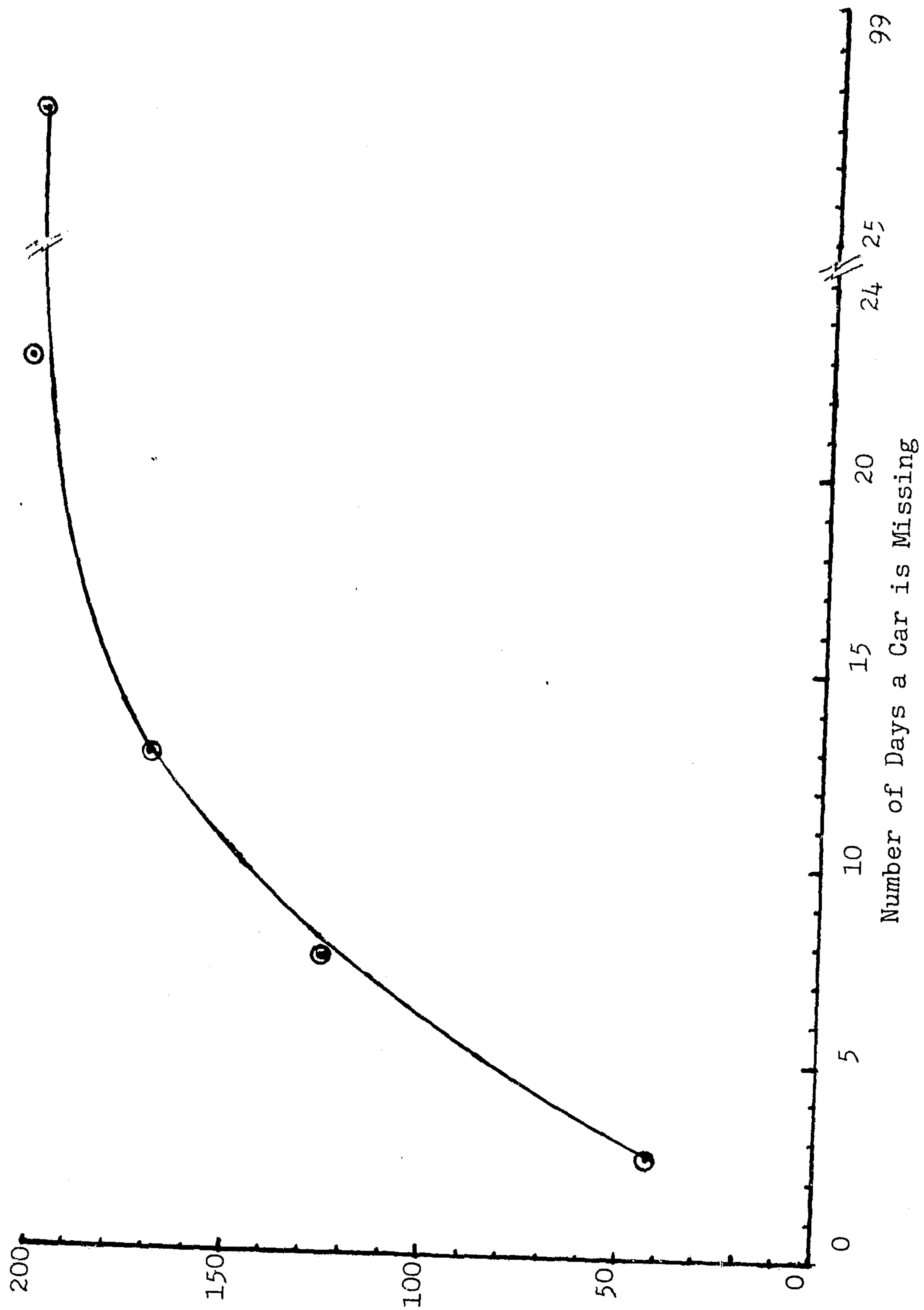


Figure A-13-2 shows the number of miles a stolen car is driven for each day it is missing. The data was derived from a 1969 New York City auto theft victims.

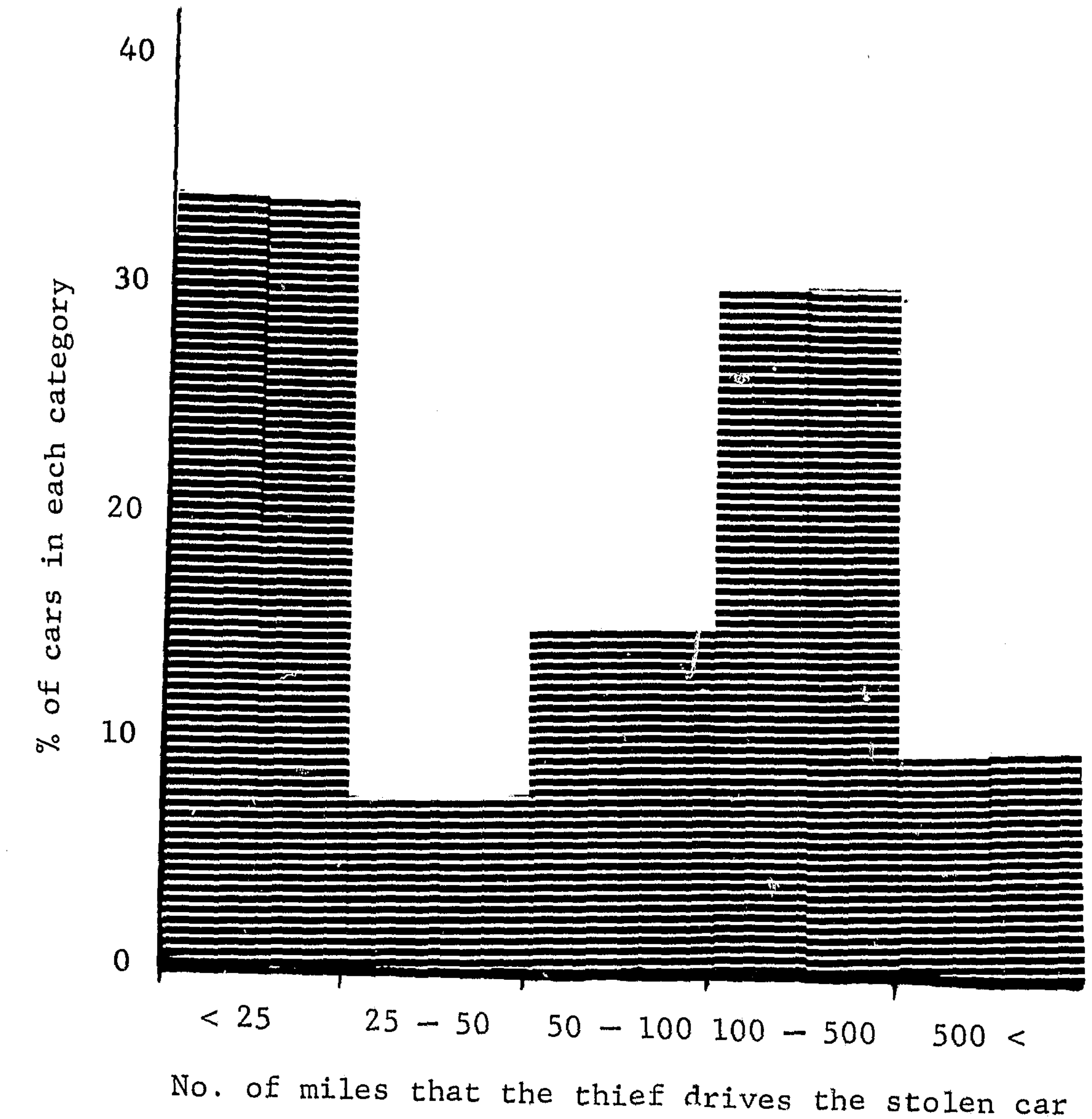


Figure A-13-3 shows the percent of stolen cars that are driven less than 25 miles, between 25 & 50 miles, between 50 & 100 miles, between 100 & 500 miles or over 500 miles respectively. The distribution was derived from a 1969 survey of Auto Theft victims in New York City.

Figure A-13-3 shows the percent of stolen cars that are driven less than 25 miles, between 25 and 50 miles, between 50 and 100 miles, between 100 and 500 miles and over 500 miles. Of those surveyed, 34% indicated that their car was driven less than 25 miles. Most of these thefts can be attributed to joy riders. Another 30% indicate their car was driven between 100 and 500 miles which seems to indicate that these thefts were made for transportation purposes. Also significant is the 10% who indicate their car was driven in excess of 500 miles before recovery. Some of these vehicles were recovered out of state while others seemed to be used daily by the thief as his means of transportation.

Figure A-13-4 shows the distribution of recoveries for days gone. From an analysis of data derived from the New York City police stolen car cancellation files for the year 1969 it appears that the median number of days is 3.25; after the 6th day, the recovery rate drops off sharply.

The rate of recovery and places where vehicles are recovered provide the key information for determining stolen car flow patterns. Four indications of stolen car traffic flow density have been devised which, when seen in total, establish a complete picture of the stolen car flow patterns in New York City as seen in Table A-13-3.

Figure A-13-5 shows the distribution of auto theft by precinct per 1/10 square mile. This map indicates by four methods of shading, the density of auto theft in each precinct.

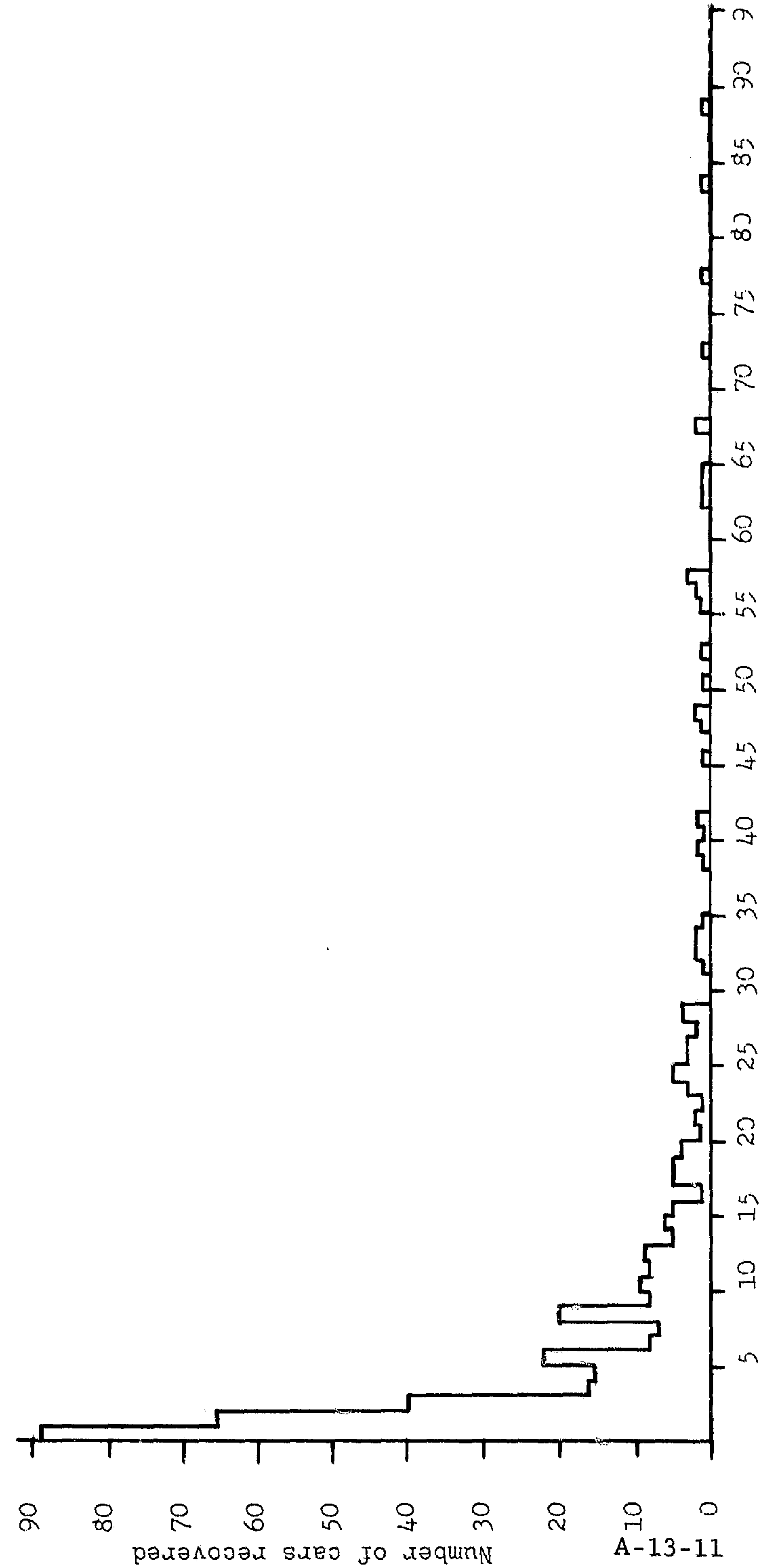


Figure A-13-6 shows the distribution of recoveries for days gone. The median is 3.25 days. The data was derived from an analysis of the New York City police stolen car cancellation files for the year 1969. A similar analysis for the years 1967 and 1968 show the median time for days gone to be 2.2 and 2.5 respectively. The median trends seem to show a significant increase in the time it takes to recover a stolen car.

TABLE A-13-3

STOLEN CAR FLOW DENSITY PER 1/10 SQUARE MILE

(The first column heading, Precinct, shows thefts per 1/10 square mile and indicates the number of vehicles which were stolen in that precinct. This figure determines the amount of theft which occurs within a precinct and enables one to compare that precinct with the others. The column titled, Recovery of Own Vehicle, indicates the rate per 1/10 square mile at which an area recovers its own vehicles. Recovery from Other Precincts column indicates the rate per 1/10 square mile at which a given area recovers cars from other precincts found in its own area. The column, Through Precinct Traffic, indicates the number of stolen cars per 1/10 square mile which probably travel through the given precinct to be deposited elsewhere. By examining these figures closely, it can be determined which precincts have the greatest amount of stolen car traffic and which areas are drop-off points for stolen cars.)

Precinct	Thefts	Recovery Own Vehicle	Recovery Other Precinct	Through Precinct Traffic
1	44.0	9.5	8.3	49.8
4	42.4	8.7	12.2	79.6
5	52.8	7.6	14.8	97.1
6	83.2	22.3	12.5	141.3
7	41.5	10.0	17.8	67.6
9	96.0	23.7	26.5	151.8
10	85.6	18.7	13.5	139.8
13	64.0	13.2	9.3	92.8
14	98.4	21.1	8.7	152.8
18	60.0	6.5	3.5	105.1
19	84.8	18.0	5.8	126.0
20	77.6	14.1	11.5	138.1
23	110.4	23.5	24.7	192.3
24	79.2	12.0	16.7	151.1
25	50.4	10.5	23.9	123.1
26	60.8	9.2	12.2	105.3
28	48.8	14.5	36.7	133.1
30	60.8	9.8	13.6	103.3
32	64.8	21.2	28.2	123.8
34	30.4	5.9	4.6	44.1
40	60.0	11.3	20.9	144.1
41	46.4	9.9	12.2	84.3
42	69.6	10.6	14.8	128.1
43	32.0	7.5	3.5	45.8
44	73.6	9.3	9.6	115.4
45	81.0	1.2	2.3	112.0
46	46.4	6.2	6.1	74.4
47	18.4	4.1	2.2	24.9
48	79.2	16.0	16.1	211.4
50	15.2	2.4	1.4	19.5
52	14.4	3.3	2.1	28.7
60	22.3	3.6	5.7	33.9
61	53.1	10.4	7.4	69.9
62	26.2	5.2	5.8	38.6
63	13.8	3.2	3.3	22.2
64	16.2	3.3	3.6	21.8
66	26.9	5.6	6.3	43.1
67	15.4	3.6	4.8	25.1
68	23.1	6.7	11.9	41.1
69	35.3	7.7	6.9	90.8
70	10.8	6.2	7.0	62.0
71	60.8	7.9	12.5	86.0
72	29.2	4.0	9.0	65.0
73	80.0	16.4	33.2	155.1
75	41.5	9.5	10.6	67.9
76	24.6	5.1	10.6	51.3
77	56.9	14.3	32.2	126.2
78	69.2	17.3	32.8	150.2
79	66.2	16.1	32.8	137.2
80	62.3	13.0	15.5	136.5
81	66.9	14.3	27.4	129.3
83	67.7	13.5	23.1	119.3
84	63.1	10.7	11.9	77.1

Precinct	Thefts	Recovery Own Vehicle	Recovery Other Precinct	Through Precinct Traffic
87	35.3	7.0	10.3	61.8
88	44.6	6.7	17.8	76.7
90	56.2	10.0	23.3	102.2
92	42.3	4.9	16.0	74.7
94	21.5	4.7	5.2	37.5
100	7.1	1.3	1.9	17.5
101	16.4	4.2	2.0	18.6
102	16.4	2.5	3.1	30.8
103	35.0	14.4	7.6	60.1
104	12.1	2.7	3.5	20.4
105	12.1	6.3	3.6	19.3
106	22.9	4.0	5.3	36.3
107	26.4	4.1	3.3	42.2
108	15.7	3.5	5.3	26.5
109	16.4	2.7	2.3	25.1
110	29.3	4.3	4.0	46.0
111	12.1	8.6	6.0	76.2
112	37.1	4.9	4.3	48.8
114	25.7	5.7	3.8	35.5
120	25.2	3.2	.5	11.7
122	9.3	.5		
123	.9	.1	.1	.6

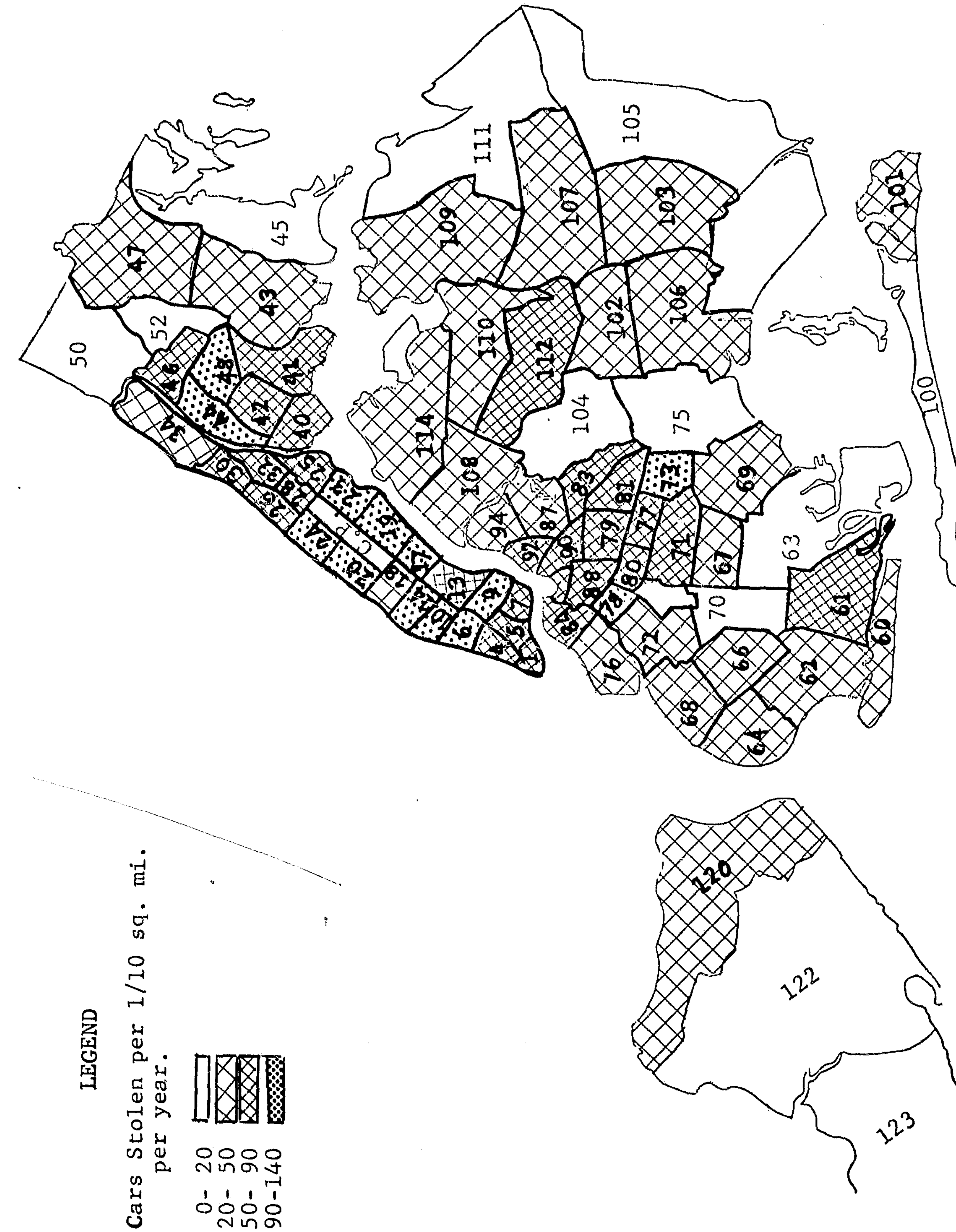


Figure A-13-5 shows the distribution of auto theft by precinct. The measure of auto theft is the number of cars stolen per 1/10 sq. mi. per year. The year is 1967.

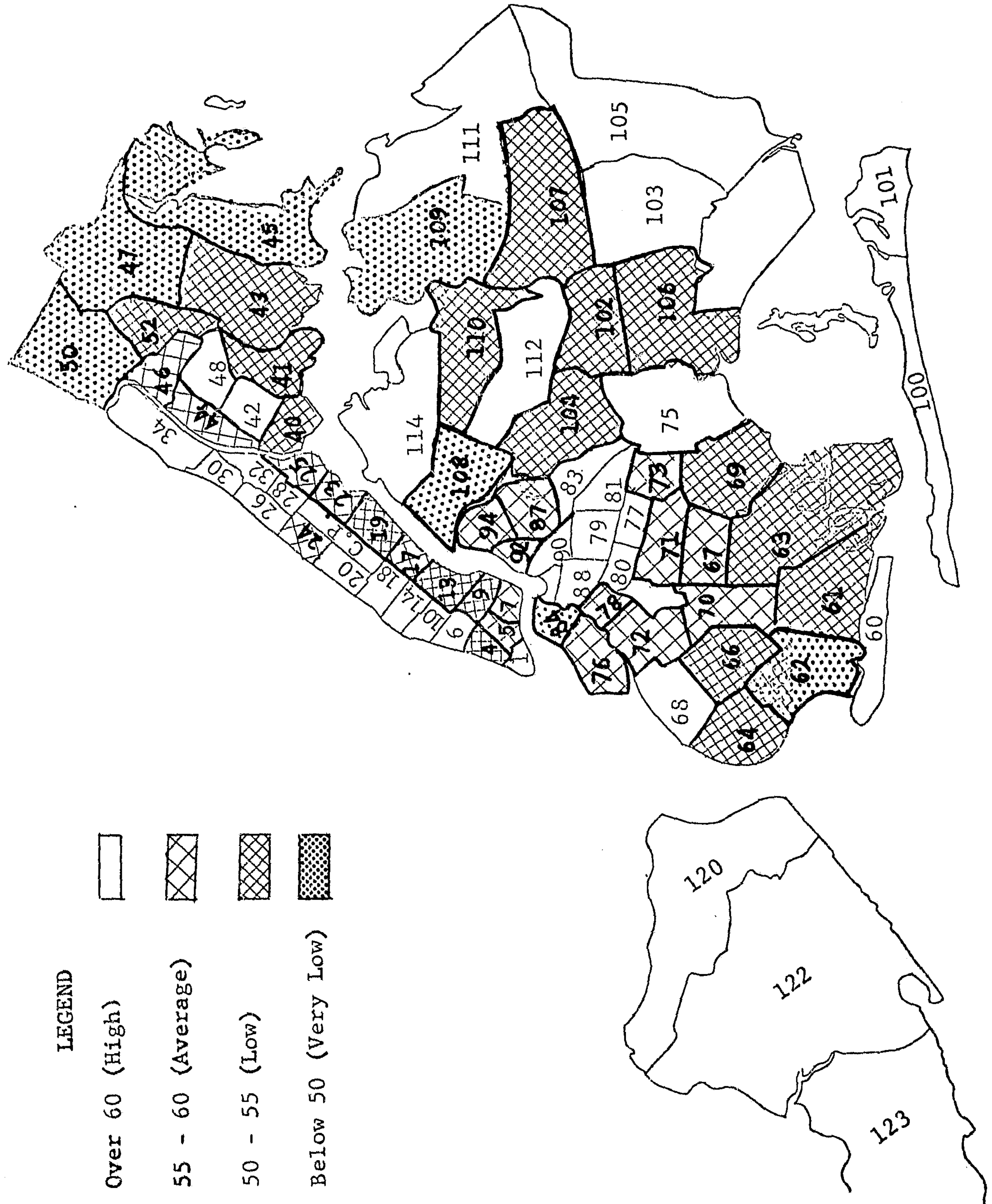


Figure A-13-6 shows the percentage of recovery by precinct.

Clearly shown is the fact that Manhattan contains the highest number of precincts with the most auto theft. Bronx and Brooklyn also have significantly high areas of theft.

Figure A-13-6 shows the stolen car recovery rate by precinct. A striking comparison can be made between this map and Figure A-13-5. Most precincts showing a high rate of theft show low recovery, while many precincts low in theft show an extremely high rate of recovery. Forty-nine percent of all cars recovered are recovered in a precinct other than the one from which they are stolen. If these cars were spread evenly throughout the area of New York City we would expect to find 5.5 "out of precinct cars" recovered per 1/10 of a square mile. Precincts with an "Import Index" of greater than 5.5 are recovering more than their share of outside cars and can be considered drop off points, as Table A-13-3 demonstrates.

Figure A-13-7 indicates in detail where the greatest percentage of a given precinct's cars are being recovered. Areas which retrieve greater than 10% of another precinct's cars are indicated with a solid zero; those with 5.1% to 10% which are shown by open zero and those with 2.5% to 5% are shown by an X.

The fourth key to stolen car flow patterns, through precinct traffic is displayed in Figures A-13-8 and A-13-9. A-13-8 shows the density of stolen car traffic flow in number of stolen cars per 1/10 square mile per year that flow through a given precinct. A-13-9 shows the actual number of stolen cars that pass through a given precinct. Clearly shown is the high through traffic travel rate throughout Manhattan and in certain

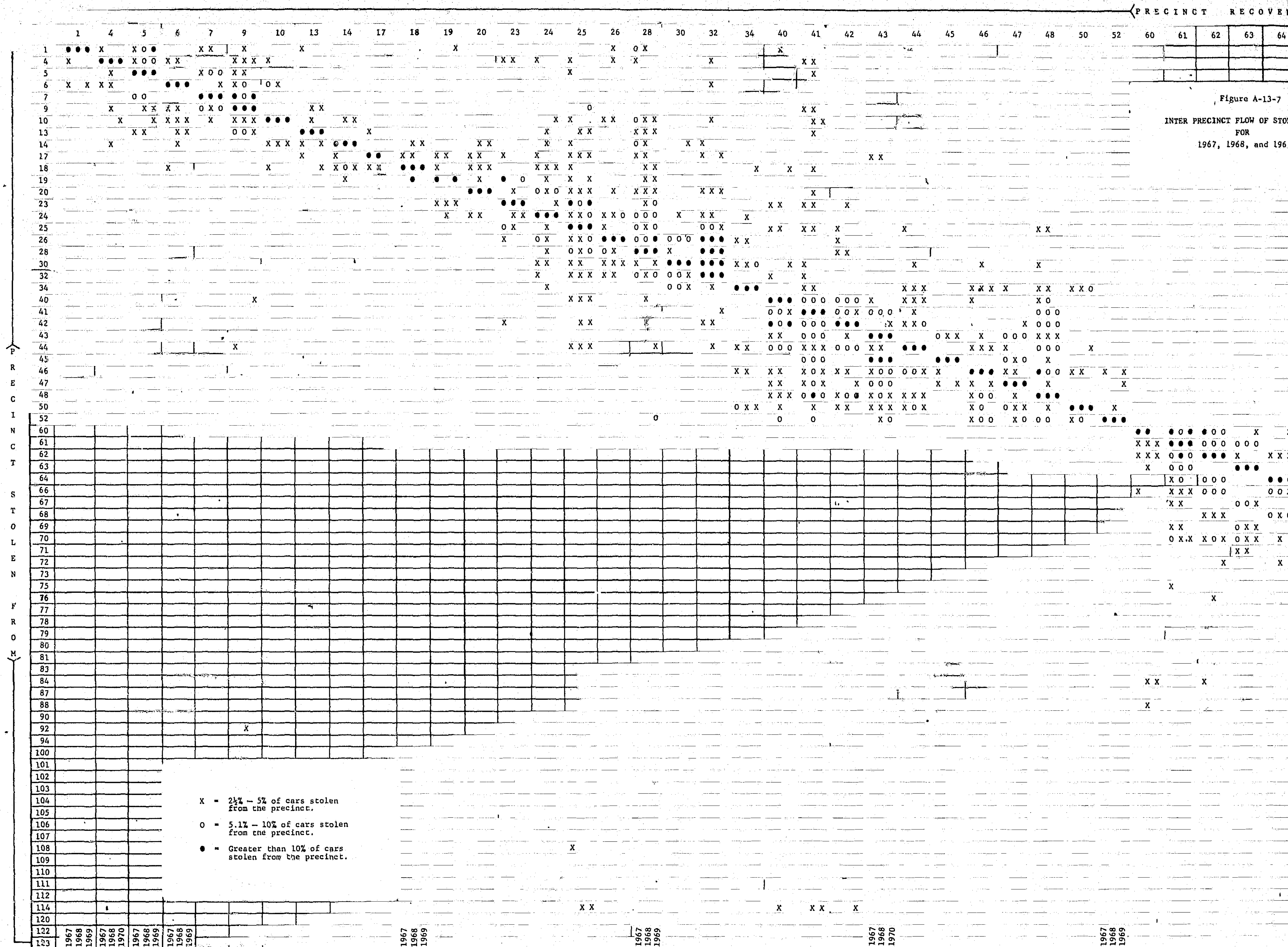


Figure A-13-7

INTER PRECINCT FLOW OF STO
FOR
1967, 1968, and 196

ED BY

66	67	68	69	70	71	72	73	75	76	77	78	79	80	81	83	84	87	88	90	92	94	100	101	102	103	104	105	106	107	108	109	110	111	112	114	120	122	123

EN CARS

1967
1968
1969

1967
1968
1969

1967
1968
1969

1967
1968
1969

1967
1968
1969

1967
1968
1969

ED BY

66	67	68	69	70	71	72	73	75	76	77	78	79	80	81	83	84	87	88	90	92	94	100	101	102	103	104	105	106	107	108	109	110	111	112	114	120	122	123

EN CARS

1967
1968
1969

1967
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1967
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precincts of Bronx and Brooklyn.

Figure A-13-10 and A-13-11 indicate the primary and secondary flow patterns for New York City. They attempt to show by the use of arrows, the precinct where the thefts occurred and the precinct where the car was recovered.

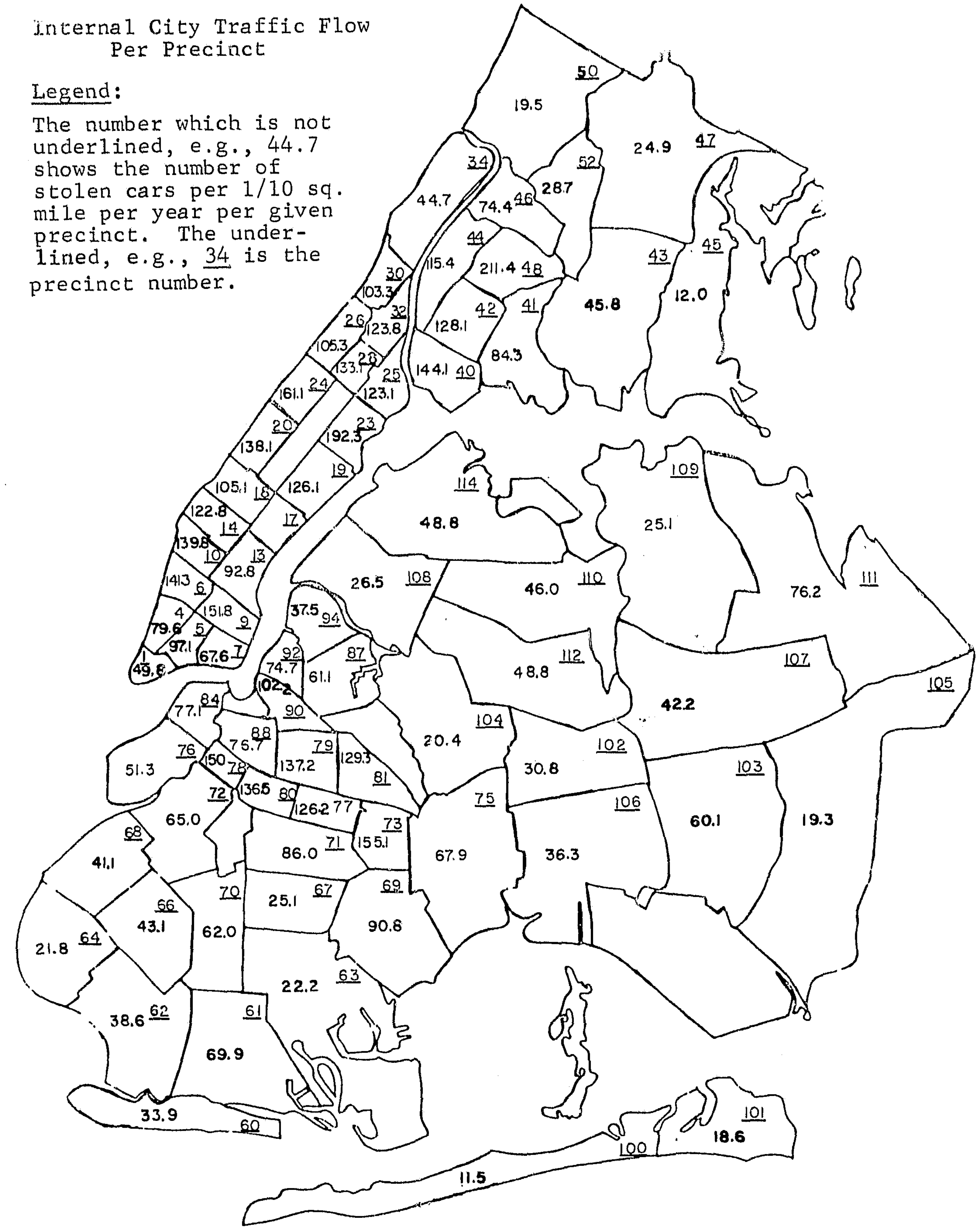


Figure A-13-8 shows the number of stolen cars which pass through a given precinct, reduced to a per 1/10 sq. mile figure.

Internal City Traffic Flow
Per Precinct

Legend:

The number which is not underlined, e.g., 1251 stands for number of stolen cars per year per precinct. The underlined number e.g., 34 stands for the precinct number.

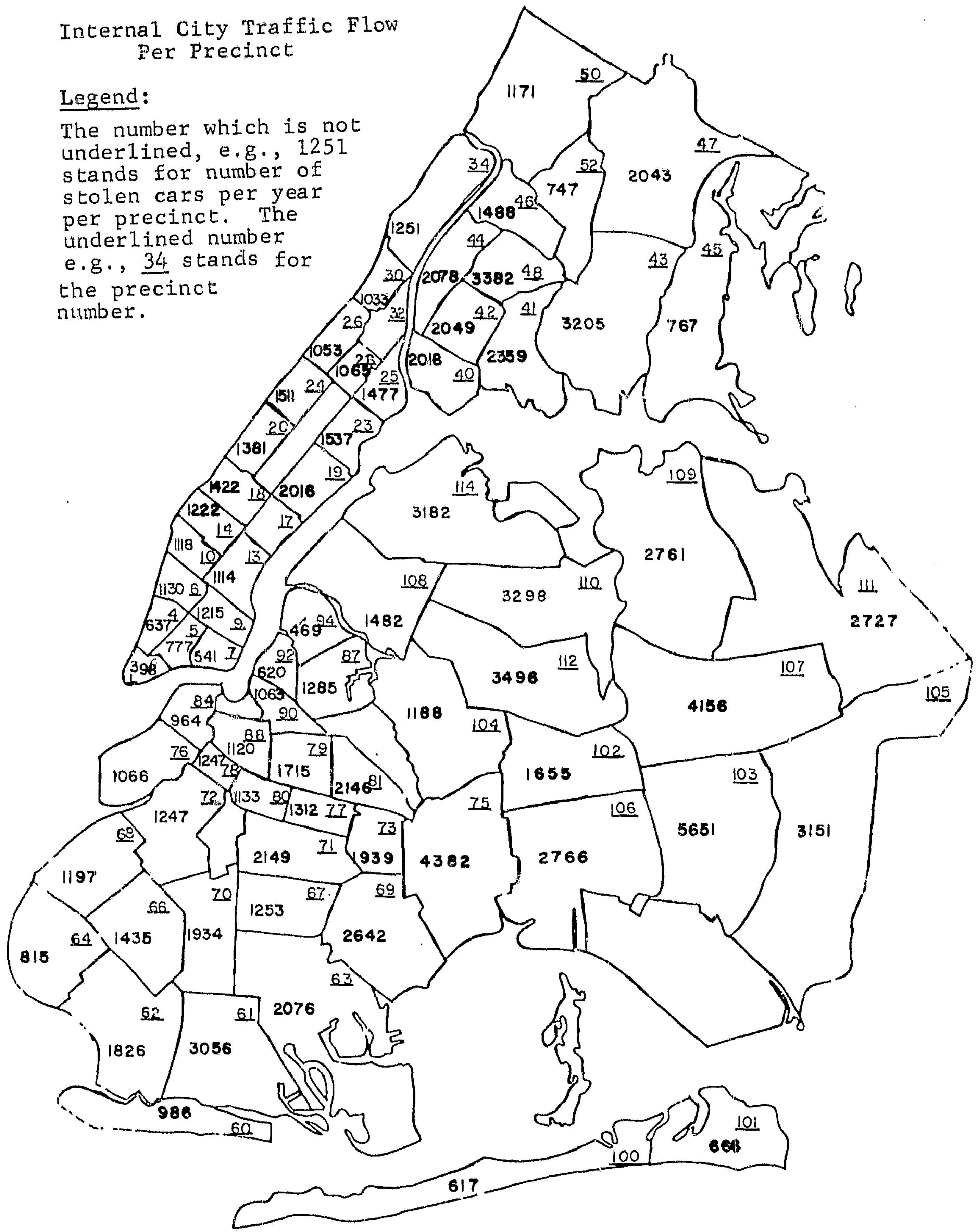


Figure A-13-9 shows the number of stolen cars which pass through a given precinct.

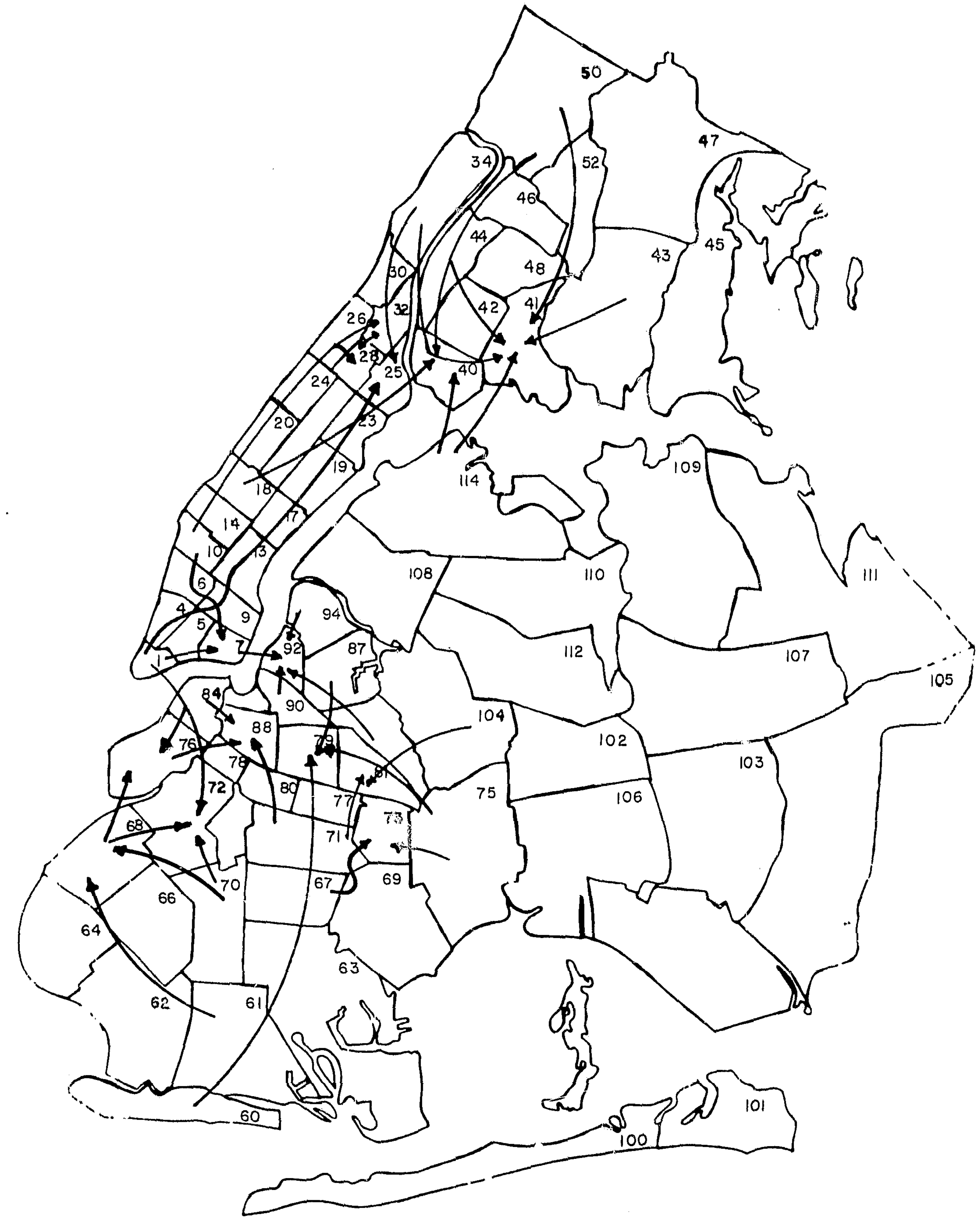


Figure A-13-10 indicates the primary stolen car flow patterns for New York City.

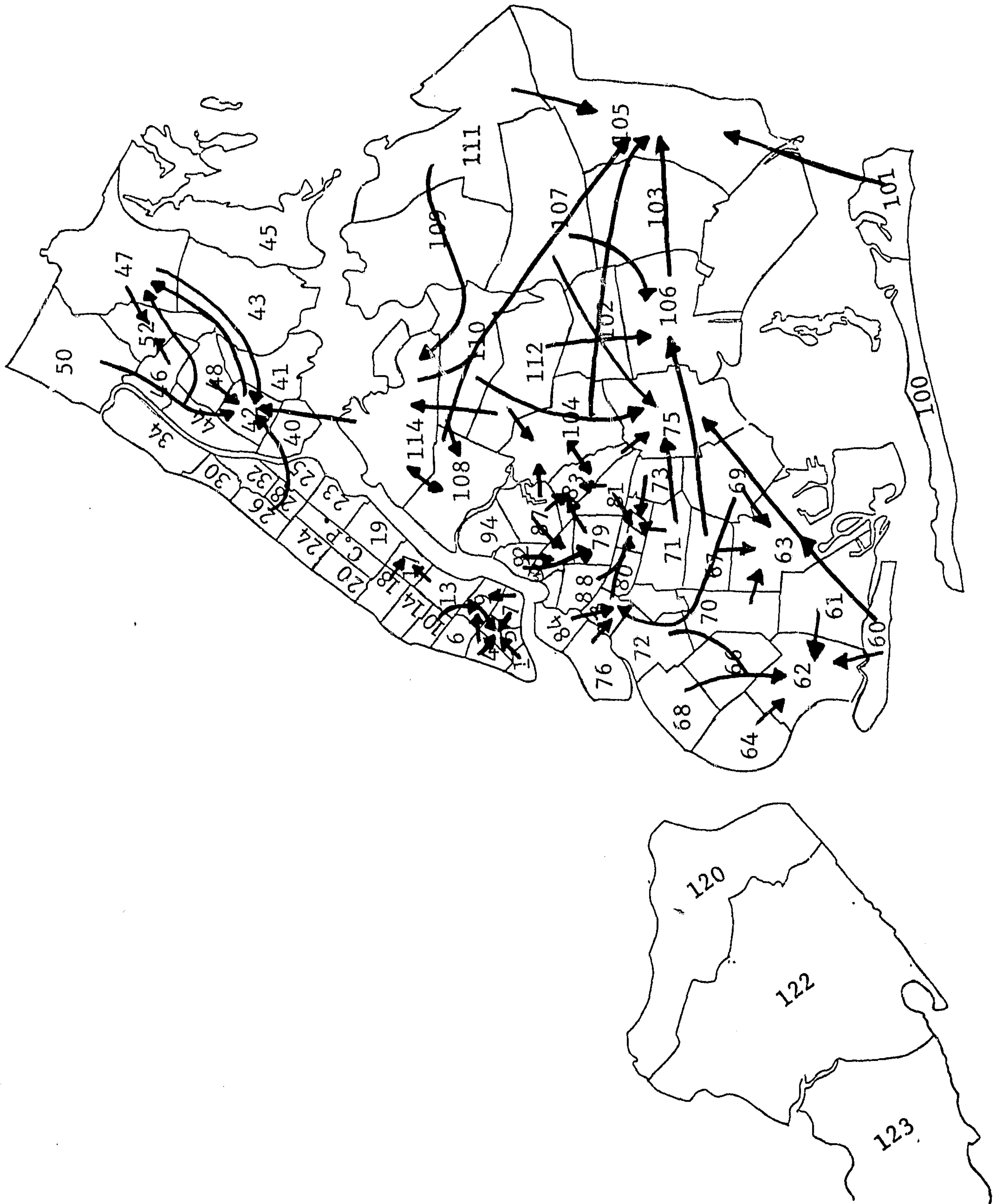


Figure A-13-11 indicates the secondary stolen car flow patterns for New York City.

In attempting to determine the reasons for auto theft, two methods of data collections were used. A survey of auto theft victims conducted by this study group documented the reason given for the theft during the police investigation. Of those surveyed, 26% indicated that the primary reason given for the theft was joy riding; 13% indicated that their car was stolen for parts and 6% felt the car was used for transportation purposes. The remaining percentage were able to give no reason (Figure A-13-12).

The second of two methods used for analysis of the reasons behind auto theft was a comprehensive study of the demographic data available in an attempt to correlate these factors with auto theft. Figure A-13-13 shows the density of crime in New York City, exclusive of auto theft, by precinct. In comparing this map with Figure A-13-5, we can see that most of the precincts in Manhattan and Bronx boroughs which are high in auto theft are also high in crime. Figures A-13-14 through A-13-17 plot auto thefts per 1/10 square mile against crime minus auto theft per 1/10 of a square mile for all boroughs. The tendency for the scatter diagram points to cluster along a continuum further supports its notion that crime and auto theft are correlated.

Another factor to be considered in an analysis of demographic features is the population distribution of youth. Figure A-13-19 shows the youth density per precinct in New York City. The measure for youth was the number of youths between the ages of 16 and 19 per 1/10 of a square mile. This index was derived from the 1960 Census tract data for New York City.

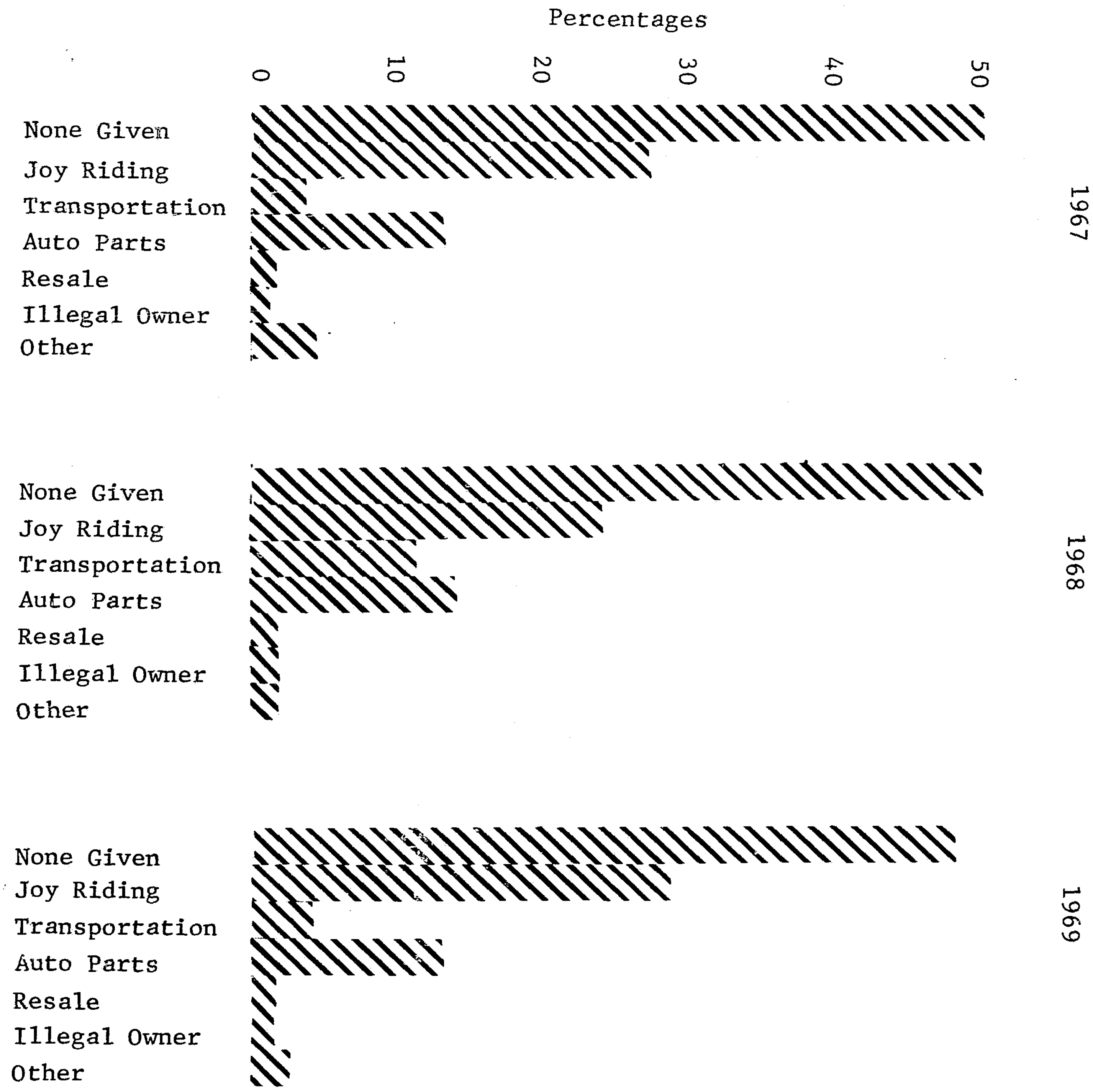


Figure A-13-12 shows the percentages for the reasons given for theft.

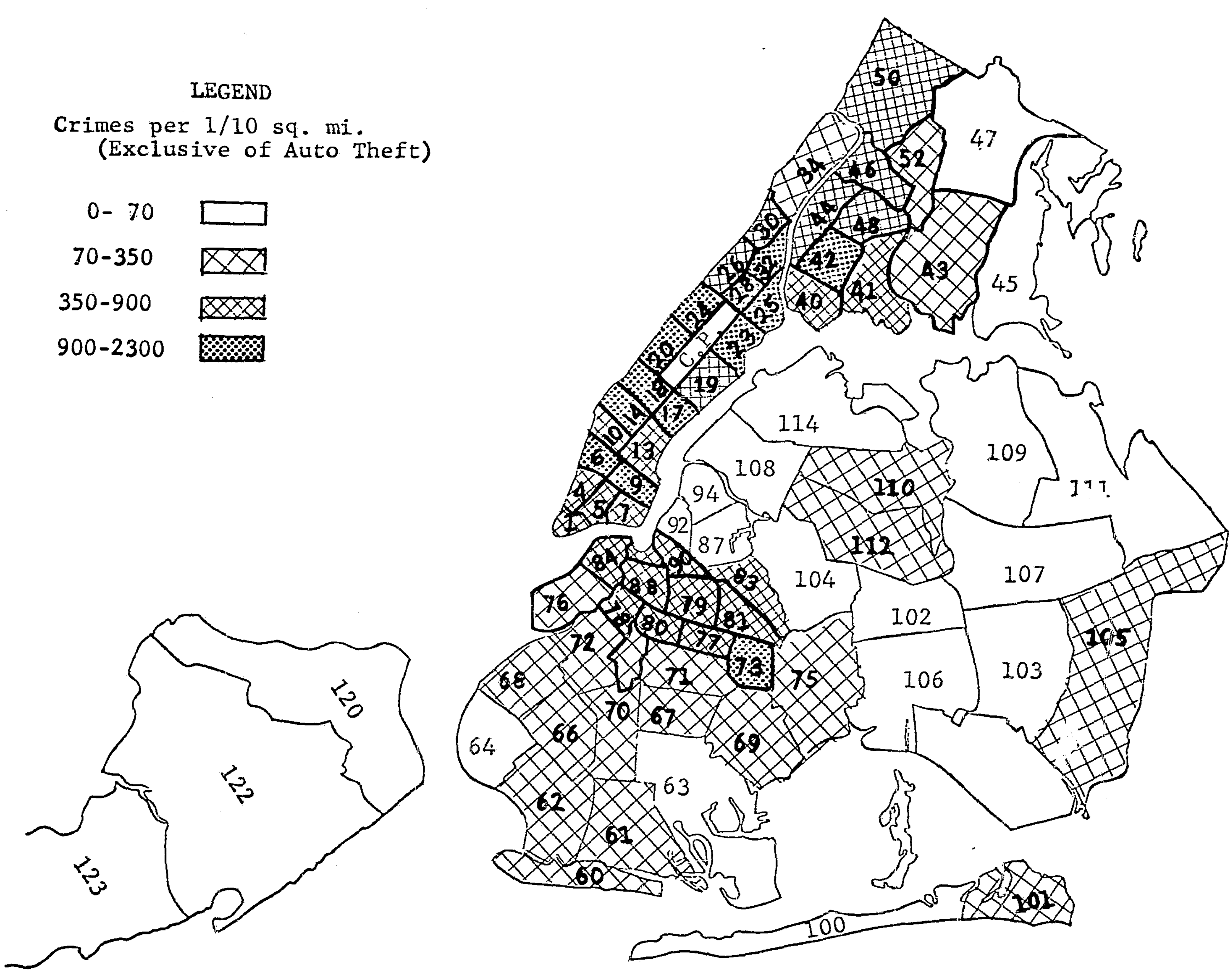


Figure A-13-13 shows the amount of crime exclusive of auto theft in each precinct. The index for crime is the number of crimes other than auto thefts committed per 1/10 sq. mi. in 1967.

Manhattan

A-13-26

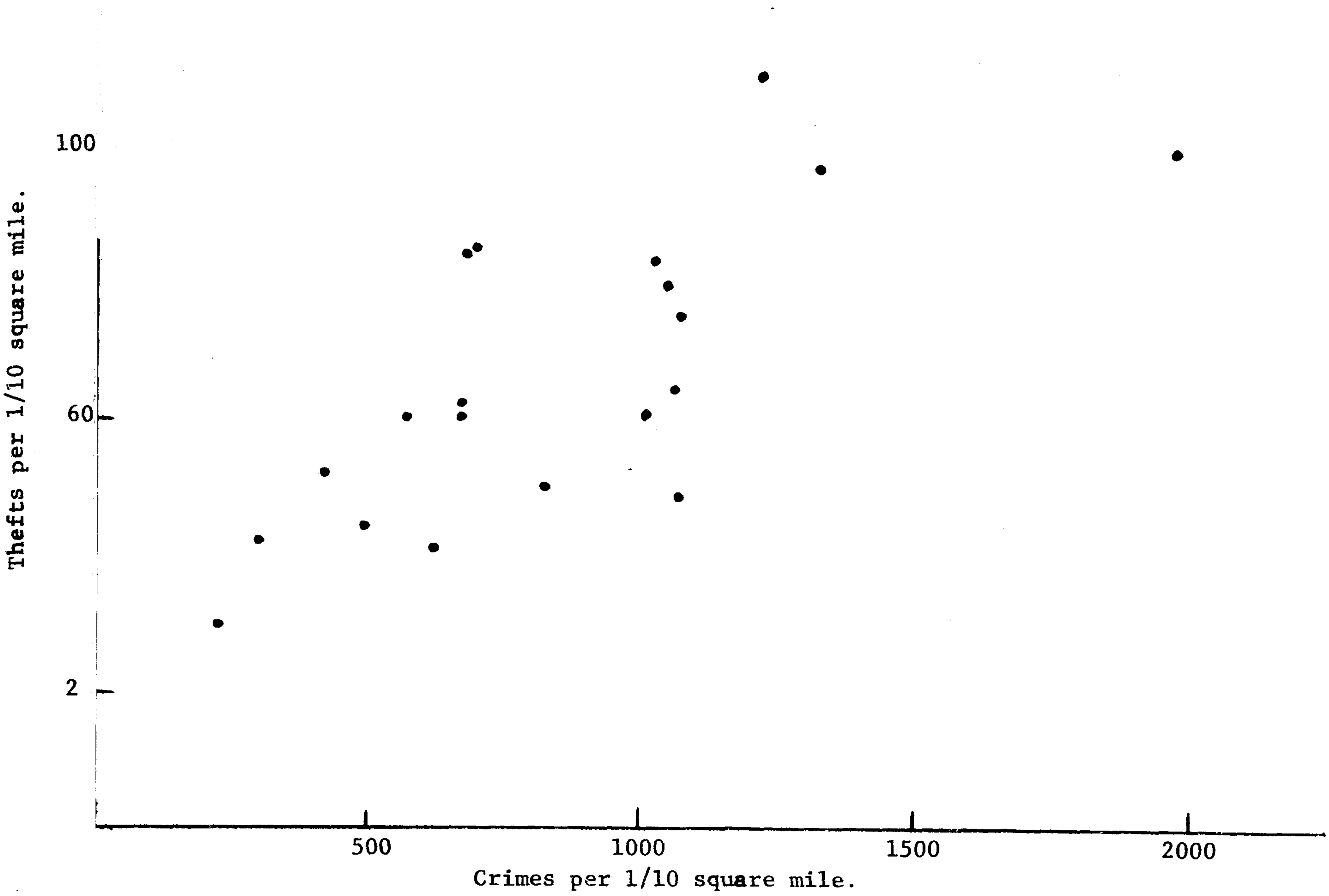


Figure A-13-14 shows the correlation of auto theft with crime in Manhattan.

A-13-27

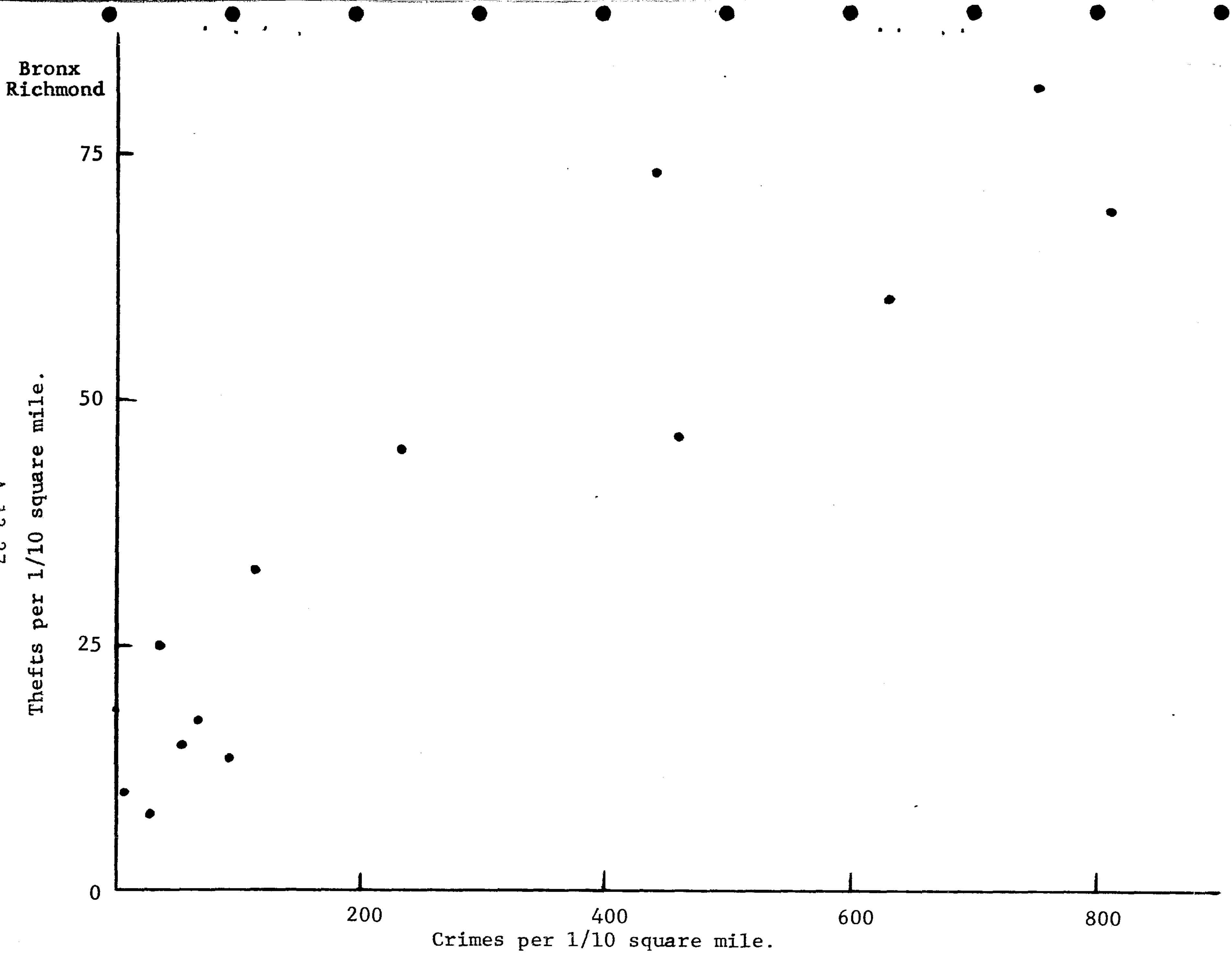


Figure A-13-15 shows the correlation of auto theft with crime in Bronx and Richmond.

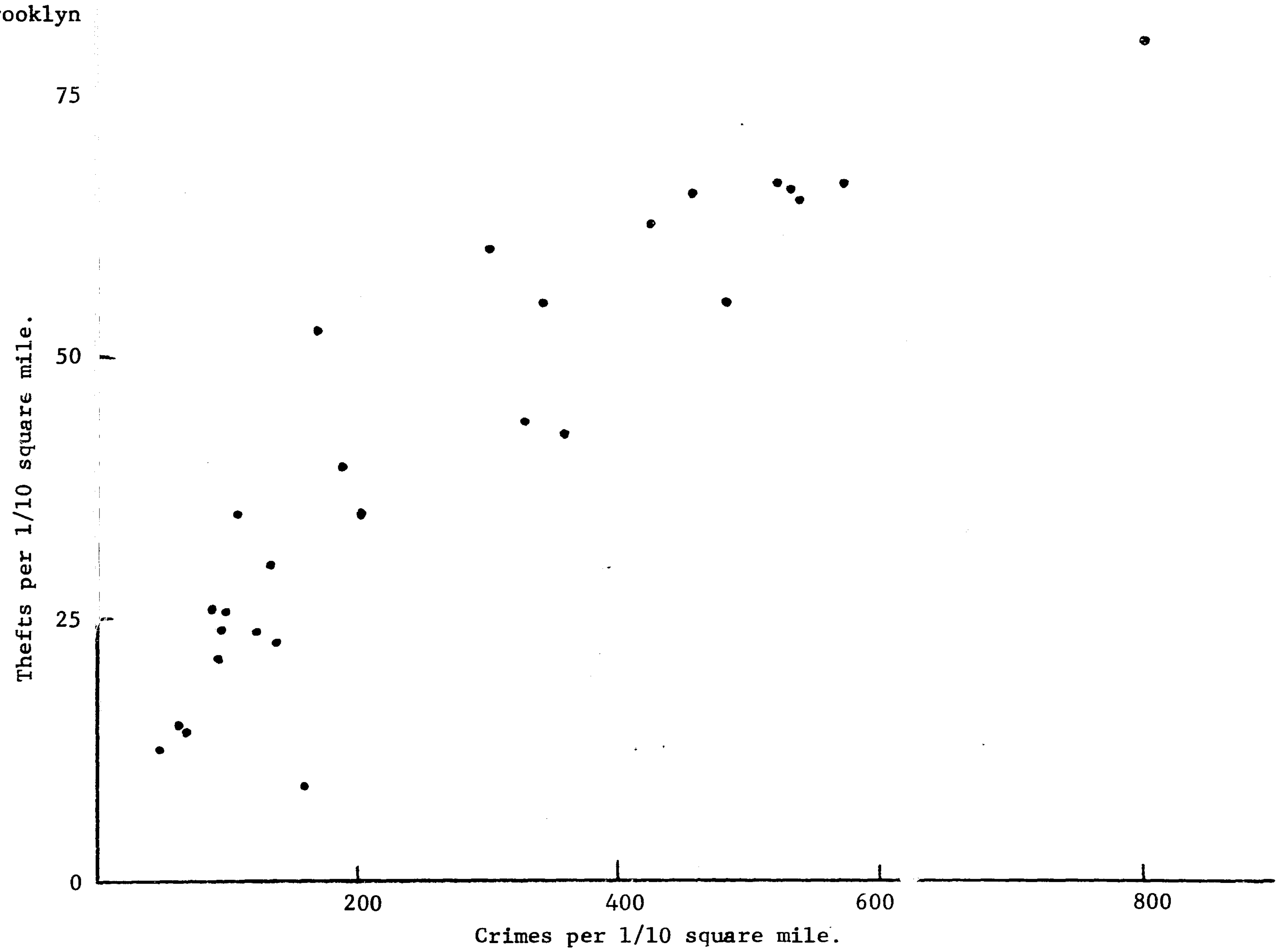


Figure A-13-16 shows the correlation of auto theft with crime in Brooklyn.

A-13-28

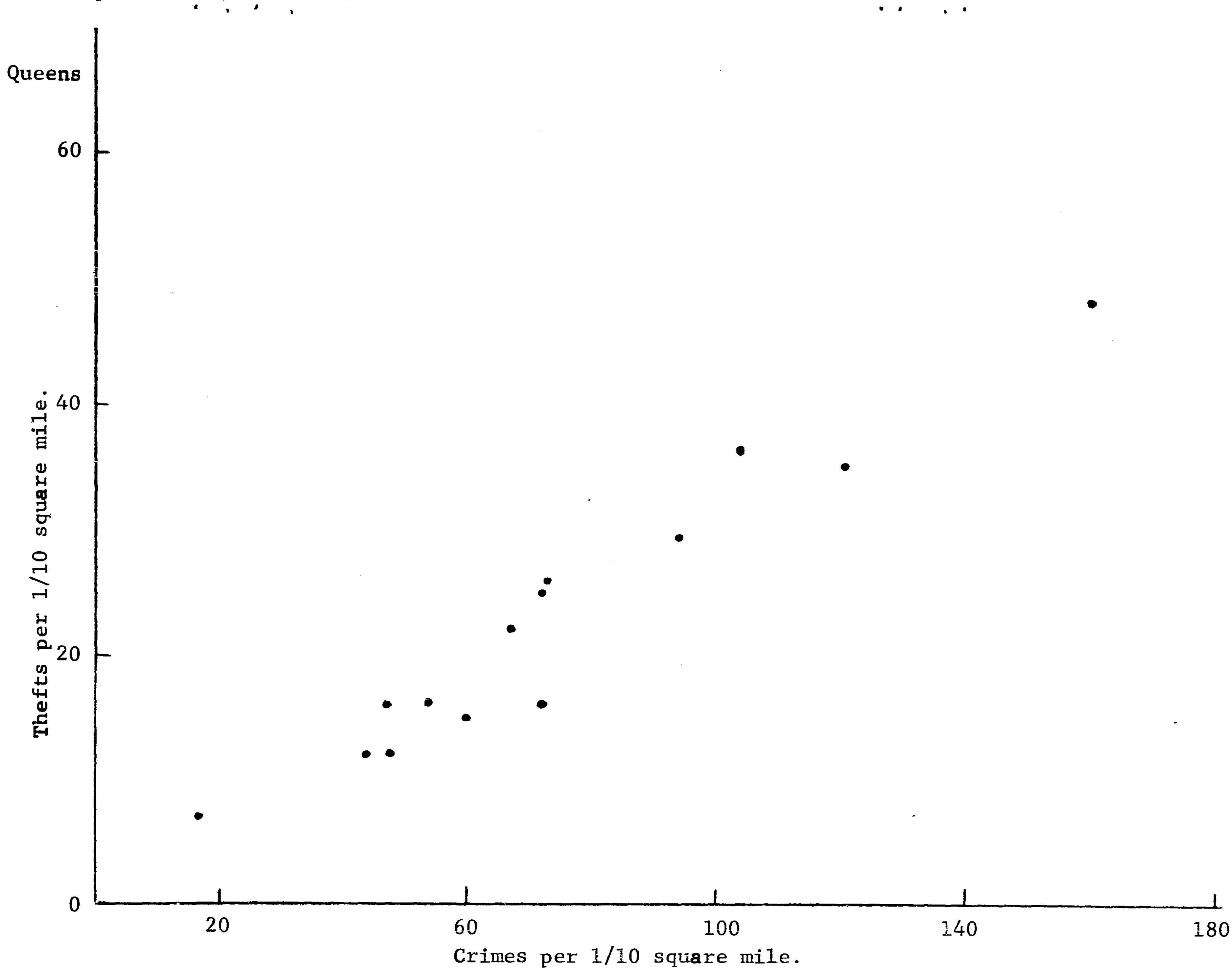


Figure A-13-17 shows the correlation of auto theft to crime in Queens.

A-13-29

In comparing this map with the previous figures we can see that only in certain precincts does a high youth factor appear along with a high theft rate. Conversly, many high youth areas have low auto theft rates and several precincts with heavy auto theft density have few youths. This would seem to indicate that there is no direct correlation between youth, the number of youths residing in a precinct and auto theft; this indication is also supported by the graphs in Figure A-13-20 through A-13-23. These graphs compare thefts per 1/10 of a square mile with youths per 1/10 of a square mile. Yet another demographic feature to be analyzed was public transportation. An analysis of the availability and access to the transportation system in New York City yielded no correlation when compared to auto theft. (Figure A-13-24) Figure A-13-25 shows the estimated number of cars in each precinct. The estimates were based on the number of cars owned or used by the members of the housing units in each 1/10 of a square mile. No apparent correlation can be made with the availability of cars and auto theft, as can be verified by the graphs displayed in Figures A-13-26 through A-13-29.

And finally Figure A-13-30 displays the median family income by precinct as indicated by the 1960 Census Tracts for New York City. An attempt to correlate income with auto theft was also fruitless as born out by the graphs in Figures A-13-31 through A-13-34.

Summing up our analyses of demographic features in regard to their relationship to auto theft it appears that theft is strongly correlated with crime and in some instances with youth. The logical mutation of these factors, juvenile

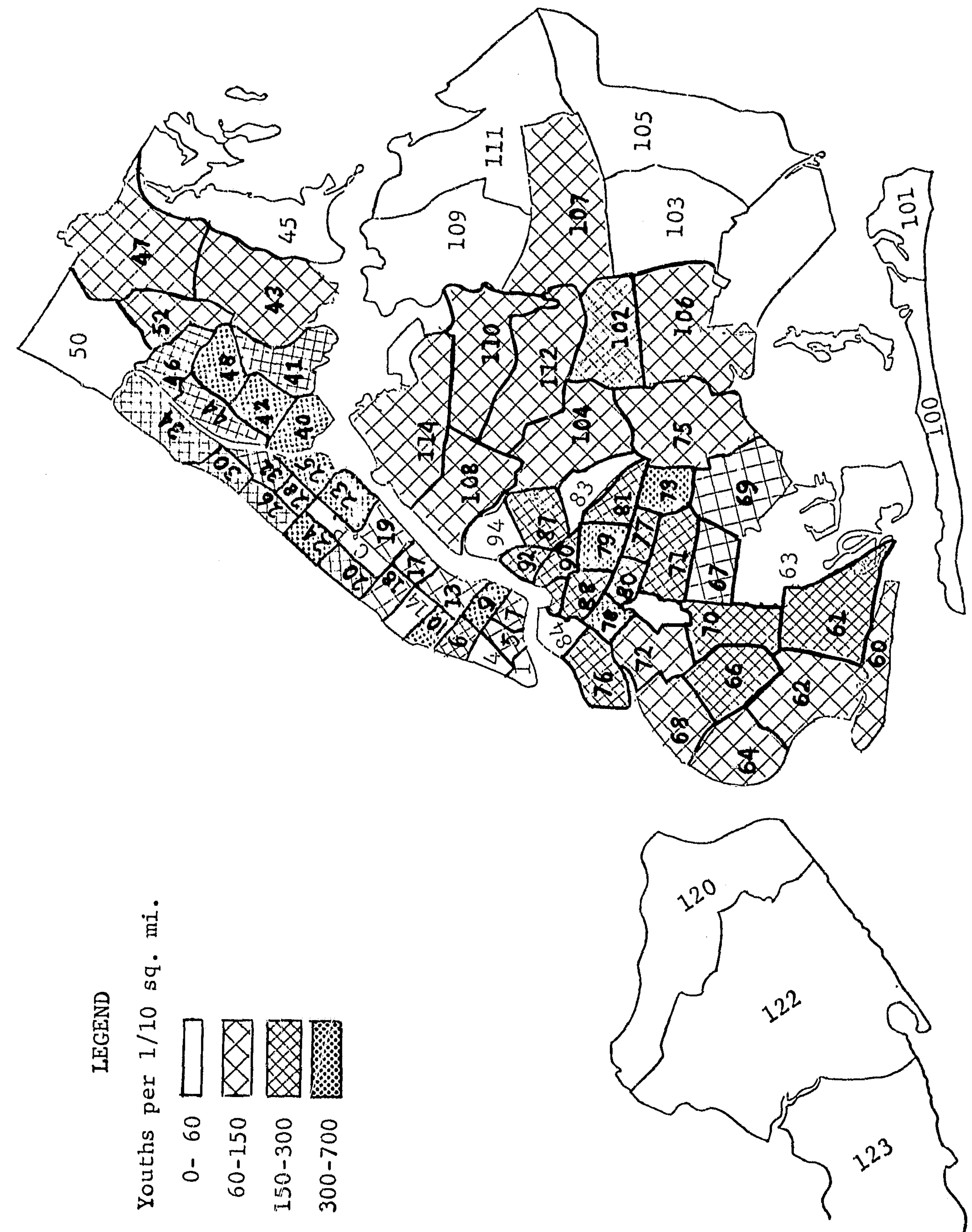


Figure A-13-19. This map shows the population distribution of youth by precinct. The measure for youth is the number of youths between the ages of 16 and 19 per 1/10 square mile. The index was derived from the 1960 Census Tract data for New York City.

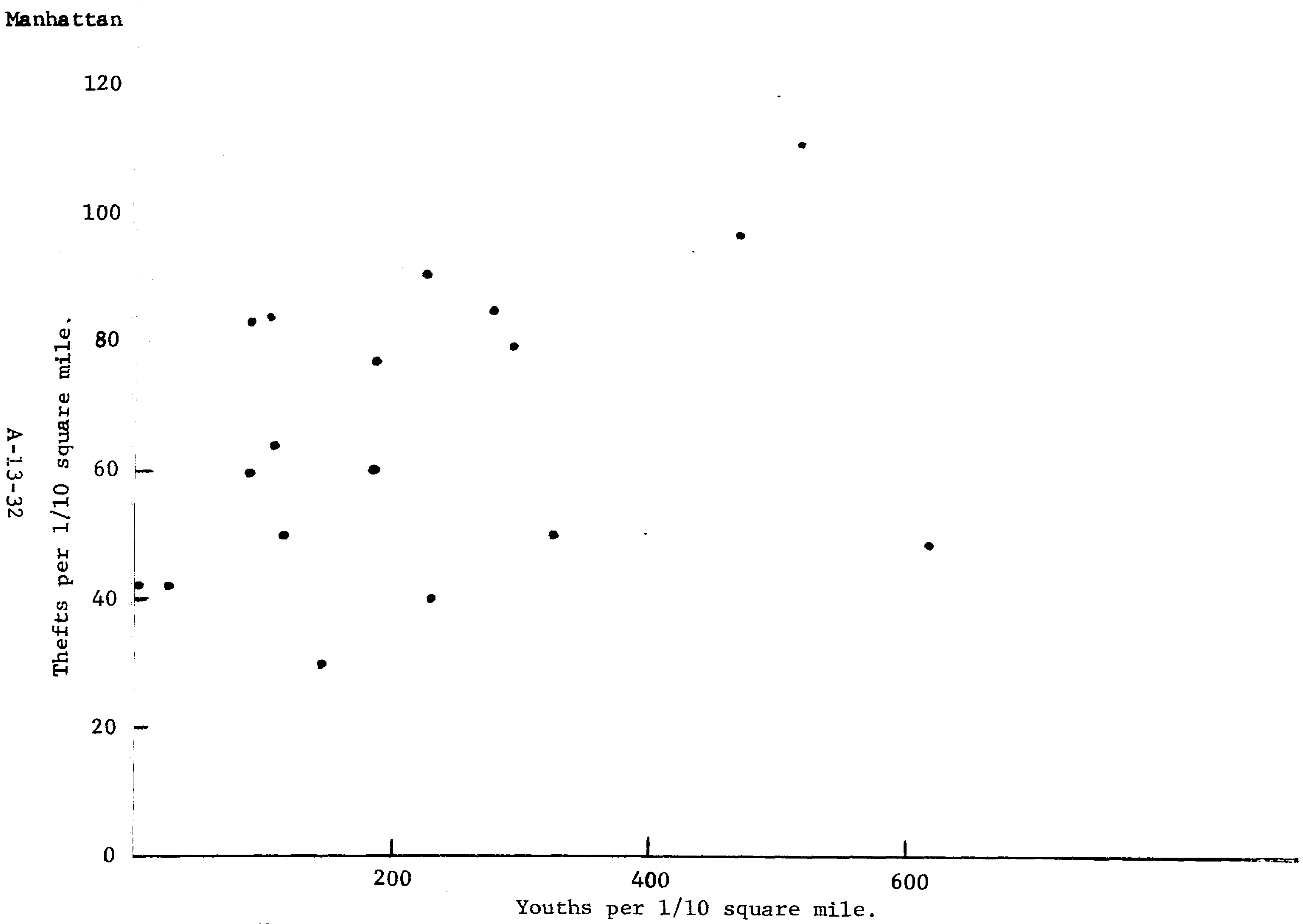


Figure A-13-20 shows the correlation of auto theft to youth for Manhattan.

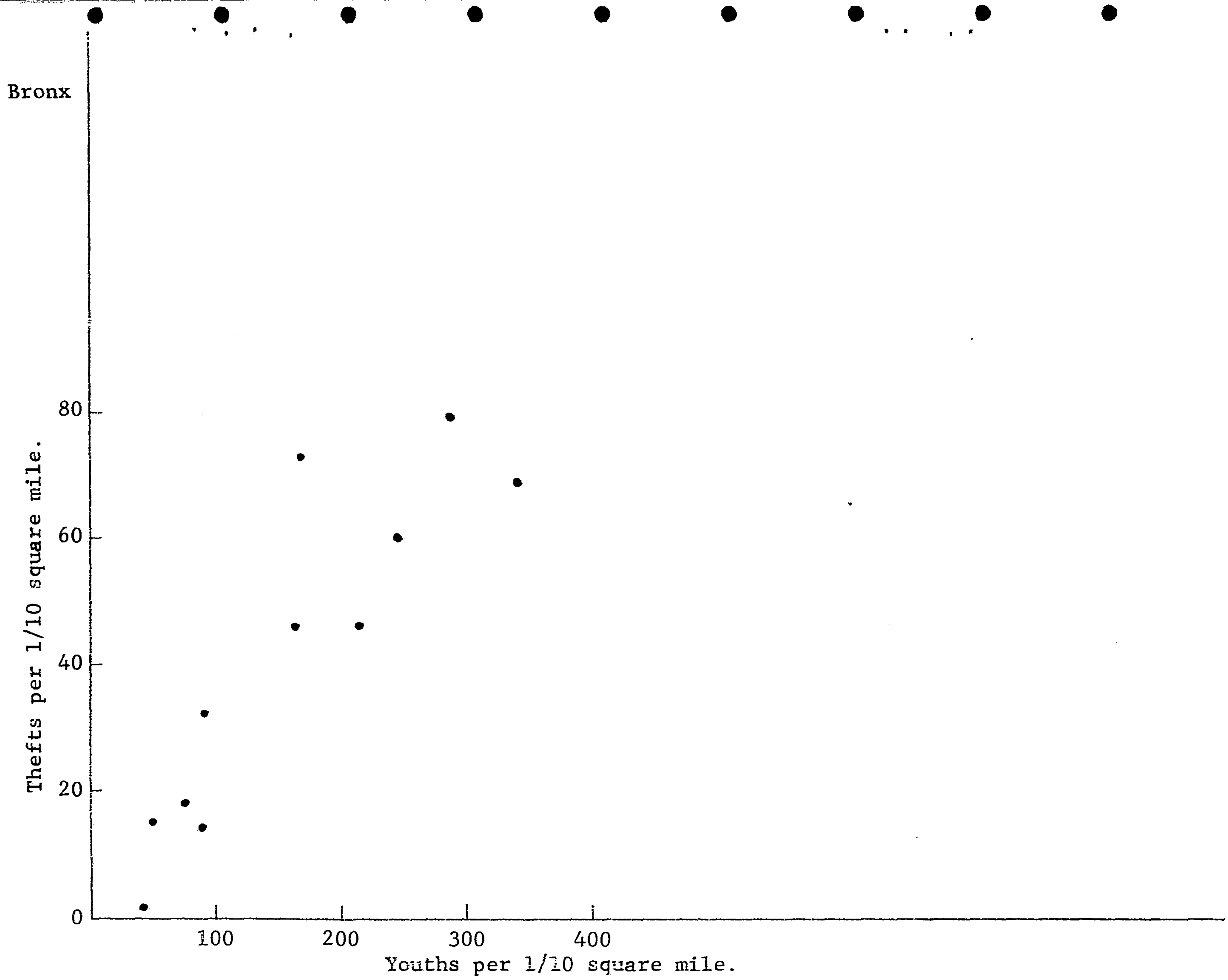


Figure A-13-21 shows the correlation of auto theft to youth for Bronx.

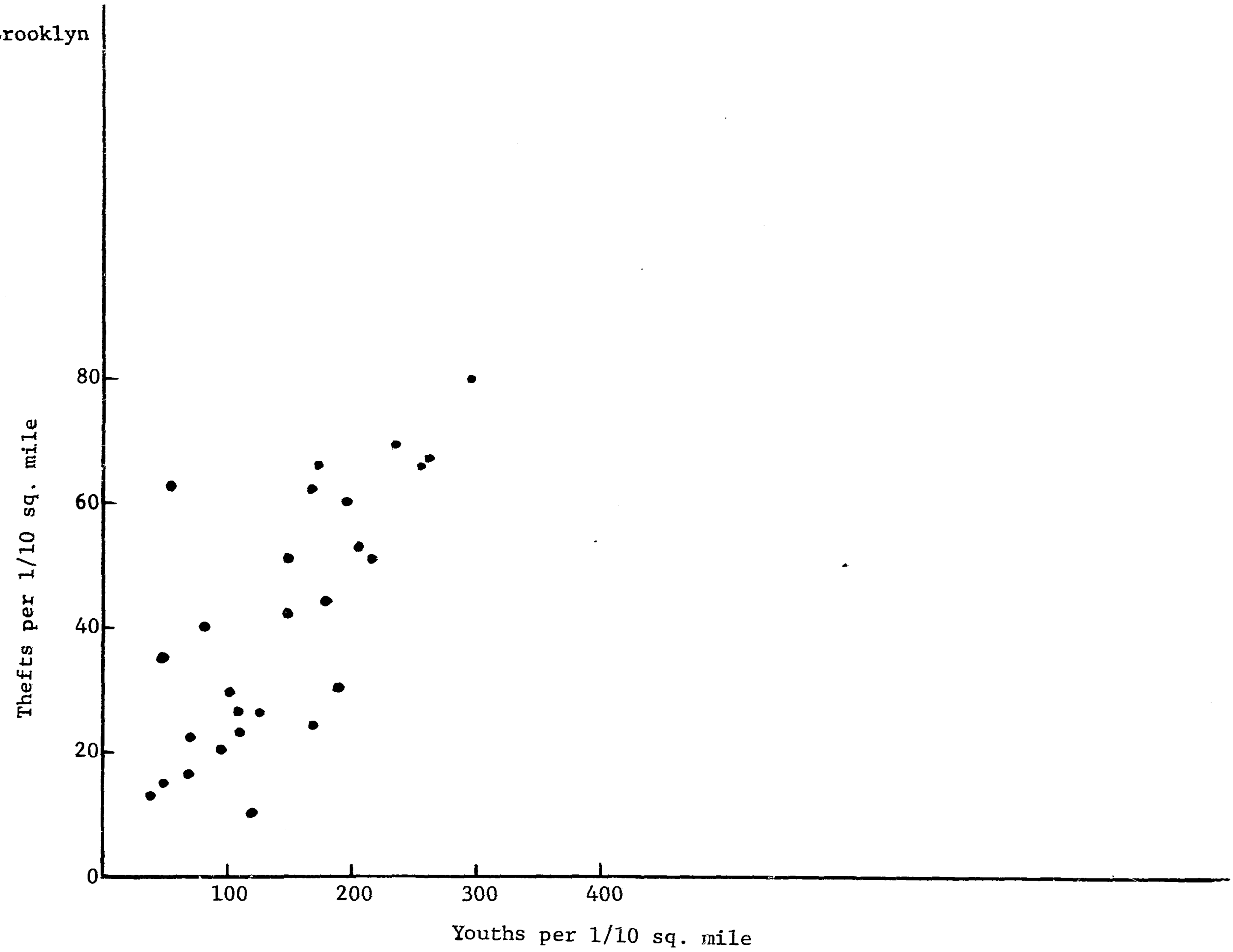


Figure A-13-22 shows the correlation of auto theft to youth in Brooklyn.

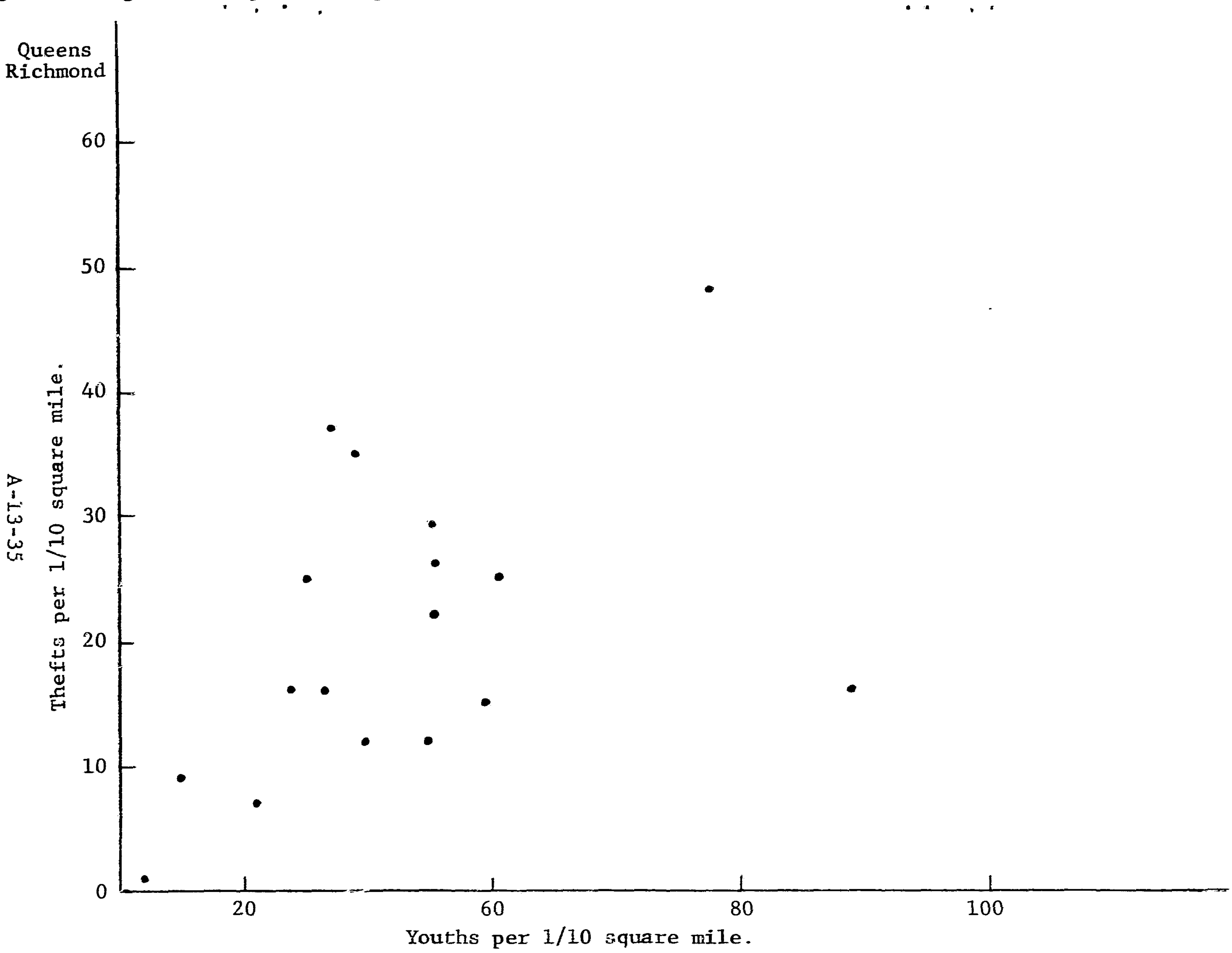


Figure A-13-23 shows the correlation of auto theft to youth in Queens and Richmond.

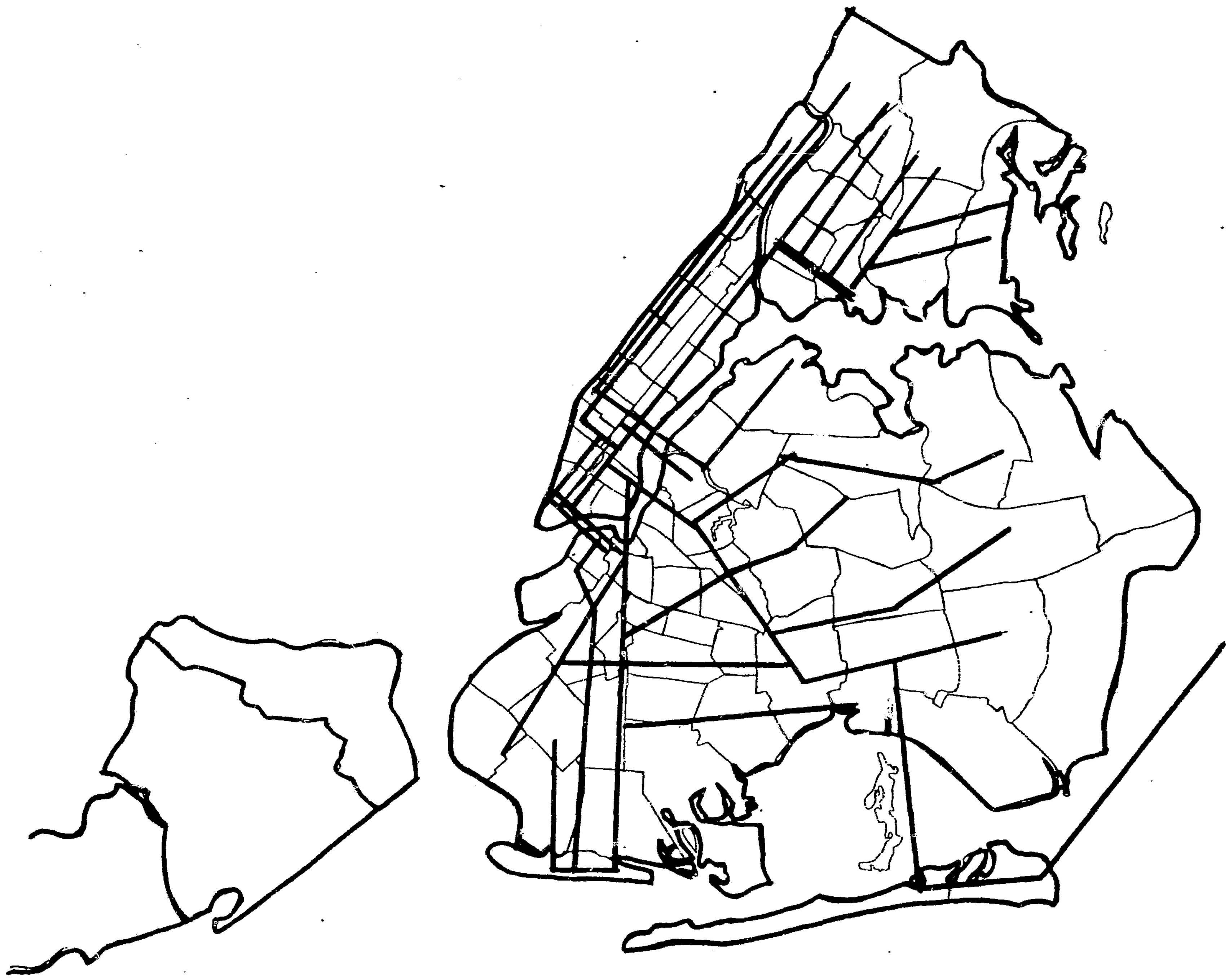


Figure A-13-24 shows the major subway lines and precinct boundaries for New York City.

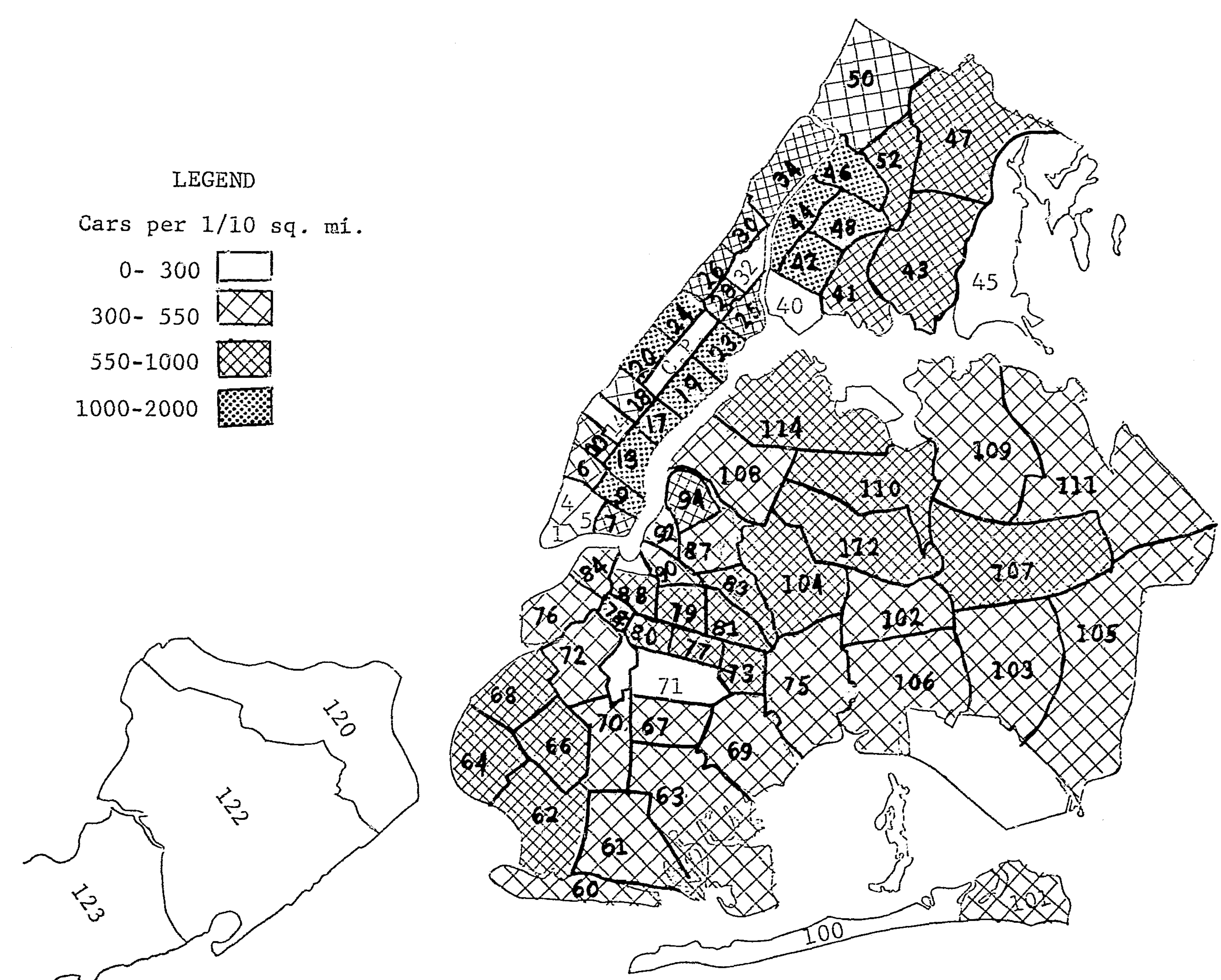


Figure A-13-26 shows the estimated number of cars in each precinct. The estimates were based on the number of cars owned or used by the members of the housing units in each 1/10 sq. mi. of area.

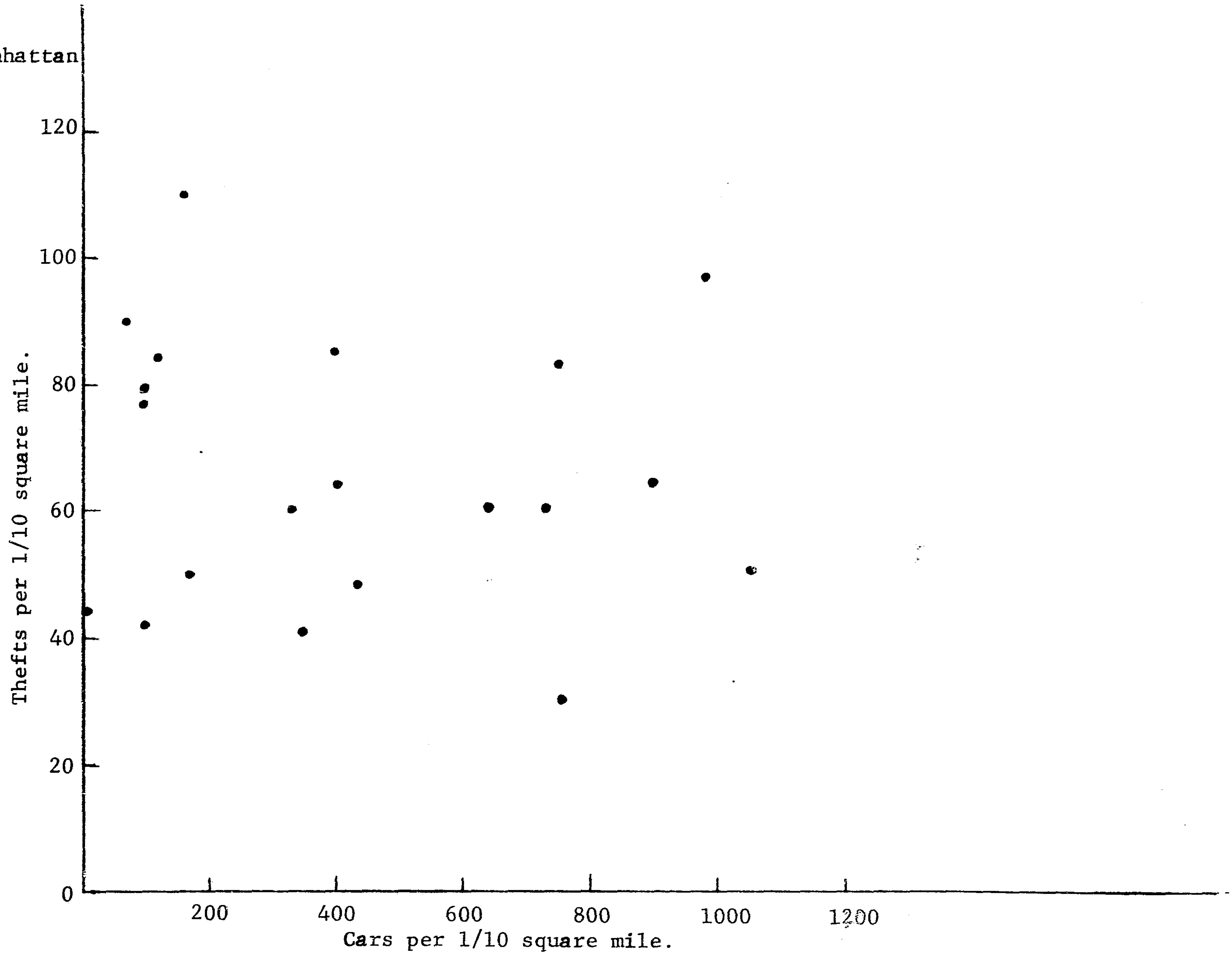


Figure A-13-26 shows the correlation of auto theft to cars per 1/10 square mile for Manhattan.

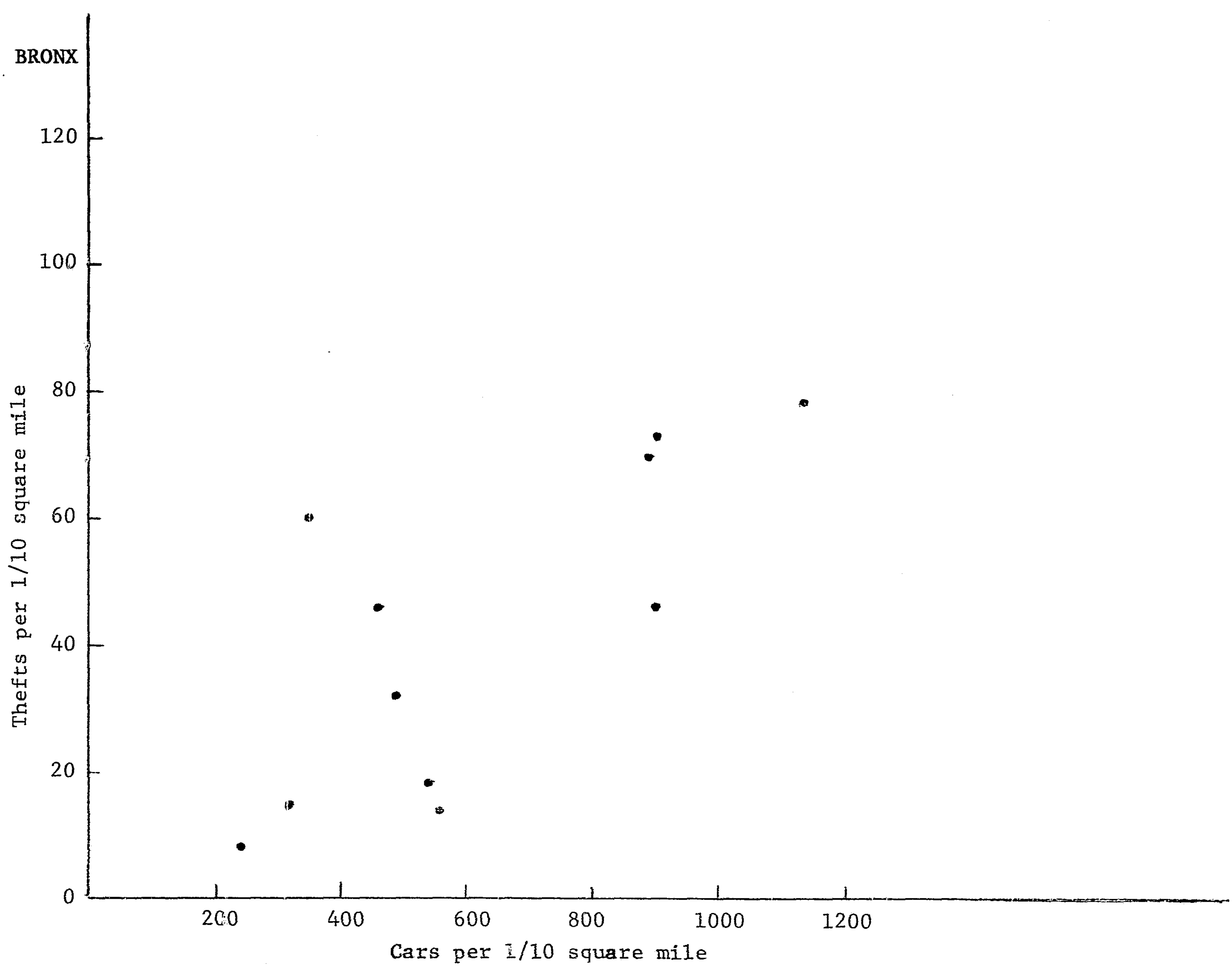


Figure A-13-27 shows the correlation of auto theft to cars per 1/10 square mile for Bronx.

A-13-40

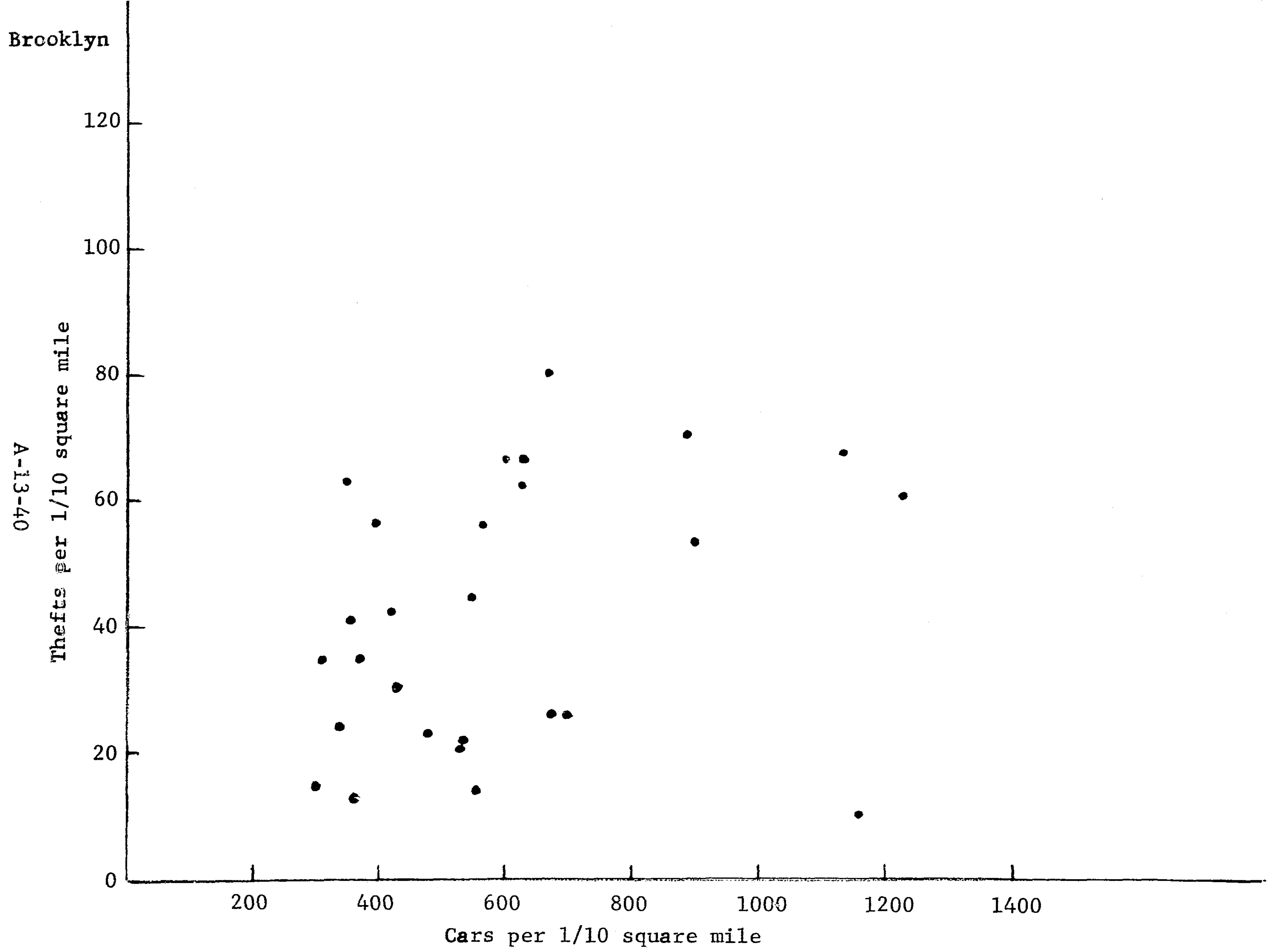


Figure A-13-28 shows the correlation of auto theft with cars per 1/10 square mile for Brooklyn.

A-13-41

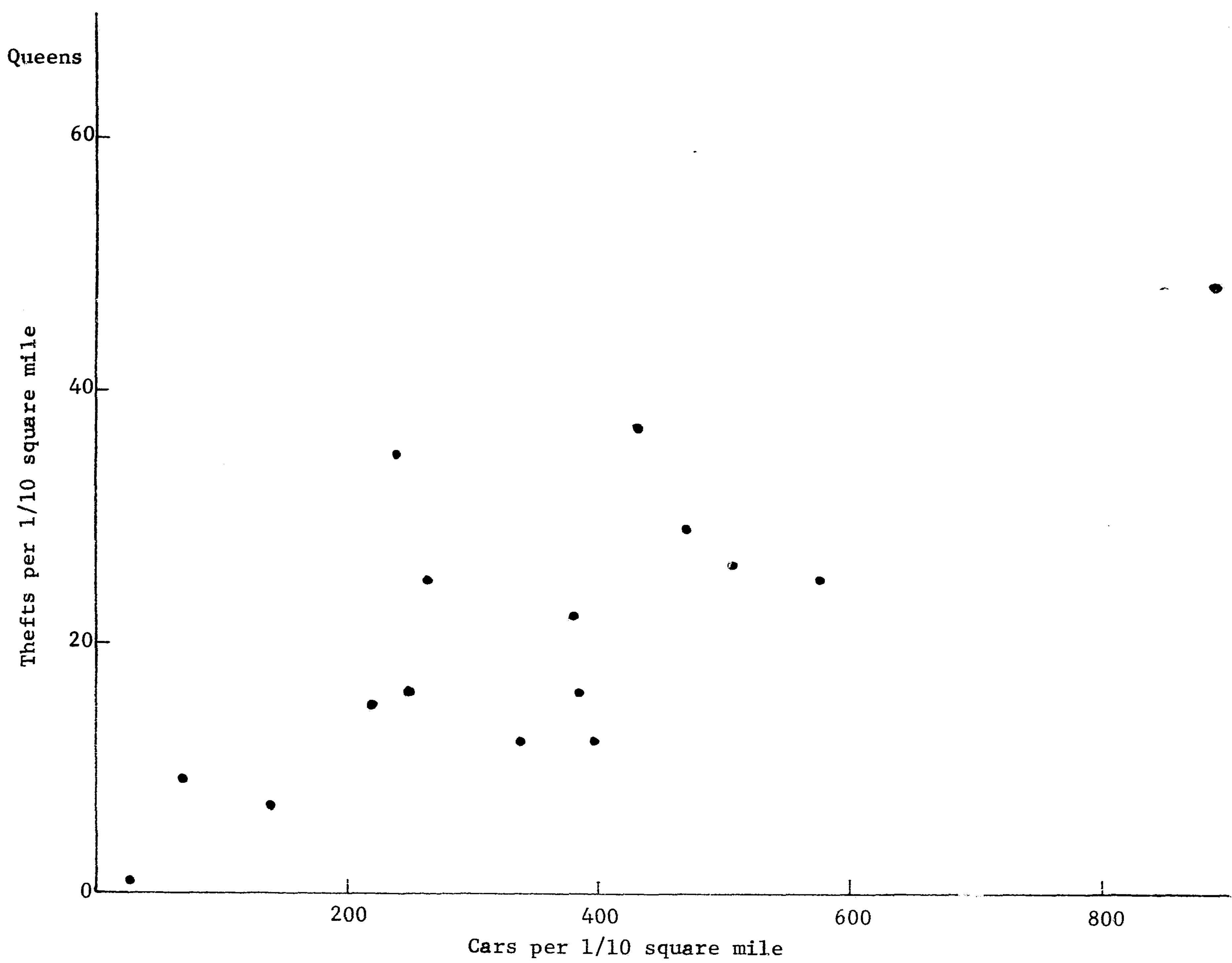


Figure A-13-29 shows the correlation of auto theft to cars per 1/10 square mile for Queens.

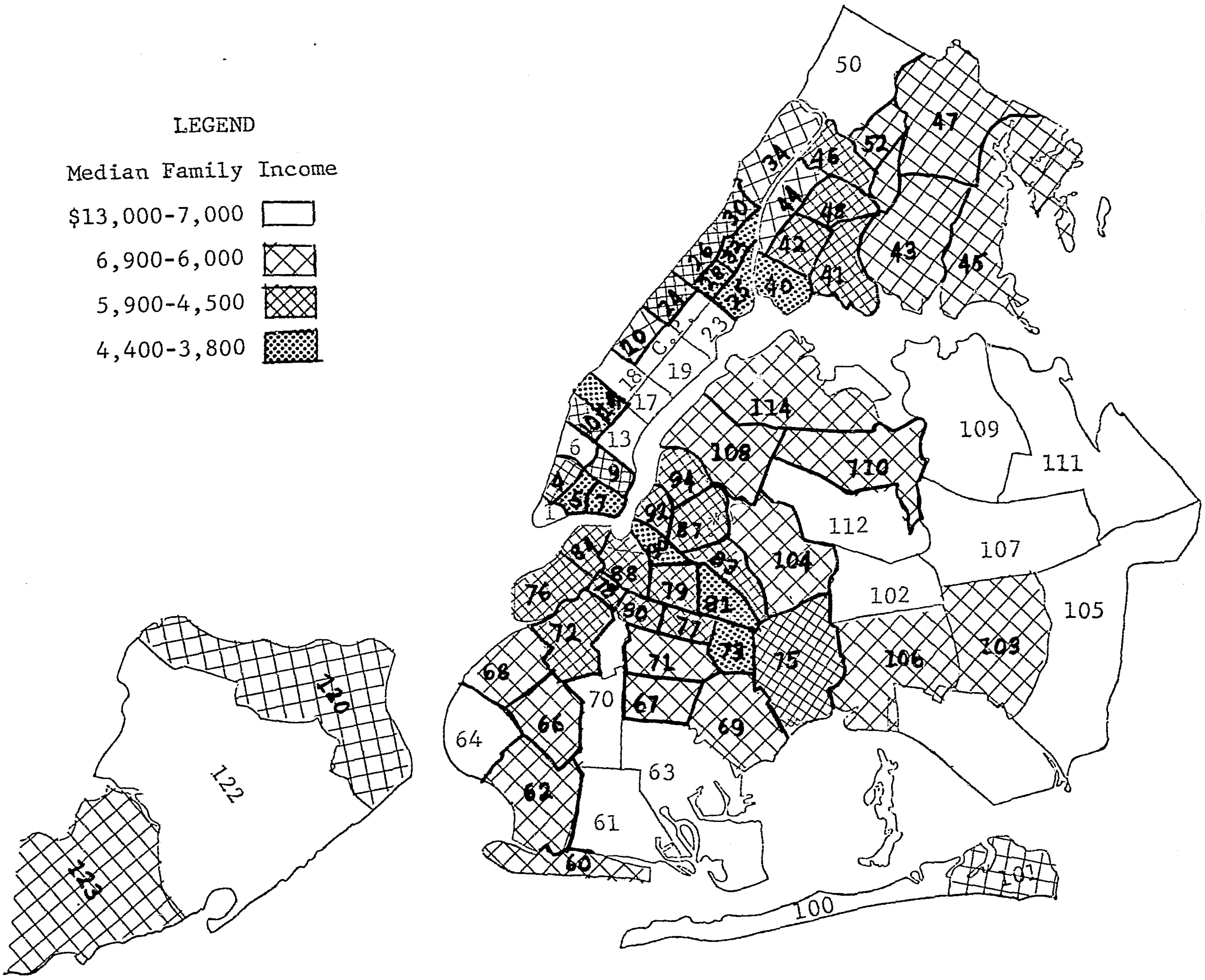


Figure A-13-30 shows the median family income of each precinct, as indicated by the 1960 Census Tracts for New York City.

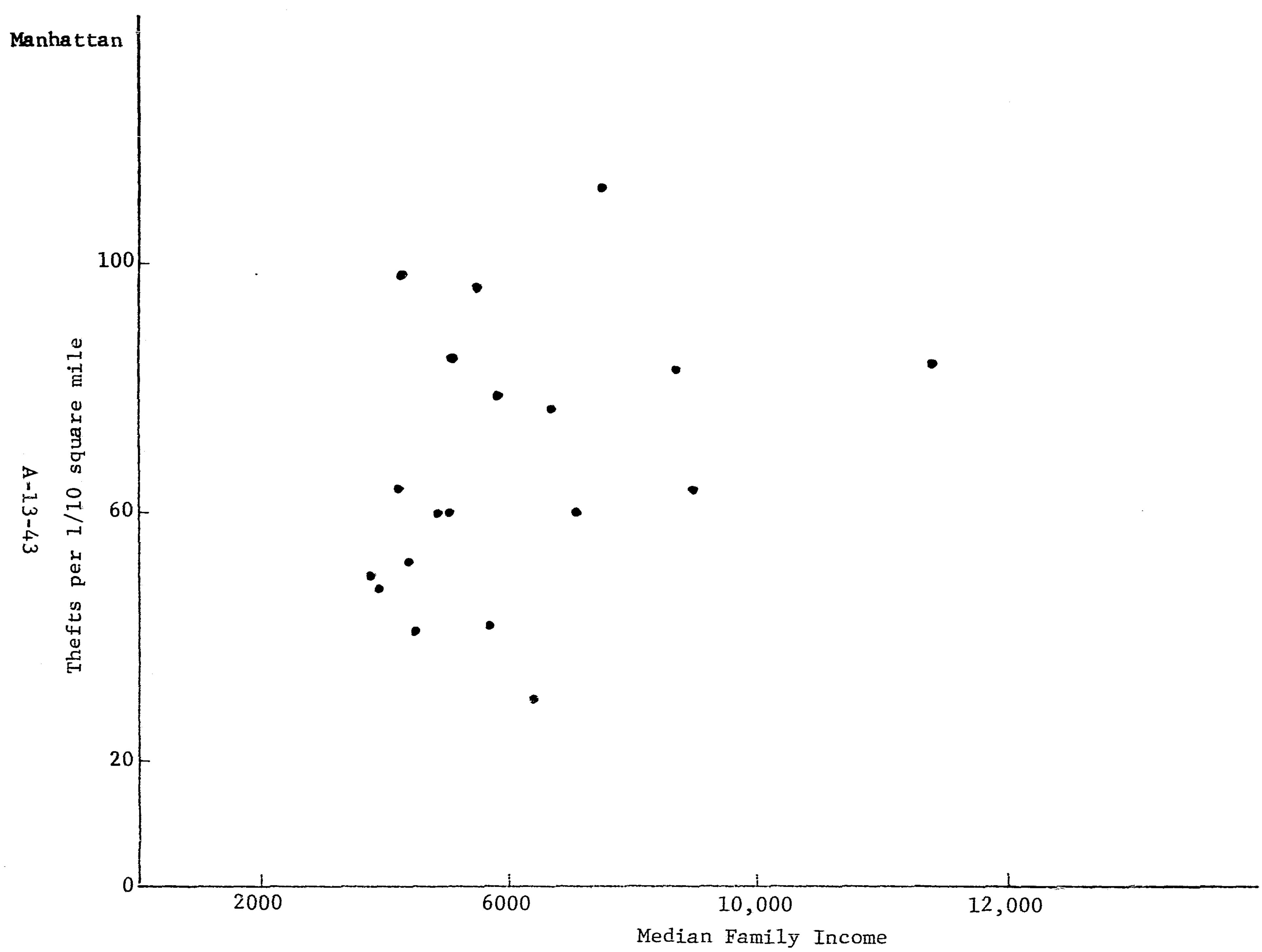


Figure A-13-31 shows the correlation of auto theft to income for Manhattan.

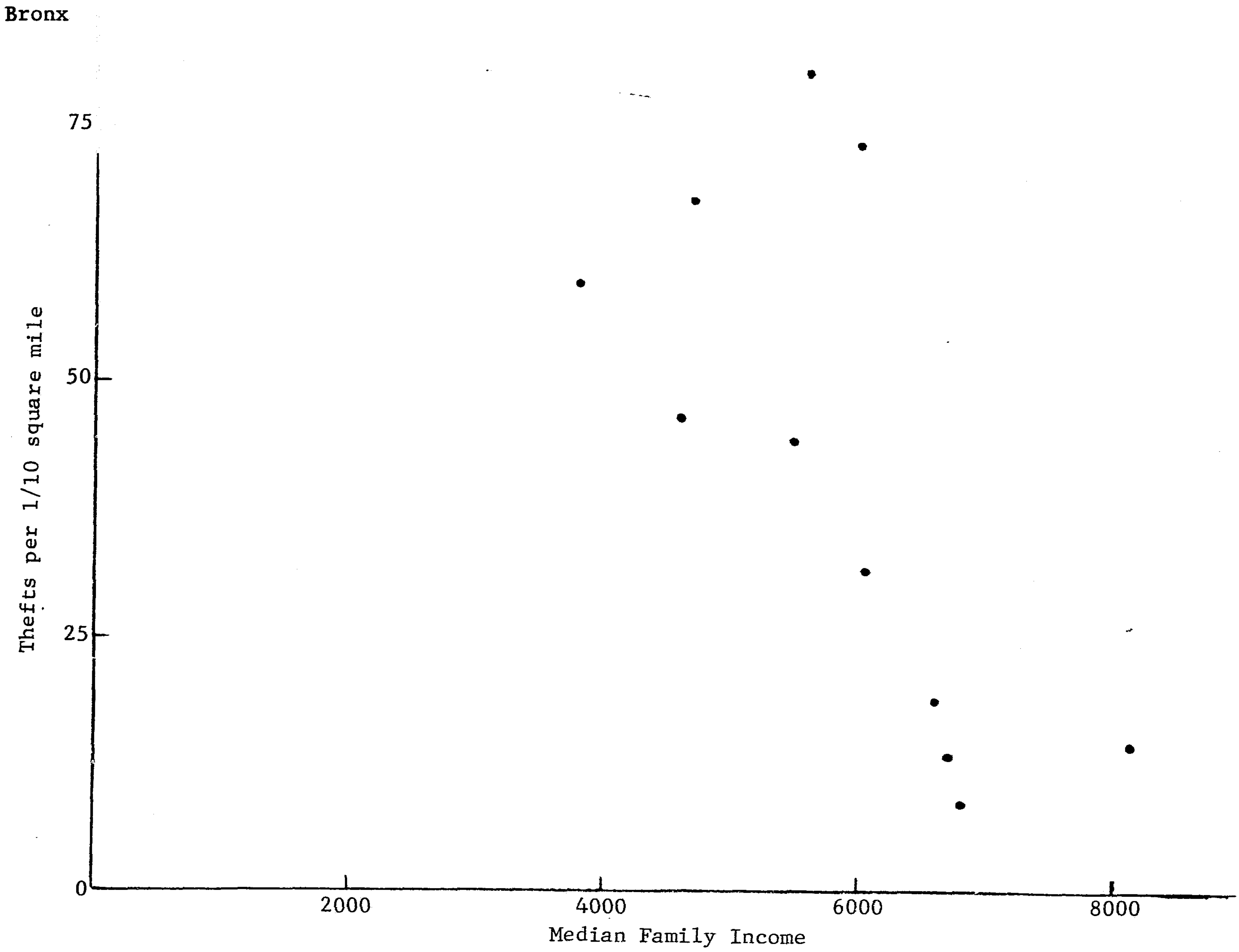


Figure A-13-32 shows the correlation of auto theft to income for Bronx.

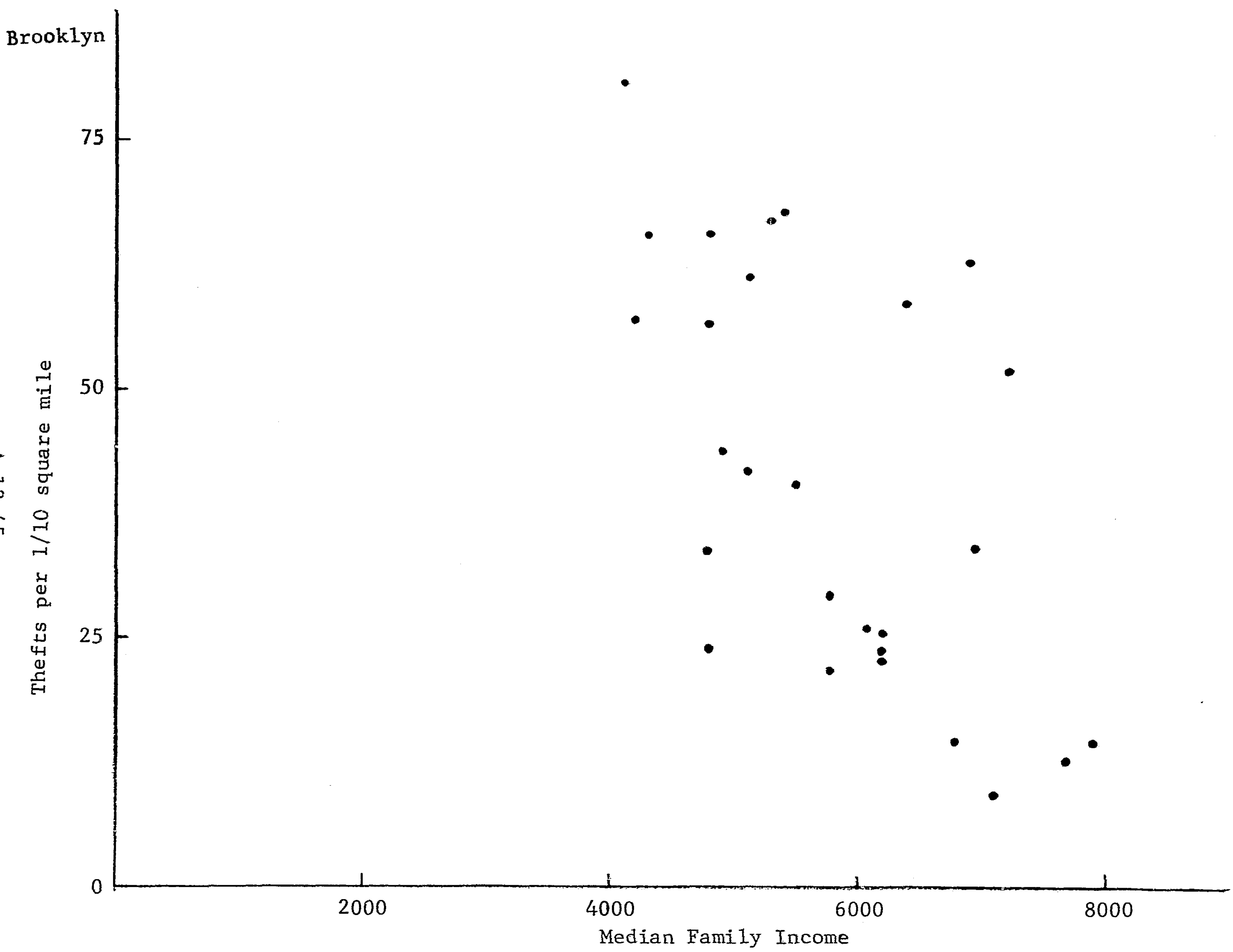


Figure A-13-33 shows the correlation of auto theft to income for Brooklyn.

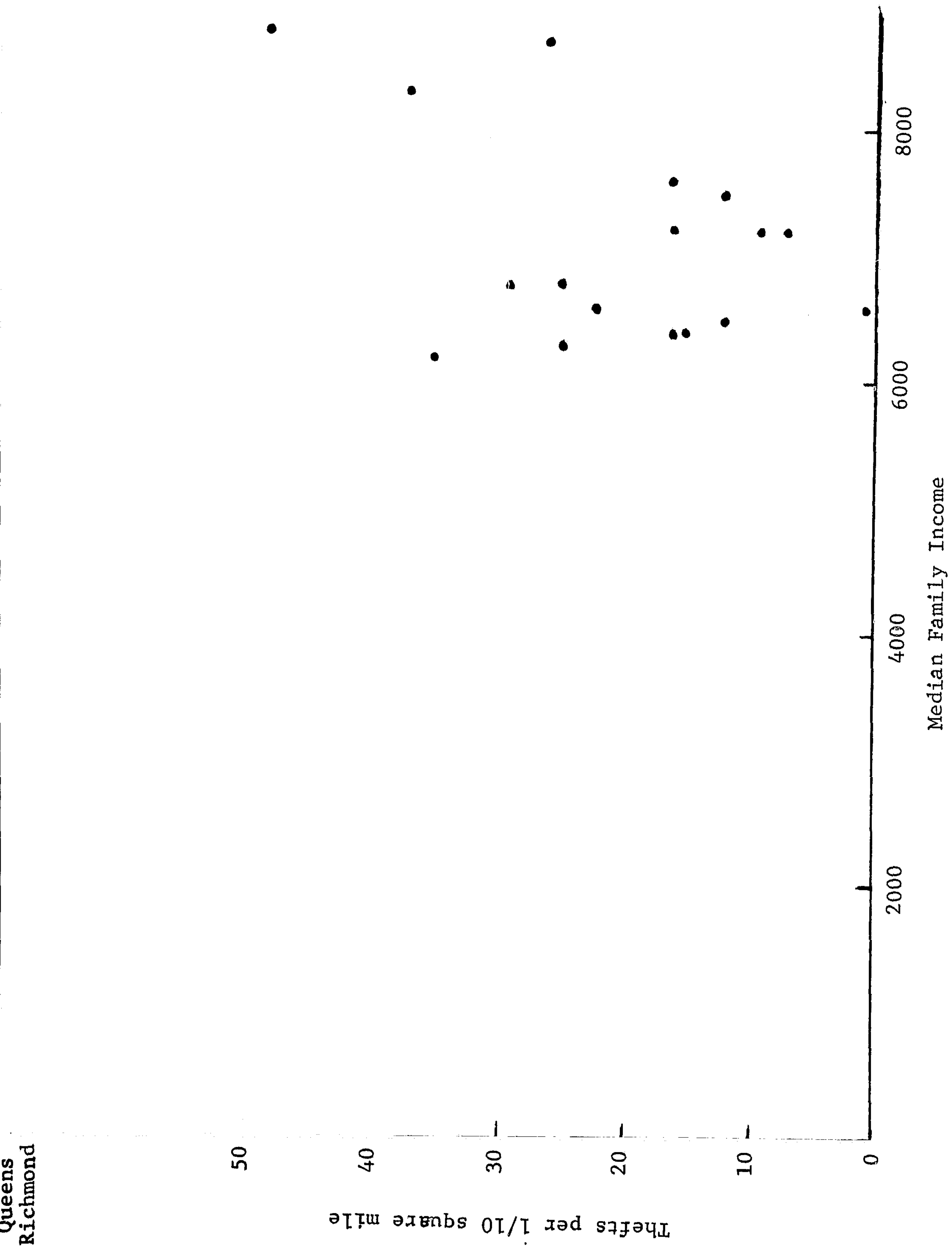


Figure A-13-34 shows the correlation of auto theft with income for Queens and Richmond.

delinquency, shows a strong correlation with theft when comparing the five boroughs (Figures A-13-35 and A-13-36). Precinct by precinct data on juvenile delinquency was not available so a detailed discussion of this possibility could not be executed.

A discussion of the type of vehicle which inhabits the stolen car flow pattern is certainly appropriate at this point. Figure A-13-37 indicates the ages of the vehicles stolen in the years 1967, 1968, and 1969. The frequency distribution over the three year period shows first, that make-years of the stolen models have a 10 year time span range and, second, that there appears to be a slight decrease in the theft of newer cars.

Table A-13-5 presents the age distribution of recovered stolen cars. A percentage of theft is given for each make year. This Table seems to suggest that cars between the ages of 2 to 8 years seem to be preferred for cars which are recovered.

Table A-13-6 indicates the age distribution of unrecovered vehicles. Here again, cars between 2 and 9 years old seem to be favored.

Table A-13-7 shows the effect of car makes on the stolen car population for the last three years. Again, the General Motors' cars have the highest theft frequency. It is interesting to note that the trend over the last three years shows a decrease in the Cadillac theft rate and an increase in the Volkswagon theft rate.

LEGEND

Arrests per 1/10 sq. mi.

Manhattan	10.8
Bronx	5.8
Brooklyn	5.4
Queens	1.2
Richmond	.6

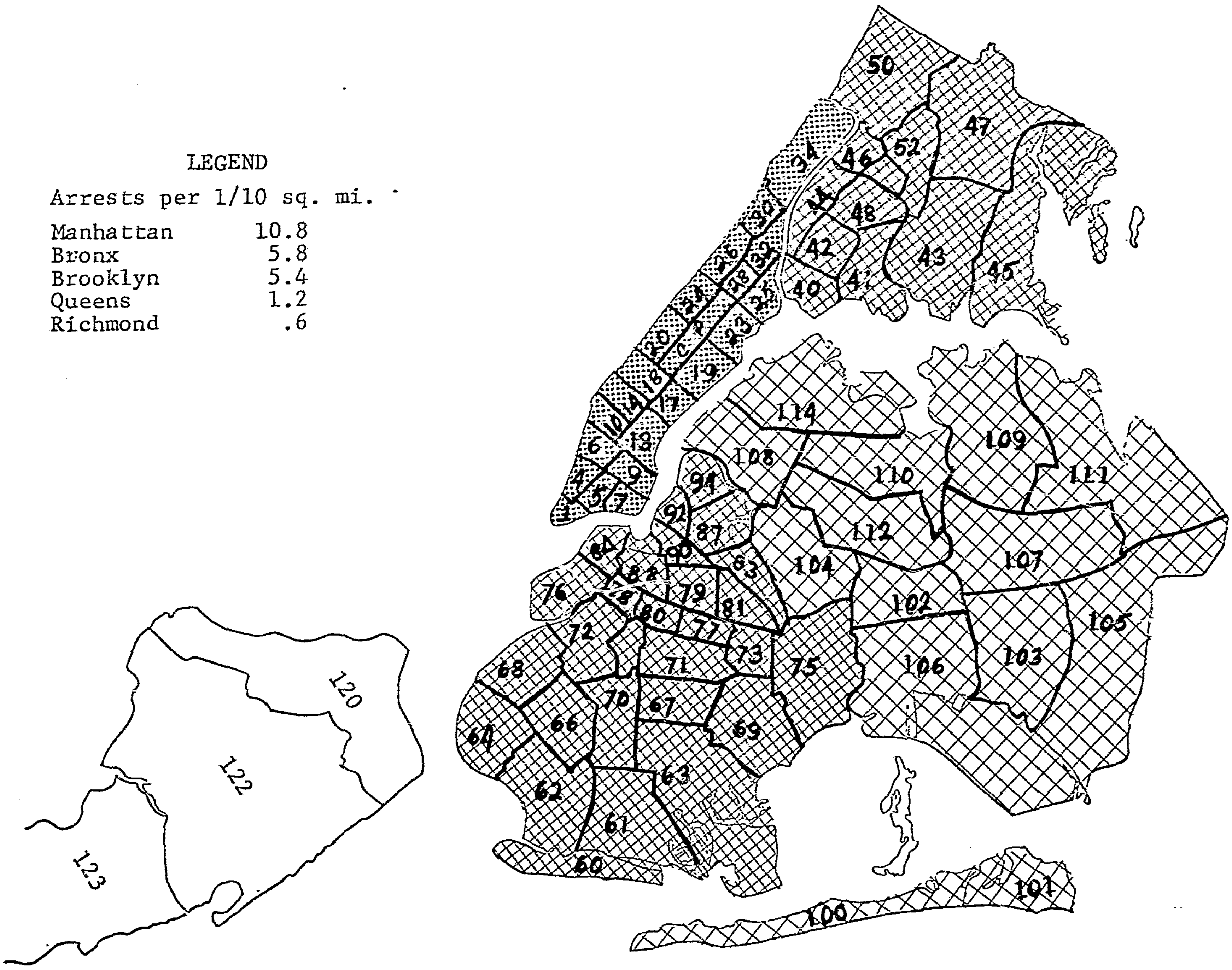


Figure A-13-35 shows the distribution of juvenile arrests per 1/10 sq. mi. by Borough. The index used to measure the rate of juvenile delinquency is the number of arrests made on juveniles, 15 years and under in each Borough, for a period of 1 year. (1968)

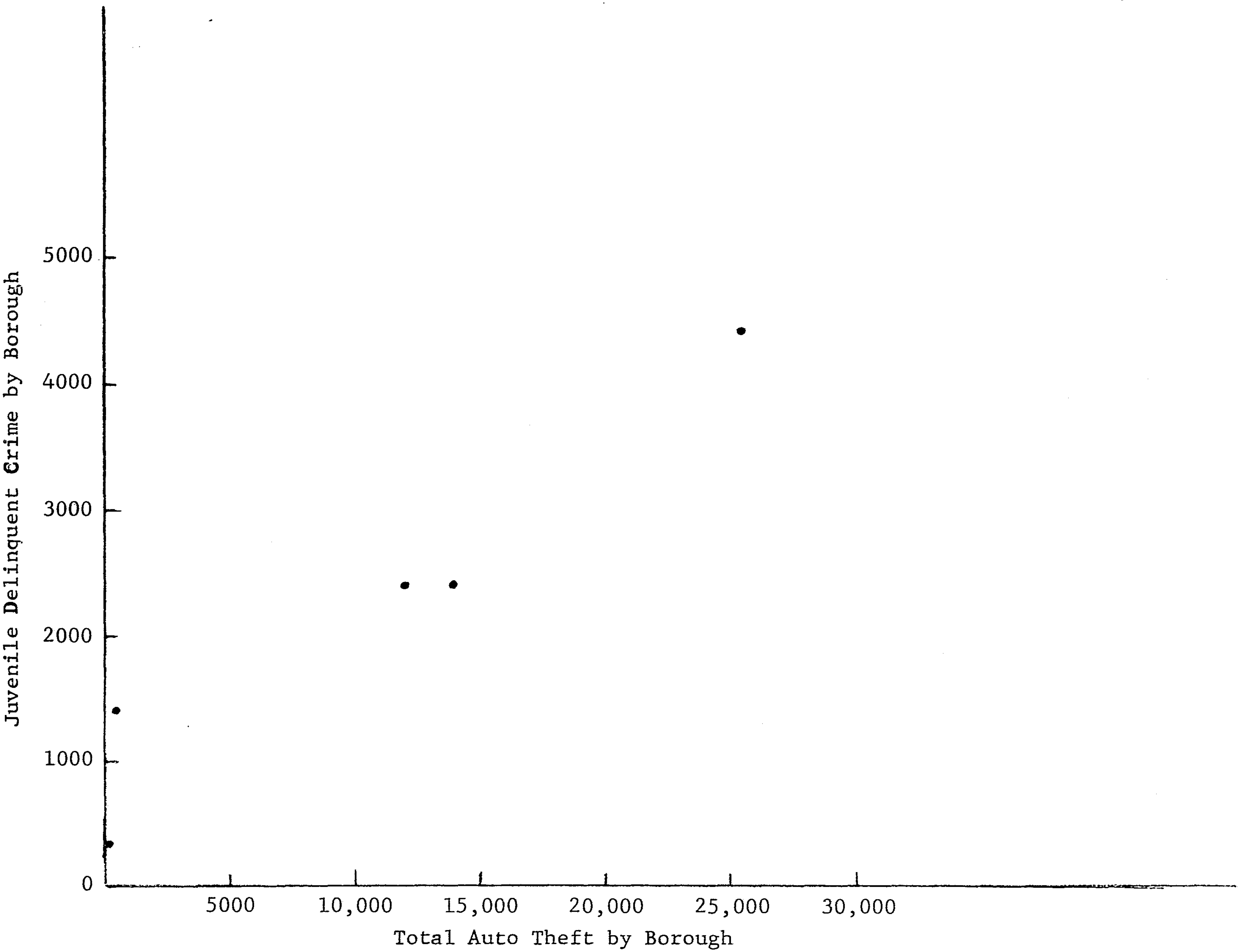


Figure A-13-36 shows the correlation of auto theft with juvenile delinquency by borough.

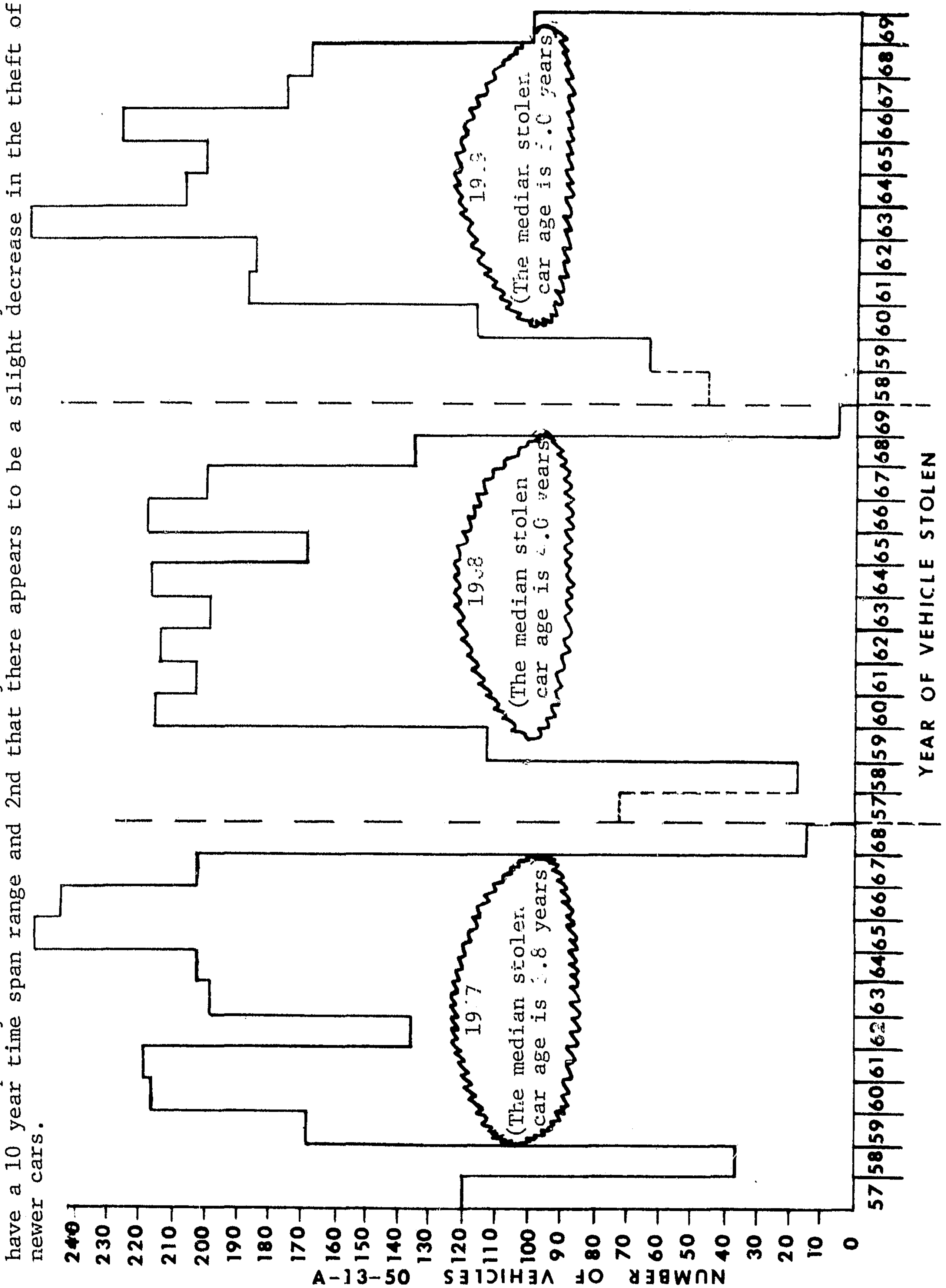


Figure A-13-37 shows the ages of the vehicles stolen in 1967, 1968 and 1969. The data was selected from a random sample of all N.Y. City vehicles stolen in the particular year. Each sample size was 2,000. The arrows on the abscissa mark points of comparison. For example, in 1967 a 1957 model is 10 yrs old, but in 1968 the 1959 model is 10 yrs old and similarly in 1969 the 1960 model is 10 yrs old. The frequency distribution over the 3 years show first that make - years of the stolen models have a 10 year time span range and 2nd that there appears to be a slight decrease in the theft of newer cars.

TABLE A-13-5

THE AGE DISTRIBUTION OF RECOVERED STOLEN CARS

Age of Car in Years	Calendar Years 1967 Make/Yr	1967 Percentage	1968 Make/Yr	1968 Percentage	1969 Make/Yr	1969 Percentage
					1957 and Below	1%
			1957 and Below	2%	1958	1.5
11	1957 and Below	4.5%	1958	.5	1959	4
10	1958	.5	1959	5.5	1960	5.5
9	1959	7.5	1960	10	1961	10.5
8	1960	11.5	1961	10.5	1962	9.5
7	1961	13	1962	12	1963	13
6	1962	6	1963	10.5	1964	11.5
5	1963	11	1964	11.5	1965	8.5
4	1964	11.5	1965	8.5	1966	13
3	1965	13.5	1966	12.5	1967	9.5
2	1966	10.5	1967	9.5	1968	6.5
1	1967	10	1968	6.5	1969	6
0	1968	.5	1969	.5	1970	Half-Yr

(This chart shows the percent of recovered cars in each age category. The column headings correspond to calendar years and the row headings signify the age of the car. The cell entries denote the make/year and the percent of cars stolen in that make/year. The column by row classification shows the percent of recovered cars stolen in each age category in 1967, 1968 and 1969. Comparisons between calendar years in the same age categories show a decrease in the percentage of the newer stolen recovered vehicles. For example, in 1967 only 10 percent of the stolen cars were late model cars. While in 1969 only 6 percent of the cars stolen were less than a year old. The data was derived from an anaylsis of New York City Police Department stolen car files.)

TABLE A-13-6

THE AGE DISTRIBUTION OF UNRECOVERED STOLEN CARS

Age of Car in Years	Calendar Years 1967 Make/Yr	1967 Percentage	1968 Make/Yr	1968 Percentage	1969 Make/Yr	1969 Percentage
					1957 and Below	1.9
			1957 and Below	6%	1958	.7
11	1957 and Below	9.3%	1958	1	1959	2.7
10	1958	3.3	1959	6	1960	6.7
9	1959	11.0	1960	12	1961	9
8	1960	9.7	1961	10	1962	10.2
7	1961	7.5	1962	10	1963	12.7
6	1962	8.1	1963	9	1964	10
5	1963	7.3	1964	10	1965	11.6
4	1964	7.3	1965	8	1966	10.5
3	1965	10.8	1966	9	1967	8.7
2	1966	15.6	1967	11	1968	10.9
1	1967	10.2	1968	7	1969	4.6
0	1968	0	1969	0	1970	0

(This chart shows the percent of unrecovered stolen cars in each age category. The column headings correspond to calendar years and the row headings signify the age of the car. The cell entries denote the make/year and the percent of that make year car stolen. The column by row classification shows the percent of unrecovered cars stolen in each age category in 1967, 1968 and 1969. Comparisons between calendar years for the same age category show a decrease in the percent of the newer stolen unrecovered vehicles. For example in 1967 10% of the unrecovered cars stolen were late model cars. In 1968 7% of the unrecovered cars stolen were one year old, and similarly in 1969 4.6% of the cars stolen were that year's model. The data was derived from an analysis of the New York City Police Department's stolen car files.)

TABLE A-13-7

% OF STOLEN CARS BY MAKE: RECOVERED & UNRECOVERED

(This table compares the kind of vehicles stolen by make in 1967, 1968 and 1969 in New York City. Trends such as the decrease in the number of Cadillacs and Pontiacs stolen and an increase in the number of Volkswagon auto thefts should be noted. The % distributions were derived from a randomly selected sample of 2000 stolen vehicles. The sample was not stratified into recovered and unrecovered categories.)

MAKE	1967	1968	1969
Chevrolet	35%	36%	35%
Pontiac	18%	16%	14%
Oldsmobile	13%	13%	13%
Buick	8%	9%	7%
Cadillac	8%	6%	5%
Ford	7%	6%	8%
Dodge	2%	2%	3%
Plymouth	1%	3%	3%
Chrysler	0%	1%	1%
Volkswagon	2%	3%	4%
Mercury	2%	2%	1%
Rambler	2%	1%	1%
Foreign	1%	2%	2%
Trucks	1%	1%	2%
Other	0%	0%	1%

If we further stratify the stolen car sample we see some interesting preferences with respect to amateurism and professionalism: for example, the makes of cars favored in both recovered and unrecovered types of thefts are shown in Tables A-13-8 and A-13-9. Chevrolet seems to be the most popular type followed by four other General Motors products. Note the amateurs go for more Chevrolets, Table A-13-8, while the professionals are more interested in the Cadillacs, Table A-13-9. The professionals will also steal a few more Fords than the amateurs.

Table A-13-10 shows the percentages of cars by make for all cars both stolen and not stolen. Comparisons between the make and distributions of all available cars and the make distributions of all stolen cars, all recovered stolen cars and all unrecovered stolen cars, show that the indicated criminal preferences are not just a matter of availability. For example, Chevrolets make up 28 percent of the market yet account for 35 percent of the stolen vehicles. Similarly only 2 percent of the cars on the road are Cadillacs yet five or six percent of the stolen autos are Cadillacs. It is also interesting to note that while 21 percent of the drivers are Ford owners only 7 or 8 percent of the victims own a Ford.

The information on criminal preferences for certain years and makes was structured into a matrix for the purposes of displaying year-by-make classification (Table A-13-11). In Table A-13-11 a preference index was developed from the ratio of recovered cars to unrecovered cars.

TABLE A-13-8

% OF RECOVERED VEHICLES BY MAKE

(This table shows the percentage of recovered vehicles by make in 1967, 1968 and 1969. These figures are based on a sample of 1000 recovered vehicles in New York City. Note that over the last three years 79% of the cars stolen were General Motors' cars. While the Fords lost only 8%.)

MAKE	1967	1968	1969
Chevrolet	36%	35%	38%
Pontiac	20%	18%	13%
Oldsmobile	15%	14%	13%
Buick	8%	12%	7%
Cadillac	7%	4%	4%
Ford	6%	4%	7%
Mercury	2%	2%	2%
Dodge	2%	2%	2%
Plymouth	1%	4%	3%
Chrysler	0%	1%	2%

TABLE A-13-9

% OF UNRECOVERED VEHICLES BY MAKE

(This table shows the percentage of unrecovered vehicles by make in years 1967, 1968 and 1969. These figures were based on a sample of 1000 unrecovered cars in New York City. 75% of the unrecovered were GMC cars & 10% were Fords.)

MAKE	1967	1968	1969
Chevrolet	34.7%	37.9%	32.2%
Pontiac	14.0%	14.7%	13.0%
Oldsmobile	10.6%	13.0%	14.4%
Buick	6.1%	5.4%	7.0%
Cadillac	9.3%	6.5%	6.5%
Ford	9.3%	7.8%	9.0%
Mercury	1.8%	1.3%	.9%
Dodge	1.2%	1.8%	3.2%
Plymouth	.8%	1.2%	2.8%
Chrysler	.4%	.9%	.9%

TABLE A-13-10

DISTRIBUTION OF CARS BY MAKE

(This table shows the estimated distribution of cars by make for the total population of cars; i.e., both stolen and non-stolen for New York City for the year 1967. The percentage value estimates were derived from official state records for national samples and from the New York City Department of Transportation District Office. The row heading corresponds to the make of the car. The column heading shows the percentage of the total distribution taken up by a particular make.)

Buick	6.0%
Cadillac	2.0%
Chevrolet	28.0%
Chrysler	2.5%
Dodge	5.0%
Ford	21.0%
Mercury	4.0%
Olds	6.0%
Plymouth	6.5%
Pontiac	8.0%
American Motors	4.0%
Miscellaneous (Foreign & Other)	7.0%
	100%

TABLE A-13-11

THE CARS THE PROFESSIONALS PREFER

(This Table shows the preferences of both the professional and the amateur by year and by make over a three year period. The number in each row by column cell is the ratio of recovered to unrecovered cars. The recovered cars are assumed to be stolen by amateurs and the latter by professionals. A number > 1 indicates more amateur thefts, < 1 more professional thefts. The column stub heading indicates the year the car was stolen, the column heading indicates the age of the car and the row heading indicates the make of the car. Only the GMC cars were shown as the sample size was too small for a row by make by age classification for the other cars. The data was taken from the New York City police files. Note the decrease in the ratio indicating a rise in professionalism. Also, note the preference for expensive model cars regardless of age and the preference for two year old Chevrolets. R = all recovered. 0 = non recovered.)

Make of Car	1967										1968										1969									
	Years Old										Years Old										Years Old									
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
Chev	1.7	1.1	3.5	3.5	3.0	1.1	5.1	1.7	0.7	0.6	0.7	0.2	1.1	0.8	2	1.6	1.4	0.7	1	1.7	1.8	0.4	1	0.8	0.9	1.1	0.9	1	1.2	0.6
Pontiac	2.4	7.4	2.8	3.9	2.7	1.9	0	1.9	1.9	0	3.2	1.5	2.1	2.5	0.3	1.9	0.9	1.8	0.3	2.7	2	0.2	2	1.7	0.9	0.9	1	0	0.6	0.7
Olds	3.2	2.2	1.2	1.8	4.3	7	5.6	4.1	1.2	0	0	2	1.2	1	0.3	0.5	0.8	3.4	1.6	0.7	0.6	0.7	0.2	0.9	1.8	1.1	1.1	1	0	0.5
Buic	R	1.4	0	1.1	1.5	1.5	1.3	2.6	1.4	R	1	0	5	5.5	5.5	3.1	7.3	1.7	1	0	0	0.3	0.8	1	0.1	1.3	1.6	1.8	0	1
Cadillac	2.3	0	0	2.3	1.1	0	4.7	1.7	7	0	0	1	0	1	0	1	1.2	5	0	0	0.4	0.4	1.3	0	0	0	0	0	0	2

Hence, in a given make-year category, more cars are classified as unrecovered than are classified as recovered, then the ratio (recovered/unrecovered) will be less than 1. Ratios less than 1 indicate that the professionals are more concerned with that particular make-year than amateurs. Similarly, a ratio greater than 1 shows that the particular make-year has attracted more amateurs than professionals. The trends are clear. Except for the two year old Chevrolets (the make-year most preferred by the South American and Puerto Rican market) the amateurs prefer the Chevrolets and the professionals take more of the Cadillacs and Buicks.

This preference also has an effect on the loss valuation of the stolen cars. (See Table A-13-12) Note the unrecovered vehicles are worth more than the recovered vehicles. Also, note that for 1967 to 1969 the value of the stolen auto has dropped for both categories. This reflects the tendency of both amateurs and professionals to steal older cars.

TABLE A-13-12

THE VALUE OF STOLEN VEHICLES

(The following chart shows the mean value of vehicles which were stolen in 1967, 1968 and 1969 in New York City. The data was derived from randomly selected samples for each year. In each case the sample size was 2000.)

	Recovered Vehicles
1967	$1,200
1968	$1,285
1969	$1,140

	Unrecovered Vehicles
1967	$1,312
1968	$1,222
1969	$1,217

With few noted exceptions it is very likely that most of the retrieved vehicles, eighty-five percent, are stolen by amateurs. About half of the amateurs appropriate the car either to take a joy ride or for transportation. They usually loot, vandalize, damage and/or strip the car of a few parts or accessories before abandoning it. The other half of the amateurs keep the car longer. They either want to borrow the car for a few weeks for frequent use as a transportation vehicle or they wish to keep the car long enough to conduct a more extensive stripping operation.

About fifteen percent of the retrieved vehicles were probably stolen by professionals. Some, perhaps five percent, were used to commit another crime. Another five percent were stolen by professional illegal auto parts suppliers who are characterized by their ability to reduce the returned part of the vehicle to the frame. About five percent of the cars were returned in better condition than when they were stolen. The car was washed and waxed and minor items which would reduce the resale value of the vehicle were repaired. It may very well have been that professionals stole these cars for resale, but for some reason or other were unable to complete the transaction.

And while all precincts in New York City must be considered areas of high auto theft the relatively higher crime precincts get most of the trade. More cars are stolen from and returned to high crime areas than low crime areas. Also many of the vehicles stolen in precincts which are characterized by a relatively low or moderate crime rate are recovered in locations noted for illegal activity.

Again the most significant factor in the prediction of the auto theft rate seems to be crime and delinquency. A large population of young people, low income, lack of public transportation and availability of cars for theft do not appear to be causal factors.

The amateur thief appears to prefer a four year old General Motors car, particularly a Chevrolet. Conversely his preferences are not reflected in the theft statistics of Ford, Chrysler and American Motors cars. Although about half of the cars stolen are not returned, we have been only partly successful in tracing the non-returned car flow patterns. Field surveys seemed to indicate that about twelve percent of these vehicles were shipped out of the country via the New York area docks; twenty percent were either lost or unclaimed in/or from the police auto pound. Some number of these uncleared cases perhaps ten to twenty percent could have been the result of owner abandonment.

We know very little about the disappearance of half of the unrecovered cars. Field surveys of the auto theft squads of New York City, Nassau County and the city of Yonkers, and news reports issued by the F.B.I., the National Auto Theft Bureau and various local and state police departments in other states have provided some qualitative information.

While there is evidence to indicate that in some cases tow trucks were used to steal vehicles which were never recovered, we feel that most of these vehicles were driven away by a professional thief for subsequent stripping or resale. Although we do not know how many are stripped or how many are resold both operations appear to be of sizeable proportions.

Even though the out of state export of illegal parts and cars is a multimillion dollar business we suspect that one of the best market places for disposition of these illegal goods is still located in the New York City SMSA. Large stripping operations have been located in many parts of the metropolitan area and a majority of the cars recovered by the various auto theft squads are found to have forged papers.

However, the extensive local trade in auto larceny does not prevent the New York metropolis from being one of the nation's largest exporters of stolen autos. The National Auto Theft Bureau indicates that its Eastern Division has the highest percentage of auto theft in the entire United States. Examination of the problem indicates that a great majority of the auto theft in the East, Midwest and Southeast radiates from New York. Large rings have been uncovered with a base in New York City from which cars are stolen and taken to New Jersey, Pennsylvania, Maryland, Florida, Ohio, Indiana, Illinois and Tennessee. States, such as New York, which have no title laws are most susceptible to this form of crime. Rings have been established between Massachusetts, New Hampshire, and Connecticut for this same purpose. Recently South Carolina and Georgia have been added to the list of regions importing from New York. Older cars and used parts find a ready market in these Southern states. Simultaneous investigations and raids by the Georgia and South Carolina troopers have 'busted' clandestine parts outlets that were grossing an annual volume of over a million dollars. Large quantities of stolen cars are shipped to South America and Europe from the Eastern seaboard. Eighty-five percent of this total contraband export comes from the Port of New York.

However, other states also have distribution centers that deal in illegal auto trade. In the South, Texas, Louisiana and Florida have an increasing number of title transfers and VIN number change rings.

The West is the lowest area in auto theft with the professional rings established in Los Angeles and the gambling areas. Cars are also transported to Mexico from the Southwest.

With respect to the total state stolen car flow patterns New York City seems to be the center of activity. About 70 percent of the states thefts occur within the city limits and 82 percent within the New York City SMSA. The Buffalo, Albany, Schenectady and Rochester SMSA's account for approximately 8 percent, 2.5 percent and 1.8 percent of the states respective car thievery. If we exclude the above four SMSA's from the tally, the rest of New York State is responsible for less than 6 percent of said taken autos. However, this does not mean that the larceny of a motor vehicle is not important to the smaller urban areas. For

in some of these places auto theft is responsible for a third of the crime.

The auto theft patterns of the metropolis are different than those observed in other SMSAs. The Buffalo, Rochester, and Albany-Schenectady-Troy areas are plagued mainly by "joy riders" and short trip transportation riders. And less than ten percent of these cars are damaged, looted, stripped or vandalized. The comparative figure for New York City is 80 percent. The non-New York City urban regions also get most of their cars back. The recovery rate for the Buffalo, Albany-Schenectady-Troy and Rochester areas are about 80, 90 and 95 percent, respectively. Whereas in the big metropolis about half of the cars are never returned.

However, in some respects the big metropolis and the smaller center city flow patterns are similar, for the behavior of the joy rider and the transportation thieves have some constancy. Most of the larcenies occur in the high crime areas. There is a primary flow between high crime areas within reasonable trip distances. There is also a secondary flow from the downtown Central Business District to locations of relatively high criminal activity. However in contrast, the evidence of the professional motor vehicle thief activity is sparse, perhaps only a few percent of the cars are lost to the professionals in the smaller cities. In contrast, it appears that the New York City career criminals take 35 to 40 percent of the cars.

From Table A-13-11 we can see that the career criminal likes a Cadillac, Buick or Oldsmobile not more than a few years old. Unless he is stealing for South America, then his preference runs to a two year old Chevrolet. Also the professionals tend to cruise the higher income neighborhoods. These areas have a much lower stolen car recovery rate than some of their not so wealthy neighbors.

In the urban regions around New York City, auto theft patterns are somewhat similar to that of the City. Thefts occur in the high crime areas and the recovery rate is comparatively low, about 65 percent. The high crime places have both more thefts and more returns than the places with less crime.

Most of the data for the preceding discussion was derived from several field surveys, conducted by this staff, of the police auto theft squads operating in the various metropolitan areas of the state. Field trips were also made to the National Auto Theft Bureau and several other concerned agencies. The auto theft alarm canceled and uncanceled files of New York City Police were also reviewed. In addition, extensive use was made of the data derived from a survey of over 4,000 New York City auto theft victims for the periods between 1967 and 1969. The survey was part of this study.

To conclude this section we offer the following statements as a summary of the findings:

1- The New York City SMSA is central to most of the state's auto theft activity. This area is responsible for perhaps 85 percent of the state's total losses. Extensive resale and stripping operations are thought to be located in the SMSA or surrounding environs and the city is a major interstate and international exporter.

2- In general auto theft does not seem to be correlated with the amount of resident youth, lack of transportation, income or availability of cars. But, auto theft does seem to be correlated with crime (exclusive of auto theft crimes) and delinquency. In general, the high or average income areas usually have a lower rate of recovery than other areas, the low income areas are those which are most frequently used by the thief for abandoning the car after the theft, and the high crime areas are also high theft areas.

3- The major reason for taking the vehicle are usually either to joy ride or to take a trip or to borrow, loot, strip or resell the vehicle. The amateurs are responsible for joy riding, trip taking, borrowing, looting and stripping. While the professional also loots, his main concern is with stripping or reselling the vehicle.

4- Although the ALPS system will be effective anywhere there is stolen car traffic, it is particularly suited for New York City. One unit properly deployed will give seven hits a day.

5- Most of the cars are stolen from the street outside the owner's home between 6:00 and 10:00 p.m.

6- We can expect a stolen car to be missing at least 2.5 days, to be driven in excess of sixty miles and to be damaged, looted, vandalized or stripped if it's recovered. And the number of miles a car is driven is related to the number of days it is missing.

7- Professionals may be responsible for about 40% of the stolen vehicles. We suspect they steal about 15% of the returned vehicles and 70% of the unreturned vehicles. New York State may recover about 60% of its stolen vehicles in 1969.

8- With certain exceptions, make seemed to be more of a causal factor than age. All thieves prefer the G.M.C. cars, the amateurs take the Chevrolets and the pros go after the Cadillacs.

9- In the non-metropolis cities joy riding and transportation seem to be the principal reasons for theft. Less than 10% of the cars are damaged and they are usually recovered in a day or two. The flow is from the C.B.D. to the high crime rate residential areas, or to and from the residential areas referenced, or to and from other similar areas. There is little evidence of professionalism.

10- For 1969 the average value of the recovered car was $1,140, the unrecovered cars were valued at $1,217.

A-14. Stolen Vehicle Criminal Justice Costs

The purpose of this task was to evaluate the costs of auto thefts to the criminal justice system. The analysis presents the sum total expenditure requirements of processing these crimes for the law enforcement, judicial and correctional institutions. The costs related in the following are 1967 costs of operations for the various departments in the New York State Criminal Justice System. Actual state figures were used wherever possible. However, where regional data was not available, national indices were used to complete the analysis. The expenditure assessments were derived by analyzing the institution's budget into its respective cost components and then checked by substructing the operational costs of selected departments into a total budget requirement. An evaluation of the cost of the crime to the victim, a study of the recidivism characteristics and an assessment of the economic loss incurred by society are rendered in other tasks.

The 1967 New York State Criminal Justice System expenditures was about 39 million dollars. The following breakout serves to identify the costs required by each subfunction in the Criminal Justice System in New York State. The following percent of budget estimates were derived from an analysis of data presented in the President's Commission on Law Enforcement.

6% of $650 million = $39 million. This is total amount of money spent from the Justice System budget on auto theft.

67% of $39 million = $26.1 million. This is the amount of money spent for police functions.

21% of $39 million = $8.2 million. This is the amount of money spent for juvenile processing.

1% of $39 million = $0.4 million. This is the amount of money spent for court proceedings.

11% of $39 million = $4.3 million. This is the amount of money spent for correctional activities.

100% $39.0 million

A flow diagram of the Criminal Justice Systems functional requirements and the respective costs of these requirements is presented in Figure A.

The preceeding Table represents one method of acquiring the Justice System costs which can be attributed to auto theft. During 1967, 70 percent of the autos stolen in New York State occurred in New York City. A comparison of the costs in New York City was made in order to check the validity of the total $39.0 million believed to have been spent throughout the state.

The Criminal Justice System's costs of auto theft were derived from a cost analysis of each function totaled into an estimated budget. The validity of this calculation was assessed by comparing it with an estimate derived solely from national benchmarks - see page A-14-1.

The appraised component cost values for each justice system function were completed first for New York City. The City figures were then adjusted and used to forecast the total state costs by function. In turn, the New York City function costs were derived, in part, from an actual operations cost accounting and budget analysis for the 1967 base year.

The New York City and state functional break does not exactly correspond to the model derived in the "Crime Commission Report" (see Figure A-14-1). For the purpose of comparison this report structured the Criminal Justice System function into the following dichotomy: police functions and prosecution, court and corrections and service functions. The latter category, corrections and services, has the following subfunctions: youth and juvenile services, adult services, probation, parole and incarceration.

New York City Police Function Costs:

There was no direct approach for costing that portion of the police function diverted to auto theft. While the national figure of 6% of the police budget for auto theft crimes seems to compare favorably with that spent by most large departments in the state of New York, New York City appears to be an exception. And it is very likely that New York City spends a smaller portion of its budget on auto theft than the other agencies. In the smaller cities and suburban areas auto theft represents 20 to 40% of the crime. In New York City it is less than 6% of the crime. This study team was unable to locate a task analysis of criminal law enforcement activities for New York State. Hence, the estimates were derived by indirect means.

New York State - 1968

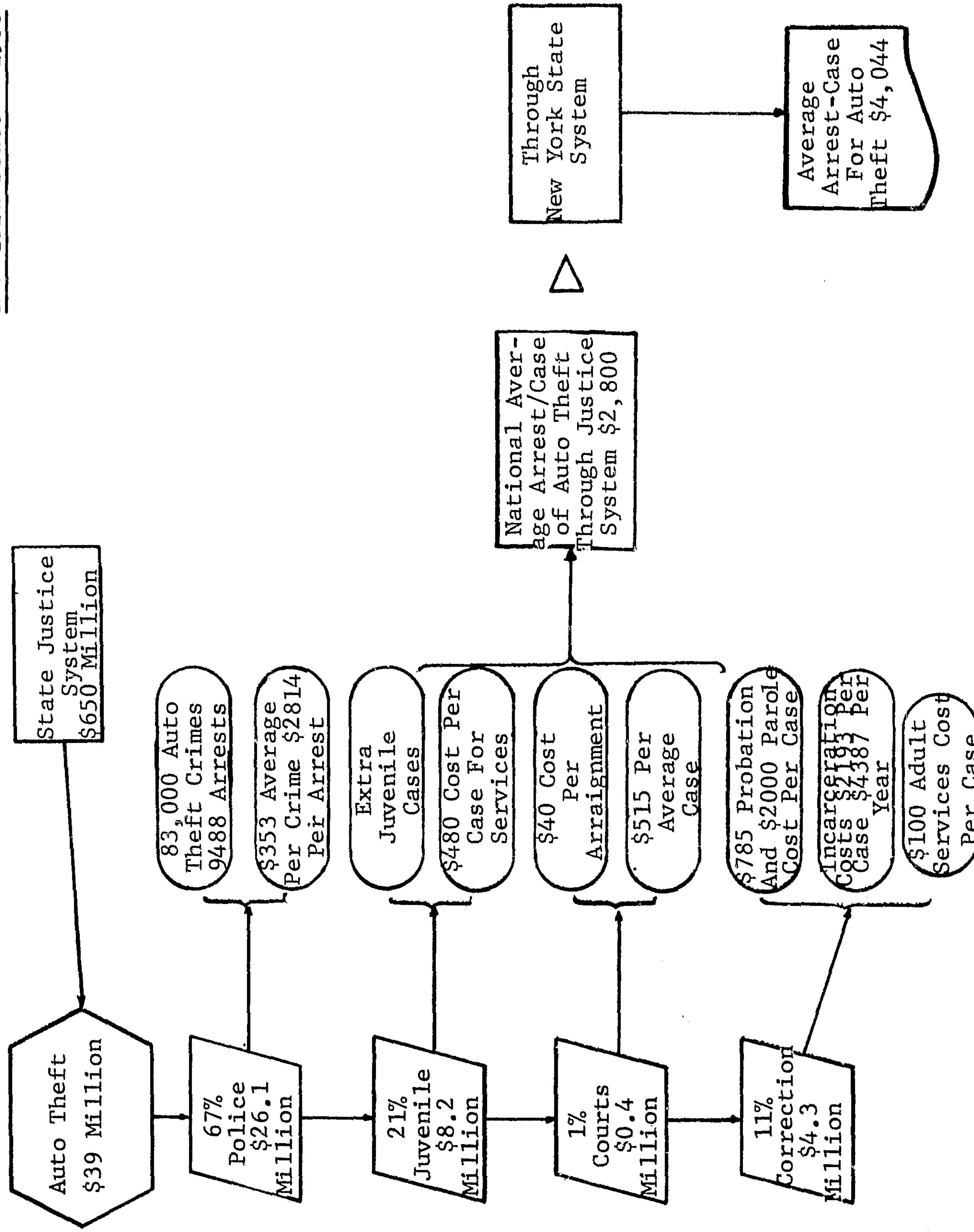


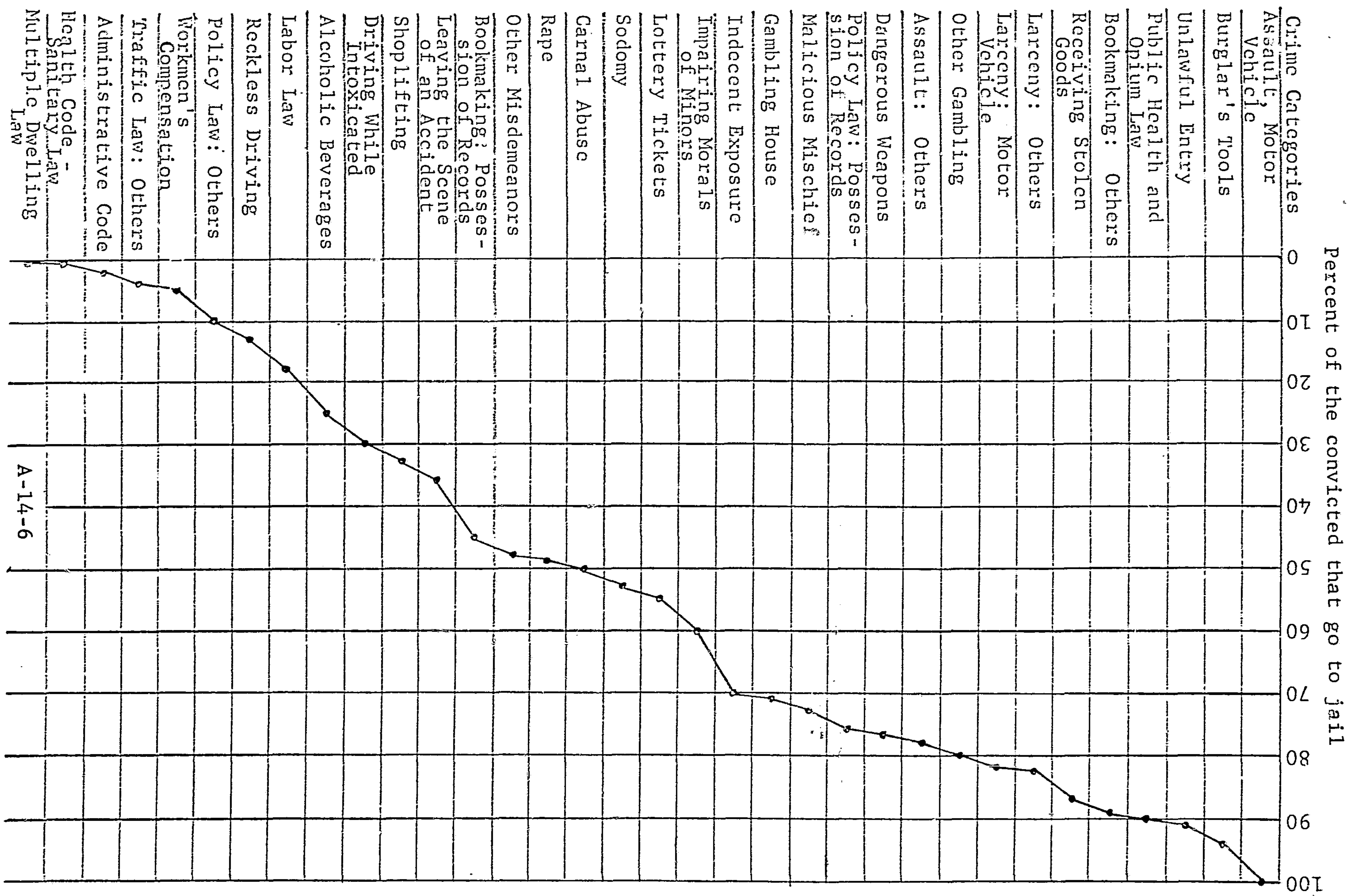
Figure A-14-1

ESTIMATED COST TO STATE FOR AUTO THEFT JUSTICE ACTIVITIES

If the police function is a rational system, then these resources should be allocated in accordance with the need or services. That is, the allocation of resources should be based on the seriousness of the crime, and the frequency of the crime. Hence, if the system is rational, one can construct a seriousness index. From this index and the crime frequency data, we can derive weighted factors for the assignment of resources. Expert judgement, arrests and conviction rates were not used in the construction of the index because they reflect operational difficulties rather than social attitude. The index was based on the two following court system variables which reflect sentence severity: the percent convicted who go to jail, and the length of the jail term.

Figures A-14-2, A-14-3 and A-14-4 show examples of how these indices were derived for misdemeanors. However, since auto theft and many other F. B. I. index crimes are frequently treated as a misdemeanor by the courts, the misdemeanor felony dichotomy was eliminated. All crimes listed in the New York City police annual report were indexed according to probability that a conviction will bring a jail sentence and the length of the jail sentence.

Figure A-14-2 shows the percent of the convicted that receive a jail sentence. The data was derived from a partial analysis of the 1966 Criminal Court Records for New York City.



JAIL YEARS - AVERAGE TERM

1-30 days	30-60 days	60-90 days	3-6 months	6-12 months
Administrative Code	Lottery Tickets	Assault, Motor Vehicle	Assault, Others	Carnal Abuse
Alcoholic Beverage Law			Burglars' Tools	
Bookmaking- Records			Dangerous Weapons	
Bookmaking, Others			Impairing Morals	
Policy Law-Records			Larceny, Motor Vehicle	
Policy Law, Others			Shoplifting	
Health Code			Larceny, Others	
Labor Law			Drugs	
Malicious Mischief			Receiving Stolen Goods	
Multiple Dwelling Law			Indecent Exposure	
Rape			Unlawful Entry	
Sodomy				
Driving Intoxicated				
Leaving Scene of Accident				
Reckless Driving				
Traffic Law, Others				
Other Misdemeanors				

Figure A-14-3 shows a sample of sentences given for various misdemeanors. This data was derived from the New York Criminal Court records for 1966.

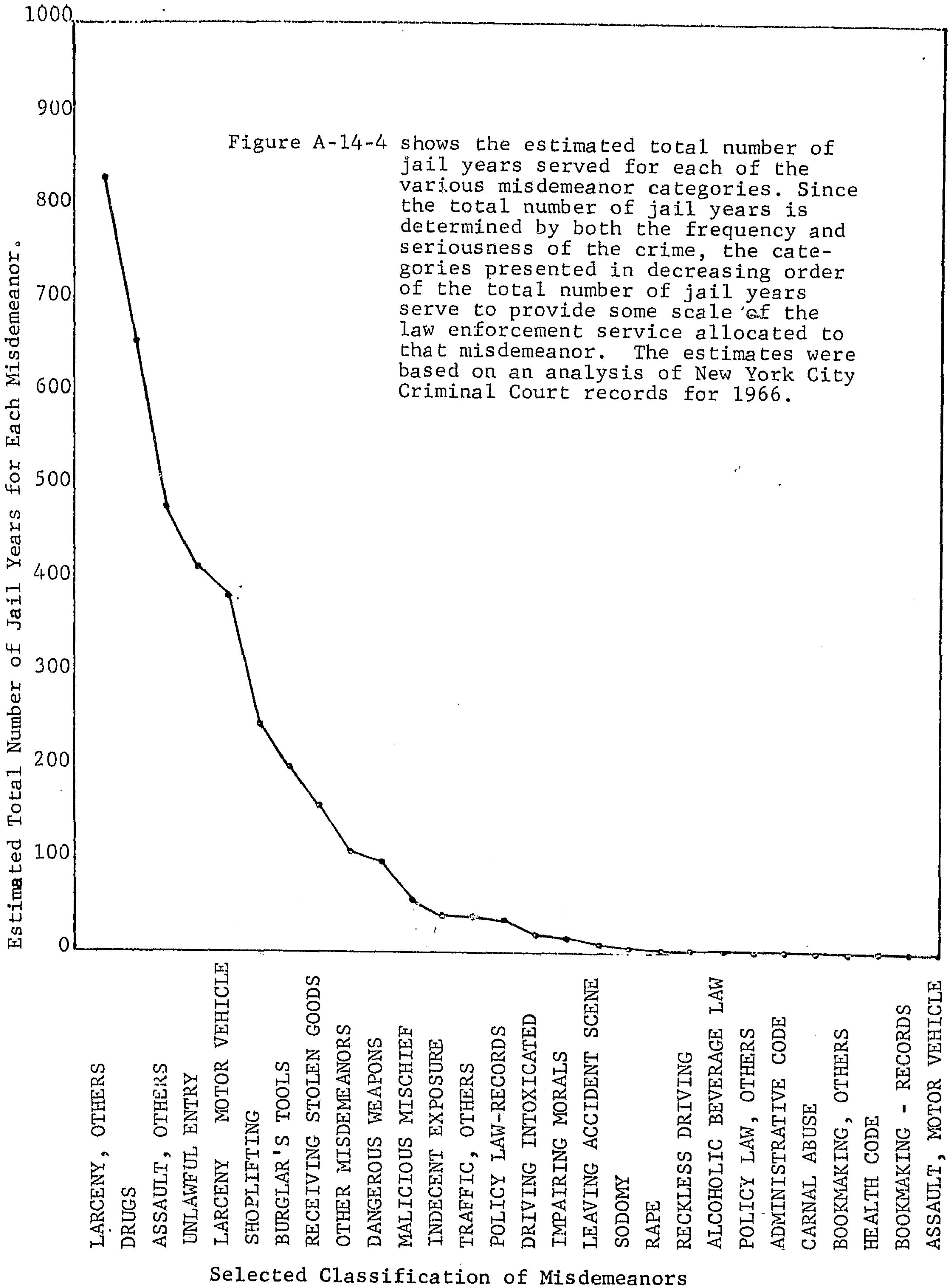


Figure A-14-4 shows the estimated total number of jail years served for each of the various misdemeanor categories. Since the total number of jail years is determined by both the frequency and seriousness of the crime, the categories presented in decreasing order of the total number of jail years serve to provide some scale of the law enforcement service allocated to that misdemeanor. The estimates were based on an analysis of New York City Criminal Court records for 1966.

For example, samples of selected court records show that in 1967 the probability of going to jail, if convicted, is .80. The average term for both felonies and misdemeanors in that year was 0.52 years. Hence, the index of seriousness for auto theft is .80 x .52 or .42. For armed robbery the index was (1.0 x 2 = 2.0) and for petit larceny the index was (.33 x .1 = .03).

However, if one is to obtain a weighted scale for the allocation of resources, we must also consider frequency. Hence, in 1967 there were 52,946 net cases of auto theft. The total weight score is then (52,946 x .42 = 22,237). The score for robbery is (36,235 x 2 = 72,470). The total of all weighted scores is 347,900. Since the weighted score for auto theft is 22,237, we assume that auto theft will take 6.4% of the police protection budget. If we subtract out 25% of the total budget for traffic and non-crime related services, we can base our forecast on the total city budget of 4.8%. 4.8% of $384 million, 1967 budget, is $18.7 million. Hence, our estimate is that New York City spent about 4.8% of its budget on auto theft.

However, this is not a startling figure. Even though most of our crimes are on the increase, the auto theft rate is disproportionately higher than the others. With a budget increase of 12% a year and an auto theft increase of 25-30% a year, the public's demand for service is likely to require that a greater portion of the budget be allocated to auto theft each year. Auto larceny will probably be allocated 5.2, 5.7, 6.4, 7.3 and 8.4% of the budget in 1968, 1969, 1970, 1971 and 1972 respectively.

Forecasting from these rates, we predict that auto theft will require $22.5 million, $27.3 million, $34.2 million, $43.9 million and $57.0 million of the police budget for the respective years of 1968, 1969, 1970, 1971 and 1972.

Before we can predict the State costs, we must make further adjustments. Law enforcement agencies in the other than New York City category have higher arrest rates and auto theft is a higher proportion of their crime. From a review of all police agencies in the four standard metropolitan areas, we find that the other than New York City departments spent in excess of 8% of their total budget on the stolen car problem. This gives a total state rate of 5.8%. Hence, in 1967 New York State will spend $37.4 million on the auto theft crime. From this reference point we predict the state to spend $43.6 million, $51.9 million, $63.3 million, $78.6 million and $100.2 million for the respective years of 1968, 1969, 1970, 1971 and 1972. These totals are recorded in Table A-14-1 and A-14- 2 entitled, "A Survey of Auto Theft Costs and Cost Indicators for New York City and New York State.

TABLE A-14-1

A SUMMARY OF AUTO THEFT COSTS AND COST INDICATORS FOR NEW YORK CITY

(This Table shows a cost by factor by year breakout for the period 1966 through 1972. The source data is referenced in Figure A-14-3 . The row stub headings indicate total cost, cost per arrest, and cost per theft.)

	Criminal Justice System Function	Calendar Year 1966	1967	1968	1969	1970	1971	1972
Total Cost	Total Cost of Auto Theft Police Functions	$16.4 million	$18.7 million	$22.5 million	$27.3 million	$34.2 million	$43.9 million	$57.0 million
	Total Cost of Auto Theft Judicial/Corrections	$ 7.2 million	7.7 million	8.0 million	9.0 million	10.1 million	11.5 million	13.1 million
	Total Cost of Auto Theft Criminal Justice System	$23.6 million	26.4 million	30.5 million	36.3 million	44.3 million	55.4 million	70.1 million
Cost/Arrest	Cost to Police Functions Per Arrest	2,552	2,559	2,577	2,608	2,658	2,732	2,839
	Cost to Judicial/Corrections per Arrest	1,115	1,118	1,125	1,138	1,159	1,191	1,237
	Total Cost to Criminal Justice System/Arrest	3,667	3,677	3,702	3,746	3,817	3,923	4,076
Cost/Theft	Cost to Police Functions per Theft	365	321	290	273	265	263	265
	Cost to Judicial/Corrections per Theft	160	132	103	90	78	69	61
	Cost to Criminal Justice System per Theft	525	453	393	363	343	332	326

TABLE A-14-2

A SUMMARY OF AUTO THEFT COSTS AND COST INDICATORS FOR NEW YORK STATE CRIMINAL JUSTICE SYSTEM

(This Table shows a cost by function by year breakout for the years 1966 through 1972. The data was derived from Figure A-14-3. The row stub headings indicate total cost, cost per arrest and cost per theft.)

	Criminal Justice System Function	Calendar Year 1966	1967	1968	1969	1970	1971	1972
Total Cost	Total Cost of Auto Theft Police Functions	$23.4 million	$26.7 million	$32.1 million	$39.0 million	$48.9 million	$62.7 million	$81.5 million
	Total Cost of Auto Theft Judicial/Corrections	$10.3 million	11.0 million	11.4 million	12.8 million	14.4 million	16.4 million	18.7 million
	Total Cost of Auto Theft Criminal Justice System	$33.7 million	37.4 million	43.6 million	51.9 million	63.3 million	79.2 million	100.2 million
Cost/Arrest	Cost to Police Functions Per Arrest	$2,801	2,814	2,834	2,868	2,924	3,005	3,123
	Cost to Judicial/Corrections per Arrest	$1,226	1,230	1,237	1,251	1,274	1,310	1,360
	Total Cost to Criminal Justice System/Arrest	$3,967	4,044	4,072	4,120	4,198	4,315	4,483
Cost/Theft	Cost to Police Functions per Theft	$ 401	353	319	300	291	289	291
	Cost to Judicial/Corrections per Theft	$ 176	145	113	99	86	75	76
	Cost to Criminal Justice System per Theft	$ 577	498	432	399	377	364	357

TABLE A-14-3

PROSECUTION, COURT, CORRECTION AND SERVICES COST

(Table A-14-3 shows a cost accounting breakout of all major cost items in the processing of perpetrators through the prosecution, court, correction and service functions of the Criminal Justice System in New York City in 1966. The items and number of cost items were derived from the above model on the flow of larceny offenders through the Criminal Justice Process. The prosecution or arraignment costs refer to all costs dealing with filing, accusation, dismissal and detention of suspects. The largest cost item is incarceration with juvenile and youth services, court, probation and parole, arraignment and adult services following in decreasing order. The value estimates were derived from an analysis of the following services: The New York City Court System records for 1966, the 1965 report, "Local and State Government Expenditures for the Administration of Criminal Justice in New York State" published by the state of New York Executive Chamber, interview surveys with key personnel in the offices of the District Attorney, the County Clerk and Probation for Supervision of Criminal Court; the 1967 Report by The President's Commission and Law Enforcement and a survey of the Supreme Court Felony Auto Theft Cases for New York County, 1966 Budget for the City of New York and the State of New York Department of Correction 1967 Budget.)

	Item	No. of Items	Cost/Item	Item Total Cost
Prosecution	Arraignments	7,779	$ 40	$ 311,200
Sub Total				$ 311,200
Court	Acquittals Trials	400	$ 250	$ 100,000
	Conviction Trials	780	$ 750	$ 585,000
	Guilty Pleas	200	$ 100	$ 26,000
Sub Total				$ 711,000
Correction and Services	Youth & Juvenile Services	4,340	$ 480	$2,083,200
	Adult Services	280	$ 100	$ 28,000
	Probation	168	$ 785	$ 132,000
	Parole	130	$2,000	$ 260,000
	1 year Incarceration	824	$4,387	$3,636,823
Total Cost				$7,162,223

Judicial Correction and Service Function Costs:

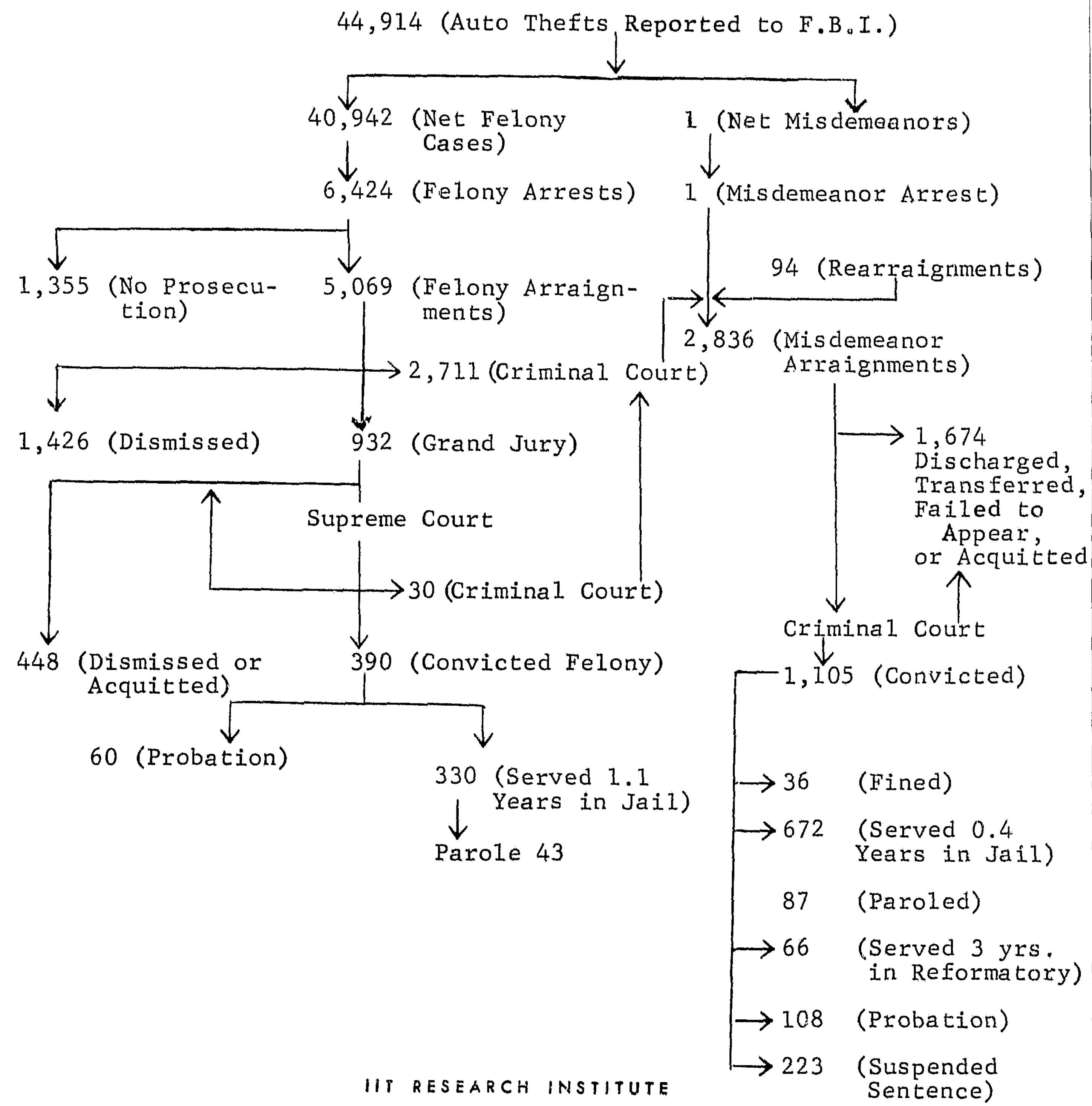
The court corrections and service functions were somewhat easier to cost out. The research staff reviewed the files of the New York City court and synthesized a flow model for all offenders passing through the court system. (See Figure A-14-5). This analysis identified the process and the number of items that flowed through that process. Survey of national systems, court officers, records and budgets and field interviews were used to establish the cost of the various process. The final price of all the services was established simply by multiplying the number of items by the cost per item. For example, the court system model shows that there were 7,779 arraignments. The Crime Commission Report cites costs of $40.00 per arraignment. Hence, the total cost per all arraignments is $311,200.00 for 1966. A cost breakout of the Judicial Corrections and Services System is presented in Table A-14-3. The court costs per process were derived from a study of the budget and field surveys of the Manhattan Court System. The incarceration cost estimates were appraised from an account of several budget years for the major institutions. Probation parole and adult and juvenile services costs were substructed from the Crime Commission Report.

Normally we would not expect the judicial corrections or police costs per current indicator to change much over the forecasted period. The data from the 1966, 1967 and 1968 reference years showed that the arrest rates very closely parallel the increases in budget. For example, in 1967 the increase in arrest rate was up 6.7% from 1966 and the budget was up 5.9%. Similarly,

FIGURE A-14-5

COURT SYSTEM MODEL

(Figure A-14-5 shows a simulated court system model for the estimated flow of auto larceny offenders for New York City in 1966. The data was derived from an analysis of the New York City Criminal and Supreme Court records and New York City Police 1967 Annual Report.)



in 1968 the budget and arrest rate increases were up 12.3% and 13%, respectively from the 1967 base figures. Hence, the judicial corrections cost per arrest values for 1966, 1967 and 1968 were $1,145, $1,123 and $1,115, respectively. Similarly the police functions cost per arrest indicator will stabilize at $2,552.

However, this stabilizing effect is not likely to last long, since auto theft is increasing at a rate disproportionately higher than the increase in the total crime index. From weighted average calculations, it appears that this increase will force more money into the auto theft police and judicial/corrections functions. For example, we estimate that in 1966 4.5% of the law enforcement & criminal justice system budget went for auto theft. Extrapolates show that as of 1972 auto theft may require nearly 8 and 1/2% of the criminal justice system budget.

These effects are forecasted in the following Tables of function budgets, indicators and costs. Table A-14-1 and A-14-2 show the judicial and correction dollars spent or to be spent on auto theft from 1966 through to 1972 for New York City and New York State.

A-15. The Economic Impact of Auto Theft Incarceration

The preceding section computed the average cost per jail year and the total cost to the Department of Correction for those involved in auto thefts. The purpose of this exercise is to establish and evaluate the economic impact that results when a number of man years are spent in prison.

According to the FBI Uniform Crime Reports for 1967, the auto theft repeater is arrested for an average of 7 crimes in a 7 year period. In addition, the President's Crime Commission report shows that this career cost the Criminal Justice System about $11,000. The thief lessens his chances for obtaining a high income status position in his working lifetime. The economy also sustains a loss; because while the recidivist is in jail, he becomes a tax eater instead of a tax contributor. The economy loses the value of the confined man's production.

By simulating the auto thief's criminal history with a conditional probability model, based on statistics from the Crime Commission Report, we estimated that 1.3 years of this crime career would be spent in jail. However, this model did not account for biases. For example, the Crime Commission Report showed that the auto theft recidivist would get three convictions over this period. Judges are not as disposed toward leniency for 2nd and 3rd convictions. This same source also indicated a trend towards the commission of more serious crimes. When we account for these factors we estimate that at least two years of this crime career period were spent in jail.

Our statistics indicate that the mean worker income in New York State was approximately $7,000 during 1967.

For every repeater who spends two years in a correctional institution, there is an estimated loss of $14,300 in potential earnings to the economy. Roughly 85% to 90% of those arrested for auto theft become recidivists. In 1967, 6,312 people were arrested in New York City for grand larceny and auto theft. If every recidivist spent 2 years in jail the final loss to the city economy alone would be $76.7 million over the 7 year period of the thieves disposition to recidivism. However, in the respective years 1967, 1968, 1969, 1970, 1971 and 1972 young men will spend 662, 762, 854, 961, 1,085 and 1,231 years behind bars. If we consider the year 1967 as the base year and account for the workers increase in productivity, the estimated loss to the economy will be $42,832,000 for that period of time. The loss during our base year, $4,656,000, will increase to $10,311,000 by 1972. Table A-15-1 shows the dollar values attributed to these loss factors for all years from 1967 to 1972.

TABLE A-15-1

COST OF INCARCERATION FOR AUTO THEFT

(This Table shows the dollar value for the loss of production to the economy for the years 1967 through 1972. The data was based on analysis of the 1967 court records to provide estimates of the total incarceration in jail years. State wide and New York City wide predicted arrest rates were used to forecast for years 1968 through 1972. The arrest rates were determined from the annual reports of the leading police jurisdictions).

Year	1967	1968	1969	1970	1971	1972
	$4,656,000	$5,504,000	$6,306,000	$7,411,000	$8,644,000	$10,311,000

A-16. Summary of Loss Valuations

In 1967 auto theft and related crimes cost the people of New York State over a hundred deaths, hundreds of jail years, thousands of injuries and hospital days, tens of thousands of hardships, scores of thousands of victims and a half billion dollars. By 1972 the price of these crimes will have risen to 350 deaths, 1,085 jail years, 40,610 injuries, 109,948 days in the hospital, 285,434 victims and 1.25 billion dollars. The 1972 forecast shows the direct cost of auto theft to be 454.0 million dollars, the indirect and auto theft related crime costs are $123.5 million and the auto related crime costs are $389.0 million. The total for all losses is $974.4 million. A breakout of all summary costs and cost components is presented in Tables A-16-1 through A-16-5.

TABLE A-16-1

A Summary of the Direct Auto Theft Costs in Millions of Dollars.

(Table A-16-1 shows the direct auto theft costs in millions of dollars for the years 1967 thru 1972 for New York State. The row heading corresponds to the loss catagories.)

	1967	1968	1969	1970	1971	1972
Stolen Car Accident Loss	$16.5	$20.4	$26.1	$33.6	$41.6	$56.8
Stolen Car Damage Loss	22.7	26.3	33.5	43.3	55.9	72.2
Unrecovered Vehicle Loss	35.8	52.7	77.7	112.8	145.6	188.0
Stolen Car Insurance Costs	8.8	13.2	16.9	21.5	27.5	36.8
Criminal Justice Costs	37.4	43.6	51.9	63.3	79.2	100.2
Total	$121.2	$156.2	$206.1	$274.5	$349.8	$454.0

TABLE A-16-2

A SUMMARY OF THE MAJOR INDIRECT LOSSES RESULTING FROM AUTO THEFT

(The projection in this Table applies to major indirect costs resulting from auto theft for the year 1967 through 1972 for New York State. The row by columns correspond to a loss factor by year classification. The cell entries denote the value of the losses in millions of dollars.)

	1967	1968	1969	1970	1971	1972
The Economic Impact of Incarceration for Auto Theft	$4.7	$5.5	$6.3	$7.3	$8.6	$10.3
Cost of Auto Theft-related Crimes	47.1	57.9	71.2	87.5	107.0	123.5
Total	$51.8	$63.4	$77.5	$94.8	$115.6	$133.8

TABLE A-16-3

THE LOSSES ASSOCIATED WITH AUTO RELATED CRIMES

(This Table shows the losses associated with auto related crimes. The loss values do not account for auto theft and auto theft related crimes as these were tallied in Table A-16-2. Cigarette smuggling is itemized separately because it constitutes a significant portion of the total loss. The projections apply to New York State for the years 1967 through 1972. The column headings are in calendar years, the row headings serve to title the loss factor components. The cell entries are the losses in millions of dollars.)

	1967	1968	1969	1970	1971	1972
Cost of Auto-related Crimes	$117.5	$145.0	$177.5	$219.0	$267.5	$309.0
The Costs of Cigarette Smuggling	30.0	40.0	60.0	70.0	75.0	80.0
Total	$147.5	$185.0	$237.0	$289.0	$342.5	$389.0

TABLE A-16-4

SURVEY OF SOCIAL NON MONETARY LOSSES

(This table lists the amount of losses in the number of deaths, injuries, hospital days, jail years and victims for years 1967 to 1972 for New York State. The row of column headings correspond to the loss entry categories for each year.)

	1967	1968	1969	1970	1971	1972
No. of Deaths	100	127	162	209	270	350
No. of Injuries	11,616	14,638	18,873	24,366	31,457	40,610
No. of Hospital Days	12,545	19,178	29,520	46,699	71,495	109,948
No. of Jail Years	662	762	854	961	1,085	1,231
No. of Victims	82,721	103,557	134,052	173,060	223,420	288,434
No. of Hardships	24,816	31,067	40,215	51,918	67,026	86,530

TABLE A-16-5

TOTAL AUTO THEFT AND RELATED CRIME LOSS

(This table shows that a total value in millions of dollars, is likely to be lost as a result of auto thefts, auto theft related crimes, and auto related crimes. The row by column classification specifies the loss value for each category for each year.)

	1967	1968	1969	1970	1971	1972
Auto Theft Loss	$121.2	$151.2	$206.1	$274.5	$349.8	$454.0
Auto Theft Related Crime Losses	51.8	63.4	77.5	87.5	107.0	123.5
Auto Related Crime Losses*	147.5	185.0	237.0	289.0	342.5	389.0
	$320.5	$399.6	$520.6	$651.0	$799.3	$966.5**

*Includes Cigarette Smuggling.

** This figure does not include the cost of warrants.

PART II - TECHNICAL REPORT

B. Systems Synthesis and Identification of Operational Requirements

B-1. Resources of the Various Political Jurisdiction.

The utility of a mass scanning concept is directly dependent on the demographic and geographic features of the area, the amount and type of wanted plate activity and the needs and priorities of the users. The concept offers unusual economies of scale for high volume auto related crimes, like auto theft, where the value of the property is high and the penalities to society are severe. In some cities the system may have a dual role as a cost effective crime deterrent system functioning to uphold the guarantee that its citizens be free of criminal exploitation and a loss saving service producing dollar benefits. For example, in New York City the reduction in human misery would significantly enhance the welfare of the citizens and the recoverable dollar benefits would pay for the capitalization of a ten unit complex in less than 100 days.

However, the days when local sheriffs got paid $.25 per arrest are long since gone. Law enforcement systems were never intended to be economically independent. They are welfare services provided for and paid by the people of the local and the commonwealth. The only requirement is that they provide the citizens with the acceptable social services that protects them from criminal exploitation. Hence, to be cost effective crime deterrent systems need not justify their existance in recoverable property. They need only to provide equivalent or more benefits or similar or better service at less cost then the other acceptable alternatives. For it is the citizens who decide their needs for protection services. Together, the town fathers and the commonwealth define and allocate the provision services necessary to insure their citizens guarantees. The police are charged with the effective administration of these services.

As a minimum, the political jurisdiction ought to have the following characteristics before considering the use of ALPS:

1. The department should be able to specify certain stolen car and wanted plate flow patterns and these flow patterns should be sufficiently congested so as to allow the capitalized equipment to monitor at least 5% of the illegal auto traffic.

2. The street geometry must allow for side of the road deployment and the traffic should be slowed down to 20 miles an hour.

3. The Department should be willing to capitalize at least $20,000 per year for five years.

4. The area should have enough stolen auto, auto-related crime, warrant, and other wanted plate activities to justify the allocation of at least two or three man years of enforcement services for detection, apprehension and deterrence. And the ALPS/police officer man/machine team must provide more effective detection, apprehension and deterrence services than the above three patrolmen or any other man or man/machine alternative of similar cost.

B-2. Response Time Requirements

There are three major delay elements in the system's response time. The time necessary to detect the theft, the time taken to code the theft on the computer file and the time taken to notify the pursuit officer that the wanted car has been spotted. The median detection delay time is eight hours, the expected coding time is about one hour and the delay between a recorded hit and chase car notification is about three seconds. This makes the total response time about nine hours. However, to make any kind of on-site arrests the response time should be less than two minutes.

There is no equipment response time problem, the delays are a product of the victim's behavior and the administrative policy of the police. In actual practice the chase officer needs ten to fifteen seconds of warning, and since the system will be required to give only about fifty five-second messages a day it is highly unlikely that a queuing problem will ever exist.

Unfortunately most people do not realize their car is gone until eight hours have elapsed. Figure B-2-1 shows the distribution of detection times. In addition, the police often receive a number of crank calls and false reports. Since it does cost about $350 to issue an alarm they require the victim to file a complaint in person. There is almost no way, then, to avoid these delays. For a ten percent error rate in

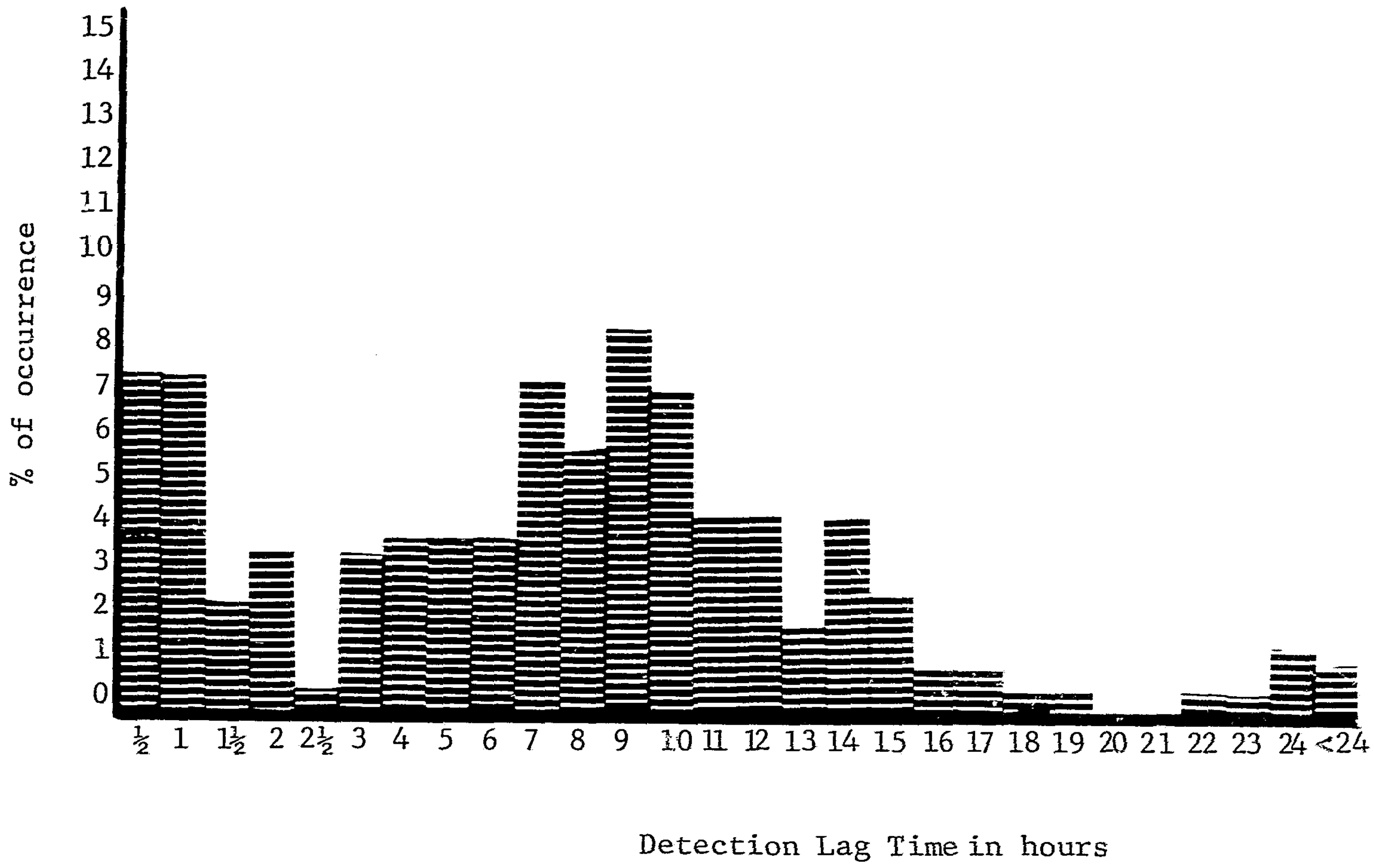


Figure B-2-1 shows the distribution of maximum detection lag times, i.e., the difference between the time the owner last saw his car and the time he first noticed that his car was missing. The median time lag is 8 hours.

reporting would cost the police over $3 million a year. A system of personally assigned numbers which could be phoned in might help but this assignment would cost even more--about $6 million.

B-3. Subscribers

Agencies will be motivated to subscribe in accordance with the level of wanted plate activity and the social penalties that result from that activity, and the dollar value of the illegal trade connected with that activity. Hence it is very likely that the initial list of potential subscribers will include the New York State Police and the following police departments: the City of New York, Nassau County, City of Yonkers, City of Buffalo, the Cities of Albany, Schenectady and Troy, the City of Rochester, the City of Syracuse, the City of Batavia, the City of Niagara, City of Utica, City of Niagara Falls, Erie County Sheriff's Office, Suffolk County, Westchester County Sheriff's Office. Also the District Attorney's office of New York, Kings and Queens Counties, the Waterfront Commission of New York Harbor and the New York State Division of Parole will certainly be interested. Aside from New York police agencies it is most likely that the F.B.I , the Treasury Department, the U.S. Customs Bureau and the National Auto Theft Bureau are potential subscribers. Officials from the surrounding states of Connecticut, New Jersey, Pennsylvania and Canada may also wish to borrow transportable units.

FIGURE B-3-1

POTENTIAL SUBSCRIBERS DIRECTLY RELATED TO POLICE FUNCTION

AGENCIES \ FUNCTIONS	Vehicle Identification	Owner Identification	Road Use Statistics	Vehicle Detection	Vehicle Sampling	Automatic Billing	Weighting Station Control	Vehicle Inspection	Vehicle Pound Control	Drug Control
City Police	X	X	X	X	X				X	X
County Police	X	X	X	X	X		X		X	X
State Police	X	X	X	X	X	X	X	X		X
Marina Police	X	X		X		X		X		
Treasury Department	X	X		X	X					
F.B.I.	X	X		X	X					X
U.S. Customs Bureau	X	X		X	X					X

B-4. First and Second Order Problems

The first order problems are concerned with cost, deployment strategy, vandalism, the professional car thief and response time reduction. Secondary problems are concerned with design improvements, public acceptance, overload of the court system, and the secondary effects of crime suppression.

There are two basic ways to reduce cost, first increase the utility of the system by assigning it other jobs and second minimize the manpower component of the system. Once the network is deployed an attempt should be made to extend the subscription lists with other applications. For example, a plan for automatic billing to eliminate bridge toll collections could be worked out with the Port of New York Authority, and the Department of Transportation should be contacted for traffic survey business.

Protection against vandalism can be provided by camouflaging the system in unmarked cars and by adding vandal proof construction and a tamper warning signal to the unit.

The twenty-four hour memory circuit will eventually become the nemesis of the professional thief. Because even if he gets the car to his distribution center before an alarm was sent out he will have left some clues as to his destination. Hence with strategic deployments police should be able to identify an area small enough for foot search.

Significant improvements in efficiency will result by decreasing the time required to get the wanted plate number on file. This delay which is often in excess of an hour could be reduced to fifteen minutes by dispatching an officer to the victim with a preprocessed form. Faster response times increase the chances of picking up more professionals.

At this time there appears to be no legal privacy problem since license plates are a matter of public record.[B-4-1] And if ALPS provides good services and the users are careful to maintain good public relations public acceptance should not be a problem.

However, the deployment of ALPS is likely to triple the arrest rate for auto theft. And while this will put an extra load on the court system, it may simplify some of the prosecution problems since the arresting officer will be provided with better evidence.

Footnotes

B-4-1 The question of privacy has been examined in an independent study by Prof. Allen Weston.

PART II - TECHNICAL REPORT

C. Performance & Cost Relationships

C-1. Alternatives Systems'Components

Out of the numerous alternative systems available, the optical type system proves the most efficient. In Section 1, entitled "Current Methods vs. ALPS", other technical approaches using manual scanning and radio, telephone and teletype processing links were evaluated and compared against an optical system. The comparison clearly showed the automatic system to be superior in both cost and efficiency. There were two automatic optical systems proposed. One used infrared, the other was designed for visible light. While the IR System was preferred because it provided better concealment, both systems were judged as suitable for deployment under the conditions required in the effectiveness model presented in Section C-2. Figure C-1-1 shows the basic component requirements necessary to acquire the models predicted requests. These basic components consist of a detector, scanner, data processor, proper illumination (if visible light is used), communication links, power source and adaptability to a mobile mode. This system uses an extra man to act as a radio relay interface with the chase vehicle and does not require the apprehenders to be stationed at a fixed location.

Figure C-1-2 shows an online storage component which can be added, allowing for a memory of vehicles which have already passed. If a vehicle that has passed a given location does become wanted, a delayed hit would be registered. This added feature would relate the movement of stolen vehicles during input lag time, therefore enhancing the operational characteristics and "hit" potential of the system.

From the specification presented by the Itek and Bendix Corporations, it would seem either system could meet the basic requirements of the effectiveness model. While the technical approaches differ each system has similar functional subsystems and comparable performance specification. Also the products of both vendors appear to interface with the NYSIIS computer file, the police dispatching center and the police chase vehicle equally well.

For the model used in Section C-2, entitled "Cost Effectiveness Analysis", certain assumptions were considered in the systems performance. The expected "hits" were based not only on the number of wanted vehicles that might pass a given point, but also on the ability of the system to recognize those that did pass. A second requirement is that the system be transportable.

From the specifications of the two optical systems and an analysis of the New York City traffic flow patterns, it was estimated that during a 24-hour period the system can expect to scan at least 60 percent of the total daily traffic passing a predetermined point. This is the expected worst case conditions. Toll booth installations will do better -- about 95 percent. This efficiency calculation was derived from a four-lane, four-scanner configuration. Two scanners were placed on each side of the road, each at an oblique angle of fifteen degrees to the center of the lane at the point of detection. However, it may very well be that the sixty

percent coverage rate could be increased by widening the scanning angle of the lens configuration. While the system can be hidden and transported in a van or car, power and telephone lines will have to be hooked up to the transporting unit once a deployment site has been selected. For both site detectors require a telephone system for data transmission and unless portable generators are used no mobile system will be able to supply the power for the required time.

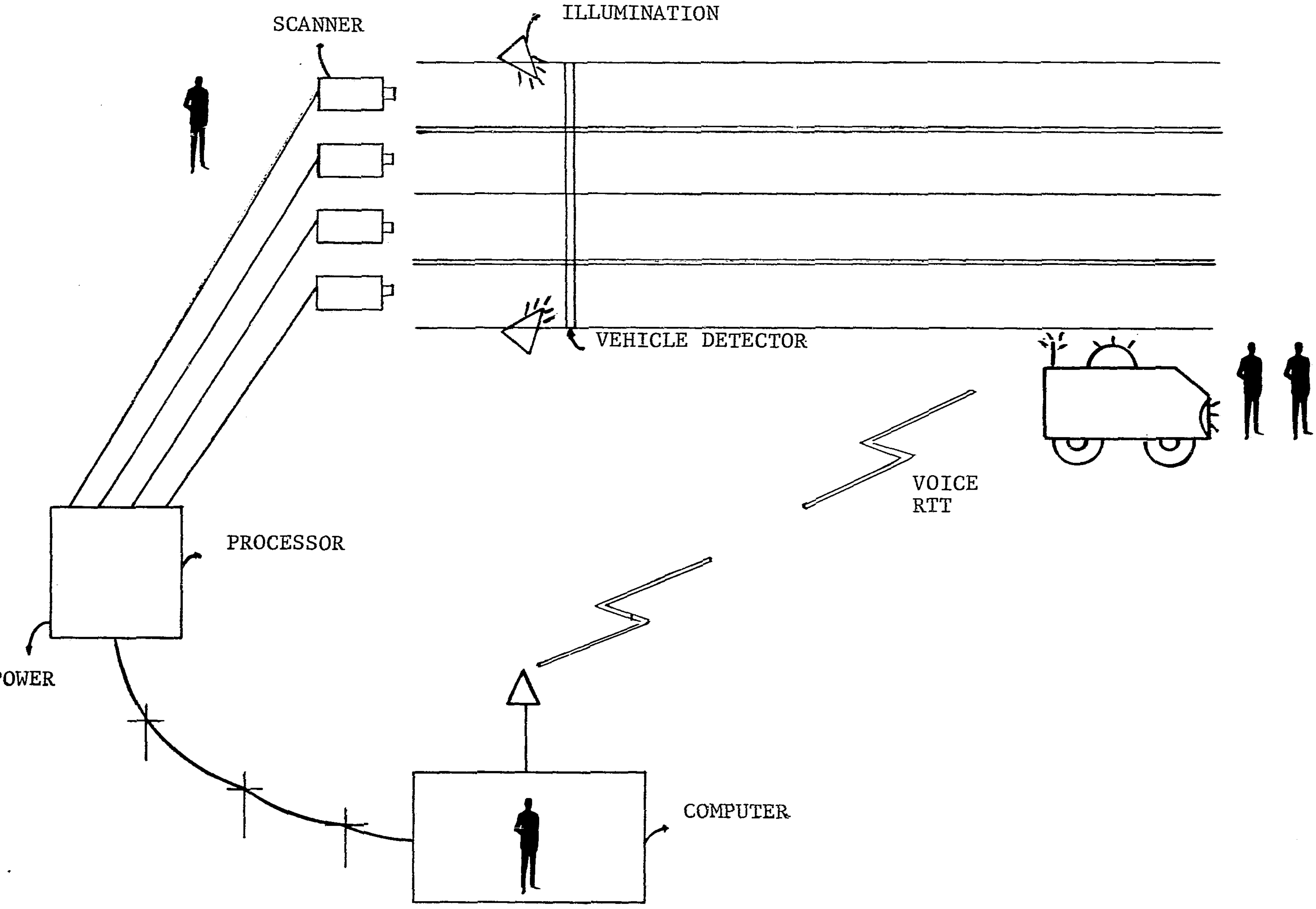


Figure C-1-1 Shows the Basic Component Requirements for ALPS.

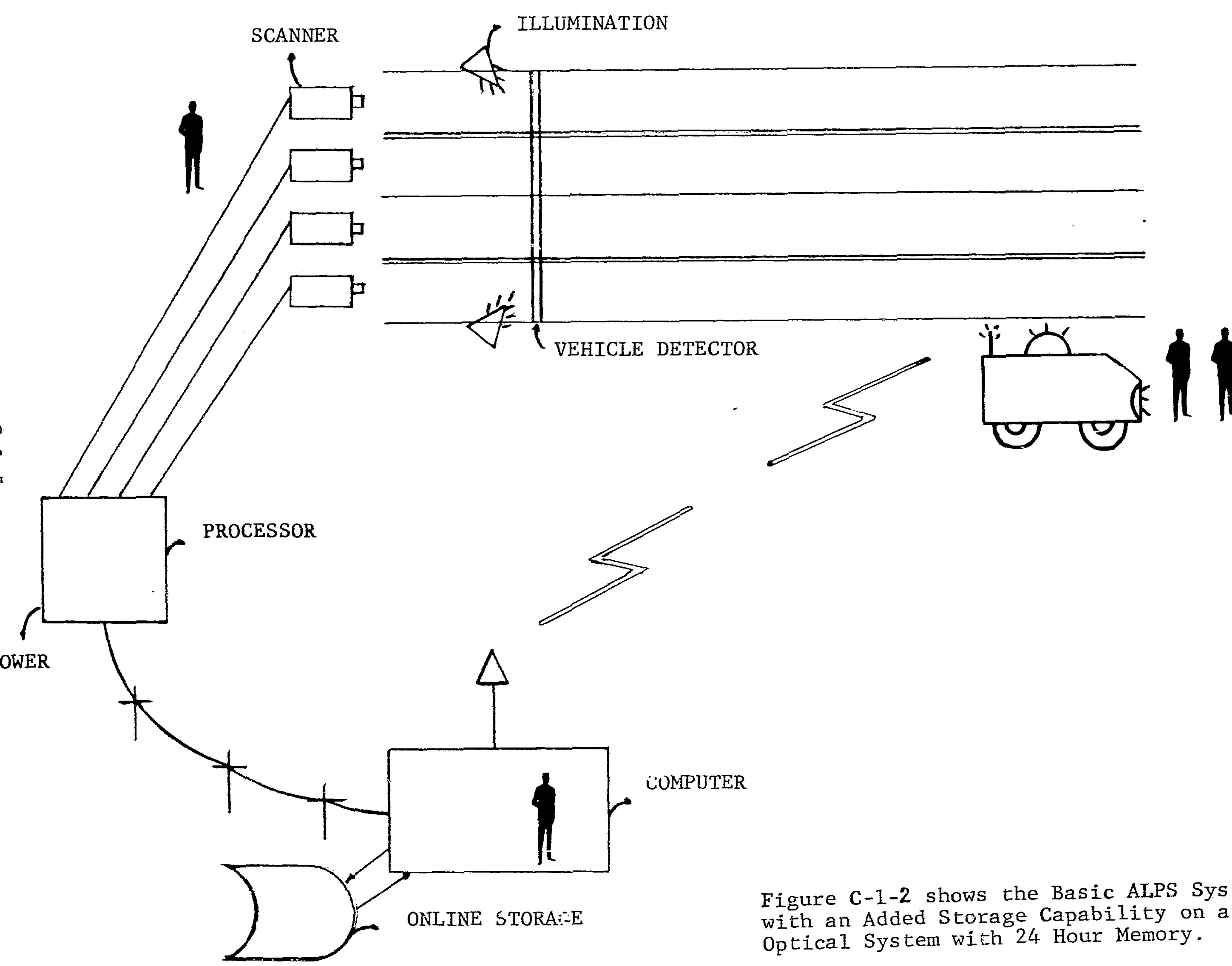


Figure C-1-2 shows the Basic ALPS System with an Added Storage Capability on an Optical System with 24 Hour Memory.

C-2 Cost Benefit Analysis

Benefits

The aim of this analysis is to determine if the stream of public and private benefits derivable from ALPS over a five year operational period is sufficient to justify the cost of implementing and operating the system.

The economic calculus of a cost-benefit analysis should not suggest that the sole criterion for deploying ALPS is economic profitability. The benefits of the system go far beyond "dollars saved" and embrace the social and public interest spheres which are most properly the primary concern of law enforcement. These social and public interest benefits include, for example, an increased arrest rate and its effect upon crime careers, encouragement of voluntary compliance to the law by creating an aura of omnipresence, engendering a feeling of safety, security and psychological well being, and reducing pain, suffering and hardships which are ofttimes the handmaidens of crime.

Indeed it can be argued that the most promising aspect of ALPS is its potential to restore a semblance of order and public confidence in several areas of law enforcement where conventional methods are in danger of being overwhelmed. Three such areas are auto theft, auto-related crimes and the problem of scofflaws.

Method

The evaluation of ALPS proceeded through three phases: First, the direct economic benefits of the system were assessed. This total encompassed the dollar savings to the general public, law enforcement agencies and victims of crime. Second, the gross expenditures required to implement and operate the system for a five year period were calculated. This total was compared with the direct dollar savings engendered by the system to ascertain if the savings were sufficient to justify deployment on economic grounds alone. Finally the potential non-economic and non-quantifiable benefits of the system were evaluated and set off against the system's cost as an additional but subjective criterion for deployment.

Auto Theft

Each "hit" on the ALPS network is expected to produce one or more of the following desirable effects: it is expected to increase the number of stolen vehicles recovered, reduce the time lag between theft and recovery, increase the rate of apprehending auto thieves and deter the occurrence of future thefts.

The direct economic value of ALPS in the crime area depends directly upon the extent to which the system can produce these four effects.

A thorough evaluation of ALPS' capabilities with respect to these four effects required a step-wise progression through three distinct stages of analysis. The first basic step was to gain a clear understanding of the characteristics of auto theft in

New York City and the environment in which the system would be required to operate.

The second step involved simulating the performance of ALPS within the known environment and measuring the number and type of hits recorded by the system. The final step involved transforming "hits" into a monetary metric and incorporating their value into the basic cost-benefit equation of this section.

System Environment

The environmental characteristics which bear upon the productivity of ALPS are discussed throughout Part II-A and II-B of the report. The most salient bits of environmental data are concerned with "stolen car flow patterns," "theft activity by time and place" "reporting time delays" and "projections of future growth in auto thefts."

One strategic piece of environmental information is reflected in Table C-2-1. This table indicates that a large percentage of the cars stolen in New York City are never recovered. This is significantly different from available national statistics which show that more than 90% of all stolen autos are recovered within a relatively short period of time.

These data suggest that professionals are committing a relatively high percentage of the City's auto thefts, and it would appear that this percentage is on the increase. Our analysis indicates that in 1969 thirty percent of all auto thefts in New York City were accomplished by professionals. This high degree of professional activity limits, to some degree, the effectiveness of ALPS; since the "pros" can be expected to avoid detection through the use of cold plates or by removing a stolen auto from the city streets well before its description is fed into the ALPS computer.

TABLE C-2-1

RECOVERY RATE OF STOLEN CARS FOR NEW YORK CITY
1967 - 1969

1967	1968	1969 (Preliminary)
67%	57%	52%

The Impact of ALPS

The initial estimates of ALPS effectiveness were based upon a "Standard Theft Year" in which 100,000 cars were assumed

stolen, the daily rate of auto thefts was assumed constant and the deterrent effect of the system was set at zero. Once the system's basic performance parameters were established, the ALPS system was simulated under the more realistic conditions of an increasing rate of theft and a positive deterrent effect which was functionally related to the past successes of ALPS.

The daily "hit" rate of a system of mass license plate scanning is functional, dependent upon a) the number of identifiable stolen cars on the road, b) the percent of the total daily traffic covered by the system and c) the reliability of the scanner system in recognizing a passing vehicle as 'hot'. Assuming a daily theft rate of 274 cars (this represents a rate of 100,000 thefts per year) we can estimate the number of stolen cars on the road in any one day by the equation

$$G\left[\sum_{i=0}^{n}(S_{t_i}) - \sum_{i=0}^{n}(R_{t_i} + E_{t_i})\right] - (S_{t_n})\quad(\delta)\quad = \rho_n$$

where S_{t_i} = The number of thefts in day i (274)

R_{t_i} = The expected number of cars recovered in day i under the present system of law enforcement

E_{t_1} = The expected daily escapes from the system through the use of cold plates, shipping the car out of state, etc.

S_{t_n} = The number of steals in day n

δ = A parameter specifying the lag between an auto theft and its placement on the system

G = The percent of autos which are hot but are not on city roads in day n.

ρ_n = An estimate of the number of hot cars with hot plates on the city streets in day n.

This equation states that the number of identifiable stolen cars on the road in any one day will equal the number of cars stolen over n days minus the number of cars recovered and minus those that have escaped the system by either changing plates or by leaving the city. This total is reduced by a suitable fraction "G" which represents the fact that some percentage of the hot cars are normally not traveling the city streets on day n.

Estimates based upon past values for each of the parameters in the equation indicate that in a year when cars are being stolen at a rate of 100,000 per year the average daily stolen car population which is susceptible to ALPS is approximately 2,050 cars.

The effectiveness of ALPS in making hits on this stock of stolen cars depends upon the percent of the daily auto traffic covered by scanners. In the simulation exercise ten installations containing a total of fifty-eight scanners were deployed. Three installations of ten scanners each were used in toll booth areas while seven fixed-mobile type installations of four scanners each were used to cover street traffic. It was felt by this team of researchers that this was the minimum deployment

density necessary to achieve an auto theft clearance rate of 15 percent. It was felt that a clearance rate of this magnitude would be sufficient to turn the explosive exponential growth trend of auto theft into a path of eventual decay.

It was estimated that the controlled conditions prevailing at toll booth installations would allow the scanners to successfully read 90 percent of all plates passing through the system. The highly variable conditions of lighting, speed and traffic density which exist along city streets reduced the coverage rate of the fixed mobile scanner to an estimated 60 percent of the traffic passing by an installation during a twenty-four hour day.

Systems Effectiveness Estimates:

This systems effectiveness estimate is based on the following factors and assumptions:

First, the number of stolen cars that penetrate a particular precinct can be calculated from the model presented below.

$$P = T + \left[TR + R(9)\ \Sigma \left(\frac{NR_1}{Q_1} + \frac{NR_2}{Q_2} + \frac{NR_3}{Q_3} \ldots + \frac{NR_k}{Q_k} \ldots + \frac{NR_n}{Q_n} \right) \right] 1.1$$

Where:

- P = number of local penetration per year.
- T = number of auto thefts in precinct. (each auto theft is considered to make a least one penetration.)
- TR = amount of stolen vehicle through traffic. (each stolen vehicle flowing through a precinct is considered to make one penetration.)
- R = total stolen vehicle recoveries in that precinct.
- (9) = estimated number of trips, made by the thief, that a recovered vehicle is expected to make through the precinct.
- NR_n = number of stolen vehicle recoveries in a neighboring precinct.
- Q = number of precincts that border the neighboring precinct.
- 1.1 = a constant to account for the number of vehicles which are considered recoverable, but which are not normally recovered.
- $\Sigma \left(\frac{NR_1}{Q_1} + \frac{NR_2}{Q_2} + \ldots \frac{NR_k}{Q_k} \ldots \frac{NR_n}{Q_n} \right)$ = the estimated total number of recoveries in all the neighboring precincts that are likely to penetrate the target precinct.

This model was derived from an extensive analysis of New York City stolen car flow patterns for the years 1967 and 1968.

Second, we assume that the scanning system is performing under the worst case 24 hour road conditions, hence, the efficiency of the system is rated at only 60%.

Third, the estimates are based on an assumption that the ALPS unit can be located on a major thru street carrying 20% of the precinct's traffic. The hit rate is directly proportional to the traffic count. Therefore, streets with higher counts are estimated to give better hit rates, conversely streets that carry less than 20% of the traffic volume will give lower hit rates.

The following example shows how the model and assumptions are used to calculate the expected ALPS hit rate for precinct #28. In 1968 precinct #28 had 347 auto thefts, 78 through traffic penetrations, 4437 recoveries and 4993 neighborhood penetrations.

Therefore, the total number of local penetrations P_1 is equal to 347 auto thefts (T) + [78 through traffic (TR) + 4437 recoveries x 9 + 4993 penetrations from neighboring precincts] 1.1. (The penetration from neighboring precincts was derived from the following calculation: $9\ \Sigma \left(\frac{NR_1}{Q_1} + \frac{NR_2}{Q_2} + \frac{NR_3}{Q_3} + \frac{NR_4}{Q_4} \right) = 9 \left(\frac{480}{4} + \frac{417}{4} + \frac{599}{4} + \frac{334}{4} + \frac{383}{4} \right) = 4993$).

Simplifying, we find that P_1 is (347 + 9508) 1.1 or 10,840 penetrations per year cr 30 penetrations per day.

But 30 penetrations per day means that there are 10 stolen vehicles driven in the local traffic flow. (This inference was based on survey data which showed how long the thief had the car and how far he drove it.)

In addition, further processing of the flow analysis indicated that the system could make at least two more hits on illicit vehicles driving in that local traffic. These hits were not accounted for in the local penetration model and must be added to the resultant of the local penetration calculation. These vehicles are operated by either thieves on an inter-borough trip or by perpetrators who intend to keep or dispose of the car they have stolen.

If each of the local illicit drivers make three daily trips then we estimate the probability of passing the scanning system to be 0.5. Hence, we expect to have at least five of those local drivers come into scanning range. These plus the two additional non-local vehicles and a 60% efficiency rate means that we can expect to get 4.2 hits per day from that system deployed in Precinct #28.

Table C-2-2 shows the number of expected hits per day that a scanning system could make in each precinct in New York City.

Using the stolen car traffic flow maps as a guide to placing the scanners it was estimated that the ten installations would intercept slightly better than 2% of the identifiable stolen cars which were on the road that day. The initial daily hit rate under simulation was 45 to 48 "hits per day", but as ALPS continues to take its toll the stock of stolen cars on the road suffered some depletion. As a consequence the number of hits made by ALPS suffered a corresponding decline. Through the following equation it was estimated that after initially skimming the cream of the stolen car stock, ALPS would settle down to a daily average of 41 to 42 hits per day.

TABLE C-2-2

EXPECTED NUMBER OF HITS PER PRECINCT SCANNER

(The pair of numbers in each cell correspond to a precinct number and the number of hits per day that a single ALPS system could expect to make if deployed in that precinct. The data was derived from analysis of 1968 stolen car flow patterns, and precinct traffic conditions. Estimates for the 1969 theft rate can be made by increasing the figures presented here by 20%.)

PCT #	EXP. # OF HITS	PCT #	EXP. # OF HITS	PCT #	EXP. # OF HITS	PCT #	EXP. # OF HITS
1	1.9	34	3	69	6.2	101	2.3
4	2.6	40	5.1	70	5.4	102	7
5	2.9	41	6.1	71	5.4	103	10.3
6	3.3	42	5.2	72	4	104	5
7	2.3	43	6.3	73	6.3	105	6.6
9	3.6	44	5	75	9.4	106	7
10	3.1	45	3	76	3.2	107	9.5
13	3.5	46	3.9	77	4.7	108	4.9
14	3.1	47	4.4	78	4	109	6
17	3.7	48	6.1	79	5.4	110	6.8
18	3.3	50	3.2	80	4.2	111	6.2
19	3.6	52	3.6	81	6.7	112	5.8
20	2.8	60	3.2	83	5.8	114	5.3
23	3.5	61	4.5	84	3.2	120	2.5
24	3.3	62	3.7	87	4.1	122	1.4
25	4	63	4.6	88	4.1	123	1
26	3.5	64	2.9	90	4.7		
28	4.2	66	3.9	92	2.7		
30	3.3	67	4	94	2.4		
32	4.1	68	3.4	100	2.2		

$$\left[G\left[\sum_{i=0}^{n} (S_{t_i}) - \sum_{i=0}^{n} (R_{t_i} + E_{t_i} + A_{t_{i-1}}) \right] - (S_{t_n})(\delta) \right] \left[C.V \right] = A_n$$

Where $A_{t_{i-1}}$ = ALPS hits in day i-1

C = Percent of stolen car stock scanned by ALPS in one day.

V = The reliability of ALPS scanners

A_n = ALPS hits in day n

Five Year Simulated Performance of ALPS

Once the basic environmental and performance parameters of the system were established ALPS was simulated over a five year period under more realistic conditions. The simulation made allowance for seasonal fluctuations in the theft rate and allowed for behavioral adjustments on the part of professional auto thieves once the system was inaugurated. Under these more realistic assumptions the growth rate of auto theft was projected over the five year period 1970-1974.

Up until 1966 the rate of growth in auto theft was quite moderate, about ten percent per year. Since, 1966 however, thefts have spurted ahead at an annual rate which is slightly in excess of thirty percent. Whether this dramatically higher rate is a temporary abrogation of the lower long term trend or a permanent change in criminal behavior is a moot question. For this reason the performance of ALPS was simulated under two different growth trends: a 12 percent annual rate and a 24 percent rate. In each instance the simulation was made first without and then with the inclusion of a moderate deterrent effect.

Table C-2-3 and C-2-4 show the simulated performance of ALPS over the 1970-1974 period assuming a 12 percent and 24 percent rate of growth in auto thefts and no deterrent effect. The simulation model was sufficiently detailed so as to distinguish between hits on vehicles that would have been eventually recovered without ALPS and those that would have remained undetected without the system. The simulation also provided information on how much sooner a recovery was made through the use of ALPS. This was essential information since our sample survey of auto theft victims revealed that in most cases a considerable savings could be realized through rapid retrieval of a stolen vehicle.

Utility of the System

In the absence of a deterrent effect, the total direct benefits of ALPS consists of 1) the dollar value of recovering a vehicle that would have remained unrecovered without ALPS, 2) the portion of the value of an auto which is preserved through early recovery of a vehicle, 3) the value of the property damage and personal injury averted by an early recovery, and 4) the savings in law enforcement cost which can be attributed to ALPS.

Each of these benefit areas are discussed in the succeeding paragraphs.

In New York City in 1968, forty million dollars worth of automobiles were stolen and never recovered. In 1969 this loss is expected to exceed the fifty million dollar mark. A prime

TABLE C-2-3

ESTIMATED PERFORMANCE OF ALPS OVER 1970-1974 PERIOD ASSUMING A 12% ANNUAL RATE OF GROWTH IN AUTO THEFTS AND NO DETERRENT EFFECT

YEAR	AUTO THEFTS	TOTAL ALPS HITS	RECOVERED* VEHICLE HITS	UNRECOVERED** VEHICLE HITS
1970	103,040	15,610	12,923	2,687
1971	115,405	17,284	14,337	3,947
1972	129,253	19,382	16,057	3,325
1973	144,764	21,732	17,984	3,748
1974	162,135	24,363	20,142	4,221
Total	654,597	98,371	81,443	16,928

* Stolen vehicles that would have been eventually recovered without ALPS.

** Stolen vehicles that would not have been recovered without ALPS.

TABLE C-2-4

ESTIMATED PERFORMANCE OF ALPS OVER 1970-1974 PERIOD ASSUMING A 24% ANNUAL RATE OF GROWTH IN AUTO THEFTS AND NO DETERRENT EFFECT

YEAR	AUTO THEFTS	TOTAL ALPS HITS	RECOVERED* VEHICLE HITS	UNRECOVERED** VEHICLE HITS
1970	112,237	17,608	14,116	2,892
1971	139,499	20,940	17,335	3,605
1972	173,383	26,074	21,545	4,529
1973	215,498	32,457	26,779	5,678
1974	267,843	40,389	33,283	7,106
	908,460	136,868	113,058	23,810

* Stolen vehicles that would have been eventually recovered without ALPS.

** Stolen vehicles that would not have been recovered without ALPS.

benefit of ALPS is that it will score "hits" on vehicles which are now escaping detection. In Section A-6 the average value of a recovered vehicle was estimated at $905. This amount was credited to ALPS each time an "unrecovered vehicle hit" was made in the simulation model.

Losses from stripping, collision and vandalism are functionally related to the number of days a car is missing. Figure C-2-1 shows that the average recovered stolen vehicle incurs a first day loss of $220 and an additional loss of $20 per day for each day it is gone, up to a maximum of 17 days. Beyond 17 days there appeared to be no further loss associated with time.

The amount of stripping, vandalism and collision damage averted through early recovery was computed via the following equation:

$D_{ij} = \$20\ (G_e - G_a)$ where $G_e = 17$ for all $G_e > 17$ and $G_a \le 17$

Where: D_{ij} is the vehicle damage averted by recoveries of the i-th car on the j-th day.

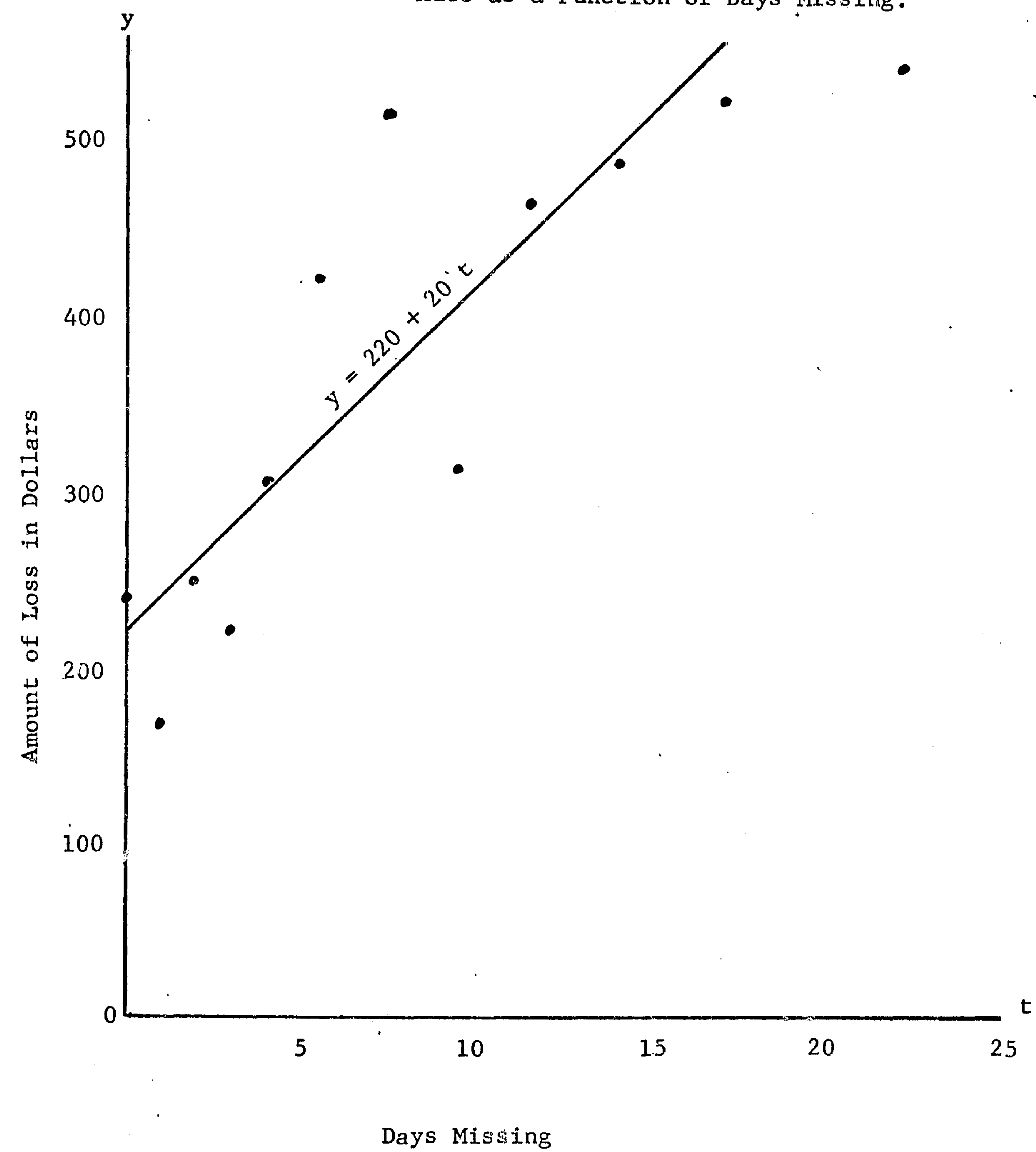
G_e is the number of days the car is expected to be gone.

G_a is the actual number of days the car is gone.

The equation simply states that the value of an early recovery is equal to the number of days saved prior to a car being gone 17 days multiplied by the value of each day saved.

In the computation of benefits an additional dollar per day was credited to the system for each day saved. This represented

Figure C-2-1. The Total Dollar Loss Per Recovered Auto as a Function of Days Missing.



the losses resulting from normal vehicle depreciation.

Stolen car accidents are directly, though not proportionally, related to the length of time a thief is in possession of a vehicle. Accidents and their concomitant cost of medical care, property damage, days lost from work, etc., are reduced through the rapid recovery feature of ALPS. These savings are credited to the system under the catch all categories of "Secondary Benefits".

A "hit" by ALPS means there is one less recovery that other elements of the police force need be concerned with, thereby, allowing these forces to concentrate on other areas of law enforcement. The current law enforcement costs associated with auto theft are discussed in Section A-14. Some portion of this amount was credited to ALPS each time a "Recovered Vehicle Hit" was recorded.

Tables C-2-5 and C-2-6 summarize the estimated dollar benefits of ALPS which are implied by the hit rates indicated in Tables C-2-3 and C-2-4 respectively. These benefits are further specified by the following equation:

$$TB = (RH)\ (D_D + D_I + L) + UH \cdot VR$$

Where TB is the total dollar benefits derived from ALPS

(RH) is the number of hits on cars that would normally be recovered without ALPS

(D_D) is that portion of a car's value which is on the average saved through early recovery

(L) is the law enforcement savings engendered by each "Recovered Vehicle Hit"

TABLE C-2-5

THE DOLLAR BENEFITS OF ALPS FOR YEARS 1970 THROUGH 1974 ASSUMING A 12% ANNUAL GROWTH RATE IN AUTO THEFTS AND NO DETERRENT EFFECT

	1970	1971	1972	1973	1974
Dollar Value of "Recoverable Vehicle Hits"	\$1,227,685	\$1,362,015	\$1,525,415	\$1,708,480	\$1,913,490
Dollar Value of "Unrecovered Vehicle Hits"	2,431,735	2,667,035	3,009,125	3,391,940	3,820,005
Dollar Value of Secondary Benefits (Reduced Property Damage, Death, Injury, etc.)	1,822,190	2,108,885	2,438,126	2,816,061	3,249,542
Dollar Savings on Law Enforcement	1,292,300	1,433,700	1,605,700	1,798,400	2,014,200
TOTAL	\$6,773,910	\$7,571,635	\$8,578,366	\$9,714,881	\$10,997,237

TABLE C-2-6

THE DOLLAR BENEFITS OF ALPS FOR YEARS 1970 THROUGH 1974 ASSUMING A 24% ANNUAL GROWTH RATE IN AUTO THEFTS AND NO DETERRENT EFFECT

	1970	1971	1972	1973	1974
Dollar Value of "Recoverable Vehicle Hits"	$1,341,020	$1,646,825	$2,046,775	$2,544,005	$3,161,885
Dollar Value of "Unrecovered Vehicle Hits"	2,617,260	3,262,525	4,098,745	5,138,590	6,430,930
Dollar Value of Secondary Benefits (Reduced Property Damage, Death, Injury, etc.)	1,984,825	2,622,788	3,270,569	4,176,353	5,368,147
Dollar Savings On Law Enforcement	1,411,600	1,733,500	2,154,500	2,677,900	3,328,300
TOTAL	$7,354,705	$9,265,638	$11,570,589	$14,536,848	$18,289,262

(D_I) is the secondary cost which are on the average averted through an early hit

UH is the number of "unrecovered vehicle" hits

VR is the average value of a recovered vehicle

It should be mentioned at this juncture that additional secondary and tertiary benefits accrue to society from the effectual deployment of ALPS. These include the effects on auto related crime, insurance rates, recidivism , etc. These benefits have been excluded from this part of the analysis because of the difficulty in estimating their magnitude and the impossiblity of relating some change in their value with a change in auto theft rates. For this reason the discussion of these related benefits was confined to the more descriptive sections of this report.

Deterrent Effect

The increased number of apprehensions which are the product of ALPS will in the course of time have some deterrent effect on the future rate of auto theft. Deterrence comes into play in several ways. First and foremost a high apprehension rate will dissuade potential thieves from turning to auto theft lest they be caught. ALPS will also cause the professional thief to invoke a greater degree of caution and thereby reduce his rate of repeated offenses. Finally apprehension itself acts as a deterrent since it keeps some repeat offenders from plying their trade during the time they are in jail. The possible deterrent effect ALPS will have upon future auto theft is a matter for subjective speculation. For the purpose of this report a moderate rate of deterrent was selected and applied to the two growth rates, 12 percent and 24 percent, being considered here.

The general form of the deterrent effect is specified by the following equation

***

$$T_{n+1} = (PT_n) \left(\gamma - 3^{-\frac{\lambda}{(E_1)n}}\right) + (AT_n) \left(\gamma - 3^{-\frac{k}{(E_2)n}}\right)$$

Where (T_{n+1}) is the number of vehicles stolen in period n + 1

(PT_n) is the number of professional thefts in period n

(AT_n) is the number of non professional thefts in period n

γ is the projected annual rate of growth in auto thefts

$(E_2)\ n$ is the ratio of the total number of cars caught, to the total number stolen in period n

$(E_1)_n$ is the ratio of the professionals apprehended to the number of professional thefts

λ and k are parameters specifying the form of the exponential equation, $0 \leq \lambda \leq 1$, $0 \leq k \leq 1$

This equation indicates that next year's auto thefts by both professionals and non-professionals will be less than the expected rate by some fraction. This fraction is the deterrent effect and is functionally related to the hit rate of ALPS. The deterrent

***This deterrent function is a modified form of a similar function employed in the Rensselaer Polytechnic Inst. Study entitled, "An Investigation of Automobile Surveillance."

coefficient for professionals is functionally distinct from the non-professional rate. In the model non-professionals were expected to react to <u>any</u> increase in the rate of criminal apprehension while the professionals were deterred only to the extent that ALPS was successful in making hits on the professional ranks. At the same time it is expected that those who steal for profit will be more concerned over a given rate of arrest, then the less calculating joyriders.

The actual coefficient of deterrence for each group is unknown, but the relatively low number of "pro hits" projected for the system indicates that ALPS will be less effective in arresting the growth of professional versus non-professional crime.

Figure C-2-2 and C-2-3 show the estimated deterrent effect of ALPS for the years 1970-1974. The upper curves show the projected number of auto thefts assuming a 12 percent and 24 percent annual rate of growth. The lower curves show the number of auto thefts with ALPS. The shaded area denotes the number of auto thefts likely to be suppressed by the system.

Given this deterrent effect Table C-2-7 and C-2-8 summarize the simulated performance of ALPS.

The total direct benefits derived from ALPS are greatly expanded with the inclusion of a deterrent effect. These added benefits include:

1) The value of deterring the theft of an "unrecovered vehicle". This included the value of the auto, its contents and

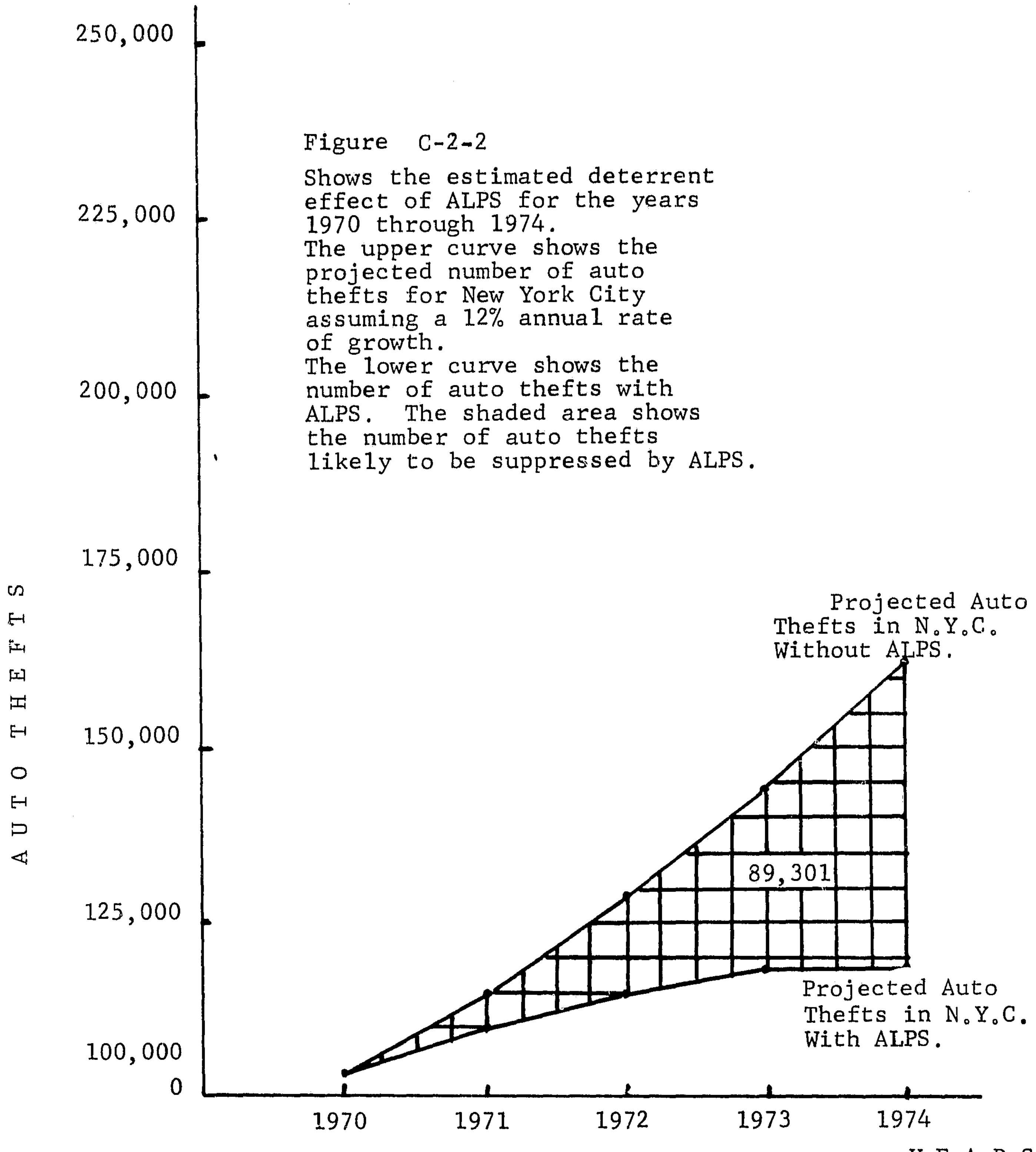


Figure C-2-2

Shows the estimated deterrent effect of ALPS for the years 1970 through 1974. The upper curve shows the projected number of auto thefts for New York City assuming a 12% annual rate of growth. The lower curve shows the number of auto thefts with ALPS. The shaded area shows the number of auto thefts likely to be suppressed by ALPS.

Estimated Deterrence Effect of ALPS

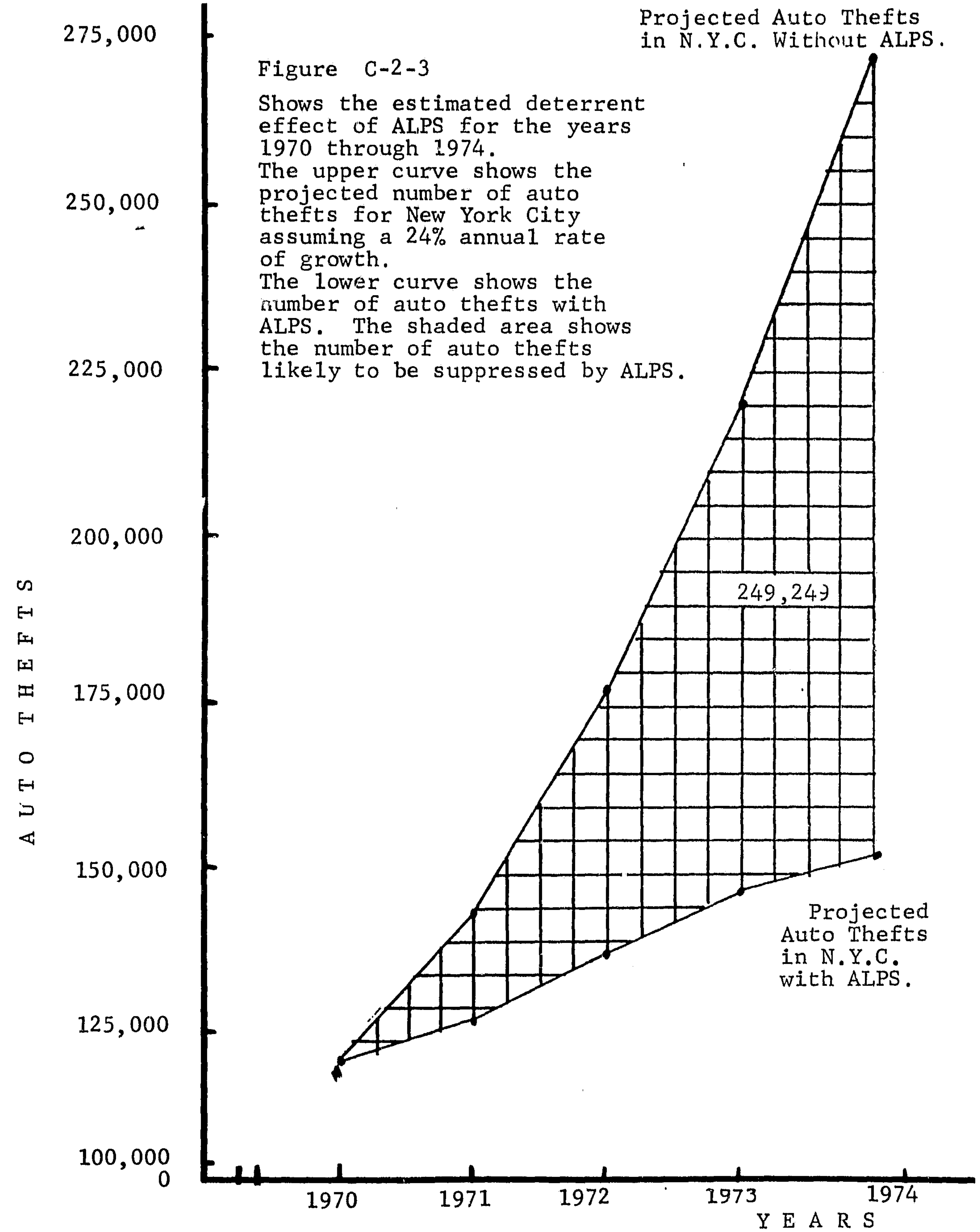


Figure C-2-3

Shows the estimated deterrent effect of ALPS for the years 1970 through 1974. The upper curve shows the projected number of auto thefts for New York City assuming a 24% annual rate of growth. The lower curve shows the number of auto thefts with ALPS. The shaded area shows the number of auto thefts likely to be suppressed by ALPS.

Estimated Deterrence Effect of ALPS

TABLE C-2-7

ESTIMATED PERFORMANCE OF ALPS OVER 1970-1974 PERIOD ASSUMING A 12% ANNUAL RATE OF GROWTH IN AUTO THEFTS AND A MODERATE DETERRENT EFFECT

			ALPS EFFECT			DETERRENT EFFECT		
YEAR	EXPECTED # OF THEFTS	ACTUAL # OF THEFTS	TOTAL ALPS HITS	RECOVERED* VEHICLE HITS	UNRECOVERED** VEHICLE HITS	TOTAL DETERRED THEFTS	DETERRED*** THEFTS OF RECOVERABLE VEHICLES	DETERRED**** THEFTS OF UNRECOVER-ABLE VEHICLES
1970	103,040	103,040	15,610	12,923	2,687	0	0	0
1971	115,405	110,253	16,837	14,049	2,788	5,152	3.504	1,648
1972	129,253	115,412	17,530	14,612	2,918	13,841	8,876	4,965
1973	144,764	118,135	17,809	14,831	2,978	26,629	16,700	9,929
1974	162,135	118,456	17,571	14,612	2,959	43,679	27,512	16,167
	654,597	565,296	85,357	71,027	14,330	89,301	56,592	32,709

* Stolen vehicles that would have been eventually recovered without ALPS.

** Stolen vehicles that would not have been recovered without ALPS.

*** In the absence of ALPS vehicles that would have been stolen and recovered.

**** In the absence of ALPS vehicles that would have been stolen and never recovered.

TABLE C-2-8

ESTIMATED PERFORMANCE OF ALPS OVER 1970-1974 PERIOD ASSUMING A 24% ANNUAL RATE OF GROWTH IN AUTO THEFTS AND A MODERATE DETERRENT EFFECT

			ALPS EFFECT			DETERRENT EFFECT		
YEAR	EXPECTED # OF THEFTS	ACTUAL # OF THEFTS	TOTAL ALPS HITS	RECOVERED* VEHICLE HITS	UNRECOVERED** VEHICLE HITS	TOTAL DETERRED THEFTS	DETERRED*** THEFTS OF RECOVERABLE VEHICLES	DETERRED**** THEFTS OF UNRECOVER-ABLE VEHICLES
1970	112,237	112,237	17,008	14,116	2,892	0	0	0
1971	139,499	124,111	18,717	15,578	3,139	15,388	10,425	4,963
1972	173,383	133,766	19,606	16,263	3,343	39,617	26,606	13,011
1973	215,498	142,044	20,197	16,696	3,501	73,454	48,566	24,888
1974	267,843	147,053	20,114	16,559	3,555	120,790	78,832	41,958
	908,460	659,211	95,550	78,212	16,430	249,249	164,429	84,820

* Stolen vehicles that would have been eventually recovered without ALPS.

** Stolen vehicles that would not have been recovered without ALPS.

*** In the absence of ALPS vehicles that would have been stolen and recovered.

**** In the absence of ALPS vehicles that would have been stolen and never recovered.

the additional expenses which would have been incurred by the potential victim. These costs were estimated in Sections A-5 and A-6 and amounted to 1450 dollars per car.

2) The value of deterring the theft of a "recoverable vehicle". This was found by subtracting 905 dollars, the value of a recovered car, from 1450 dollars.

3) Secondary benefits which include reductions in accident rates, personal injury, property damage, loss of life, etc. This was valued at 155 dollars per recoverable vehicle for 1970 and rose each year due to increases in medical cost and the rising productivity of labor, and

4) The savings on law enforcement and correction. A deterred theft reduces the burden on the police, the courts and correctional institutions, this savings was set at 310 dollars per deterred theft.

The total benefits of ALPS assuming a deterrent effect are presented in Tables C-2-9 and C-2-10.

CONTINUED

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TABLE C-2-9

THE DOLLAR BENEFITS OF ALPS FOR YEARS 1970 THROUGH 1974 ASSUMING A 12% ANNUAL RATE OF GROWTH IN AUTO THEFT AND A MODERATE DETERRENT EFFECT

	1970	1971	1972	1973	1974
Dollar Value of "Recovered Vehicle Hits"	$1,227,685	$1,334,655	$1,388,140	$1,408,945	$1,388,140
Dollar Value of "Unrecovered Vehicle Hits"	2,431,735	2,523,140	2,640,790	2,695,090	2,677,895
Dollar Value of Secondary Benefits	1,822,190	1,926,383	2,055,450	2,188,308	2,228,765
Dollar Savings on Law Enforcement	1,292,300	1,404,900	1,461,200	1,483,100	1,461,200
Dollar Value of Deterring Thefts of Recoverable Vehicles	0	1,331,900	3,372,880	6,346,000	10,454,560
Dollar Value of Deterring Thefts of Unrecoverable Vehicles	0	2,389,600	7,199,250	14,397,050	23,442,150
Dollar Value of Secondary Benefits	0	543,120	1,420,160	2,755,500	4,677,040
Dollar Savings on Law Enforcement and Correction Expenses	0	1,597,120	4,290,710	8,254,990	13,540,490
TOTAL	$6,773,910	$13,050,818	$23,828,580	$39,528,983	$59,870,239

TABLE C-2-10

THE DOLLAR BENEFITS OF ALPS FOR YEARS 1970 THROUGH 1974 ASSUMING A 24% ANNUAL RATE OF GROWTH IN AUTO THEFT AND A MODERATE DETERRENT EFFECT

	1970	1971	1972	1973	1974
Dollar Value of "Recovered Vehicle Hits"	$1,341,020	$1,479,910	$1,544,985	$1,586,120	$1,573,105
Dollar Value of "Unrecovered Vehicle Hits"	2,617,260	2,840,795	3,025,415	3,168,405	3,217,275
Dollar Value of Secondary Benefits	1,984,825	2,164,899	2,401,661	2,637,742	2,801,912
Dollar Savings on Law Enforcement	1,411,600	1,557,800	1,626,300	1,669,600	1,655,900
Dollar Value of Deterring Thefts of Recoverable Vehicles	0	3,961,500	10,110,280	18,455,080	29,956,160
Dollar Value of Deterring Thefts of Unrecoverable Vehicles	0	7,196,350	18,865,950	36,087,600	60,839,100
Dollar Value of Secondary Benefits	0	1,615,875	4,256,960	8,013,390	13,401,440
Dollar Savings on Law Enforcement and Correction Expense	0	4,770,280	12,281,270	22,770,740	37,444,900
TOTAL	$7,354,705	$25,587,409	$54,112,821	$94,387,777	$150,889,792

Warrants

In a system such as ALPS the number of hits is functionally related to the size of the wanted plate file. By including plates associated with outstanding warrants the data base for New York City would be enlarged by an additional 300,000 plates, and the total file for New York State would easily exceed the half million level.

A survey of police and court files clearly indicated the need for ALPS or an ALPS type system in the area of warrants. New York City and other metropolitan areas of New York State have experienced both a secular decline in the ability of the criminal justice system to execute warrants and a serious erosion in the willingness of the public to respond to warrants once they are served. For example, in 1968 in New York City approximately 360,000 warrants were either newly issued during the year or outstanding from the previous year. Of these less than half were successfully executed. The data further indicate that warrant-serving officers in other SMSA's in the state, are experiencing the same degree of frustration as their New York City counterparts.

The major impediment to effectively executing warrants is the overwhelming number that must be served by a relatively small staff. New York City averages 4,000 warrants per warrant officer, while the county and state systems average 2,000 per official. The woefully inadequate execution rates have tended to further exacerbate this critical problem by encouraging avoidance behavior on the part of essentially law abiding citizens. Individuals who would in normal circumstances submit to a warrant now seen to be engaging in evasive activity since the chances of being successful in this hide and seek game are relatively good.

Operation Corral

The ability of ALPS to perform a warrant function was amply demonstrated by "Operation Corral" which took place during the summer of 1965. This experiment was conducted for a total of 158 days and employed the basic operational concepts and components of ALPS; though on a less automated basis. Out of 183,950 inquiries, the "Corral" operation scored 2,982 hits; eighty-five percent of which were hits involving warrants. This performance was impressive both from the standpoint of the number of hits scored and the percentage of hits that were classified as "warrant hits."

In addition to its operating success in the field, the "Operation Corral" experiment provided valuable data from which to predict the probable successes of ALPS. The following evaluation of ALPS' capabilities will lean heavily upon this information:

The Effectiveness of ALPS

Each "warrant hit" scored by the ALPS network is expected to produce one or more of the following effects, some of which cannot be measured in dollar terms: ALPS is expected to increase

the number of warrants successfully served, ease the work load now borne by warrant officers, reduce the need for reissuing warrants; deter individuals from committing further warrant offenses; make it less palatable for individuals to engage in avoidance behavior; and reduce the number of warrants which are classified as "served, but not answered."

The basic environmental characteristics surrounding warrants are not at all similar to those relating to auto theft. Unlike auto thefts, the productivity of ALPS in the warrant field is not hindered to any measurable degree by "professionalism", nor is the system constrained by "reporting time delays" or "early drop offs." A license plate associated with a warrant may be placed in the computer file at any time; either when the warrant is initially issued, or after conventional techniques have proven futile.

Two limiting factors do present themselves, however. First, if an individual does not own an auto he is relatively secure from the searching eye of the ALPS scanner. In this case the use of conventional methods are still required to ferret him out. This limitation is not too restrictive, however, since the majority of warrants originate from motor vehicle violations. A second and more serious constraint stems from the fact that the driver of a vehicle at the time of interception may be someone other than the person named in the warrant, thereby nullifying the hit. By necessity, both of these limitations were used to modify and constrain the "warrant hit" rates which were generated by the predictive model.

Year to year fluctuations in the number of outstanding warrants is caused as much by administration fiat as it is from actual changes in community behavior. For example, an edict to "clear the books of stale warrants" may reduce the number of outstanding warrants by several thousand; while an all out campaign against scofflaws would sharply boost the rate at which new warrants are issued. The dearth of reliable and consistent time series data forced this team of researchers to eschew any attempt at projecting the growth rate of warrants over time or from attempting to estimate the possible deterrent effects which ALPS might have upon future warrant violators. Data limitations of this degree obviously imply that estimates of future "warrant hits" will be less reliable than the predictions made for auto thefts. When the estimates do err, however, they will most likely do so on the conservative side; understating the true effectiveness of ALPS.

In the absence of a more accurate data base, a less sophisticated probability technique was used to predict the productiveness of ALPS. Table C-2-11 shows the estimated performance of ALPS over a five year period under the assumptions of a zero rate of growth in new warrants issued and no deterrent effect.

The higher than average hit rate in 1970 and 1971 reflects the initial skimming off of the accumulated backlog of warrants. In 1972 and succeeding years the system settles down to a more

TABLE C-2-11

ESTIMATED PERFORMANCE OF ALPS OVER 1970-1974 PERIOD ASSUMING WARRANTS ARE ISSUED AT A CONSTANT RATE OF 220,000 PER YEAR

YEAR	WARRANT HITS
1970	63,400
1971	48,700
1972	42,600
1973	42,600
1974	42,600
Total	239,900

maintainable rate of hits.

Dollar Benefits of Warrant Hits

The total direct dollar benefits of a warrant hit consists of 1) the dollar savings to the court system because some warrants need not be reissued or kept on the books, 2) the savings in law enforcement costs, because warrant servers have fewer individuals to seek out, and 3) the increased flow of revenue from collecting fines that would not have been paid in the absence of ALPS. Data on the cost of issuing and serving warrants were collected from the files of the New York Police Department and from court records. Data on fines were collected in a similar manner from three other major metropolitan areas and analyzed to verify the New York City figures. Once verified the data was used to compute the total benefits generated by ALPS when it produces warrants hits. The results of this analysis are presented in Table C-2-12.

TABLE C-2-12

THE DOLLAR BENEFITS OF ALPS FOR YEARS 1970 THROUGH 1974
ASSUMING WARRANTS ARE ISSUED AT A CONSTANT RATE OF 220,000 PER YEAR

	1970	1971	1972	1973	1974
Dollar Savings to Court System	$500,000	$400,000	$360,000	$360,000	$360,000
Dollar Savings on Law Enforcement	340,000	280,000	240,000	240,000	240,000
Revenues From Fines	1,105,000	775,000	630,000	630,000	630,000
Total	$1,945,000	$1,455,000	$1,230,000	$1,230,000	$1,230,000

Cost

The costing of a uniquely new system such as ALPS is fraught with uncertainty. The precise operating procedures that will be employed in the field and the amount of "down time" experienced by the system can only be estimated with some degree of error. Operating, maintenance and repair schedules, and their associated costs, must also be learned through experience and, as yet, represent unknown variables. Gray areas such as these will tend to endow our estimate of the system's total cost with a degree of uncertainty which no amount of a priori analysis can eliminate.

Fortunately, however, the two major costs components comprising ALPS are fairly well known. These are the initial cost of the equipment and the manpower requirements needed to operate the system on a 24-hour basis. The investment cost for a four scanner unit with processor was estimated for 1967 to be $50,000, while a ten scanner unit costs approximately $100,000. At these rates the initial first year investment expenditures for the ten installations specified, plus spares, would be approximately $750,000.*

The system, as described in Section C-I, will have a fixed mobile capability. This will require the purchase of several vans and will give rise to an additional investment expenditure of approximately $20,000.

* Recent advances in computer and scanner technology have reduced the costs and improved the effectiveness of these units. These new cost figures were unavailable at the time this study was concluded.

If the scanners are operated on a 24-hour basis the manpower cost would amount to an estimated $180,000 per installation per year. This figure is exclusive of initial training costs, but does include allowances for fringe benefits, personal police equipment, and annual pay raises.

The total first year cost incurred by the system is estimated to be $2,600,000. This includes all expenditures for purchasing, installing, and operating the system's equipment, as well as monies to hire, train, and utilize the manpower which is requisite to the system operation. Costs over the succeeding four year time frame are expected to occur in equal annual increments of $2,200,000.

As a final adjustment to the cost totals, ALPS was credited with $100,000. This represented the remaining value of the scanning equipment after five years of use.

On this basis our best estimate of the expenditures required to fund the system over a five year operational period is $10,500,000; in excess of 90% of this represents the cost of manpower needed to insure the system's effective operation.

This figure actually overstates the true cost of ALPS. The cost total should properly be credited with the savings in law enforcement costs which are directly attributable to ALPS. Under some sets of assumptions these savings are sufficient to offset the entire cost of the system. However, four different estimates of "law enforcement savings" have been generated, so for simplicity's sake these savings were entered on the benefit side of the ledger.

C-3. Socio-Economic Evaluation of Study Findings.

The basic fabric of this report is woven with dollar totals which often reach into the tens and hundreds of millions, and on occasion exceed the billion dollar level. Grand sums of this magnitude often have a tendency to push social and public interest benefits into the fringes of conscienceness.

The emphasis on dollar benefits however, is necessary on purely analytical grounds. It is always desirable to base decisions on objective, compatible, and easily measurable criteria. Cost and dollar benefits are ideal in this respect since they are in the same metric and their relative values are not open to subjective interpretation. Social and public interest criteria are essentially subjective in nature, their relative worth stemming from the personal value system of each individual. To avoid being mired in the quicksands of philosophical debate such criteria are usually relegated to the final phase of analysis and then handled by descriptive rather than quantitative techniques.

The analytical emphasis on economic measures should not be construed to mean that the critical values of the ALPS network are reducible to a purely dollar and cents calculus. Law enforcement has been and will continue to remain primarily a social and public interest function, designed to insure the safety of individuals and create an environment which is free of fear and is conducive to the free functioning of daily activities.

Comparative Analysis

Within the expanded scope of this evaluation the benefits reaped from the ALPS system fall into three distinct categories; direct economic benefits which are tangible and immediate in nature; indirect benefits, which are tangible but emanate from a variety of diverse sources over long periods of time, and intangible benefits which cannot be reduced to a dollar measure.

ALPS will be deemed feasible to deploy on purely economic grounds if the total dollar benefits derived from its use exceeds the total dollar cost of the system over a five year operational period.

In Table C-3-1 the dollar benefits of ALPS for each of the four simulations are summarized. When compared with the total system's cost, the results show that even in the most unfavorable case, a 12% growth rate in thefts and no deterrent effect, the economic benefits derived from ALPS exceed costs by a factor of five. And in every case the total five-year costs were easily recouped before the second year of operation was completed.

The data presented in Table C-3-1 indicate that on the basis of economic benefits alone ALPS easily meets the strictly economic criterion for deployment, i.e., $\frac{\$\ \text{Benefits}}{\$\ \text{Costs}} > 1$. These figures, however, represent only the performance of ALPS in New York City. The findings of the New York City analysis were generalized and applied to other populated areas of the

TABLE C-3-1

THE ESTIMATED DOLLAR BENEFITS FROM ALPS OVER FIVE YEARS UNDER ALTERNATIVE SETS OF ASSUMPTIONS

	12% Growth No Deterrent	24% Growth No Deterrent	12% Growth With Deterrent	24% Growth With Deterrent
Direct Dollar Benefits				
Auto Theft	$43,736,000	$61,017,000	$143,052,000	$332,332,000
Warrants	7,100,000	7,100,000	7,100,000	7,100,000
Indirect Dollar Benefits				
Auto Theft Related Crimes	3,700,000	5,000,000	8,300,000	15,400,000
Auto Related Crimes	2,500,000	3,400,000	5,600,000	10,100,000
Savings on Insurance	1,900,000	2,685,000	5,850,000	12,000,000
Total	$57,936,000	$79,202,000	$169,902,000	$376,932,000

state. The results showed that three other SMSAs, Buffalo, Rochester and Albany-Schenectady-Troy, also exceeded the threshold for deployment, again on purely economic grounds. The extent of deployment in these three areas, however, would obviously be less extensive than in New York City.

Non-monetary benefits are shown in Table C-3-2. Together they represent a primary though non-additive adjunct to the economic benefits summarized in the preceding table.

Expanding the criteria for deployment to include the social aspects of ALFS will undoubtedly justify the system's use beyond the confines to the four SMSAs, as well as provide the rationale for increasing the deployment densities within these areas.

It would appear from a cursory analysis that some degree of additional coverage could be justified for several major inter-urban routes. This coverage could be on a random basis with respect to both time and location, following the strategy employed by radar units.

The justification of more extensive coverage will depend upon the subjective valuations placed upon the social and public interest benefits by the general public, the state legislature and cognizant law enforcement officials.

The total analysis presented here, however, indicates that ALPS meets the criteria for limited deployment on economic grounds alone. When non-monetary benefits are also considered, ALPS then becomes an attractive candidate for implementation.

TABLE C-3-2

QUANTIFIABLE, NON MONETARY BENEFITS OF ALPS OVER FINE YEARS UNDER ALTERNATIVE SETS OF ASSUMPTIONS

Quantifiable Non Monetary Benefit	12% Growth No Deterrent	24% Growth No Deterrent	12% Growth With Deterrent	24% Growth With Deterrent*
Reduced Number of Deaths	30	45	100	190
Reduced Number of Injuries	3480	5220	11,600	22,040
Reduced Number of Hospital Days	3750	5625	12,500	23,750
Reduced Number of Auto Theft Victims	----	----	89,301	249,249
Reduced Number of Hardships	16,600	23,210	32,110	65,870
Increased Number of Warrants Served	114,000	114,000	114,000	114,000
Increased Number of Arrests	68,000	76,000	68,000	76,000

* ALPS will undoubtedly increase the number of crime-free years. Unfortunately we were unable to calculate the reduced losses attributed to the suppression of criminal career activity. However the increased number of crime-free years attributed to reduced criminal career admissions is calculated at 3,244 years for these conditions.

Micro Analysis of Auto Theft

The bulk of the economic benefits stemming from ALPS come directly from its successes against auto theft.

The purpose of this section is to first evaluate this study's findings on a more understandable per theft basis and second, to compare the system's cost benefit relationship from this same microscopic viewpoint.

Figure C-3-1 indicates that each auto theft in New York State carries with it a potential direct loss of $1910. (Not shown in the diagram are the indirect costs such as higher insurance premiums, increased rates of auto related crime, etc.) With each theft the victim stands to lose his auto, which has an average value of $1220, his personal property left in the car, valued at $40, and he could incur additional expenses for auto rental, lost time from work, etc. representing an additional $190.

Each time a vehicle is stolen, private individuals other than the victim will sustain an average loss of $192. Much of this loss will be in the form of accident damages suffered at the hands of the reckless joy rider.

As a taxpayer the private citizen, victim and non-victim alike, will bear the burden of additional law enforcement costs

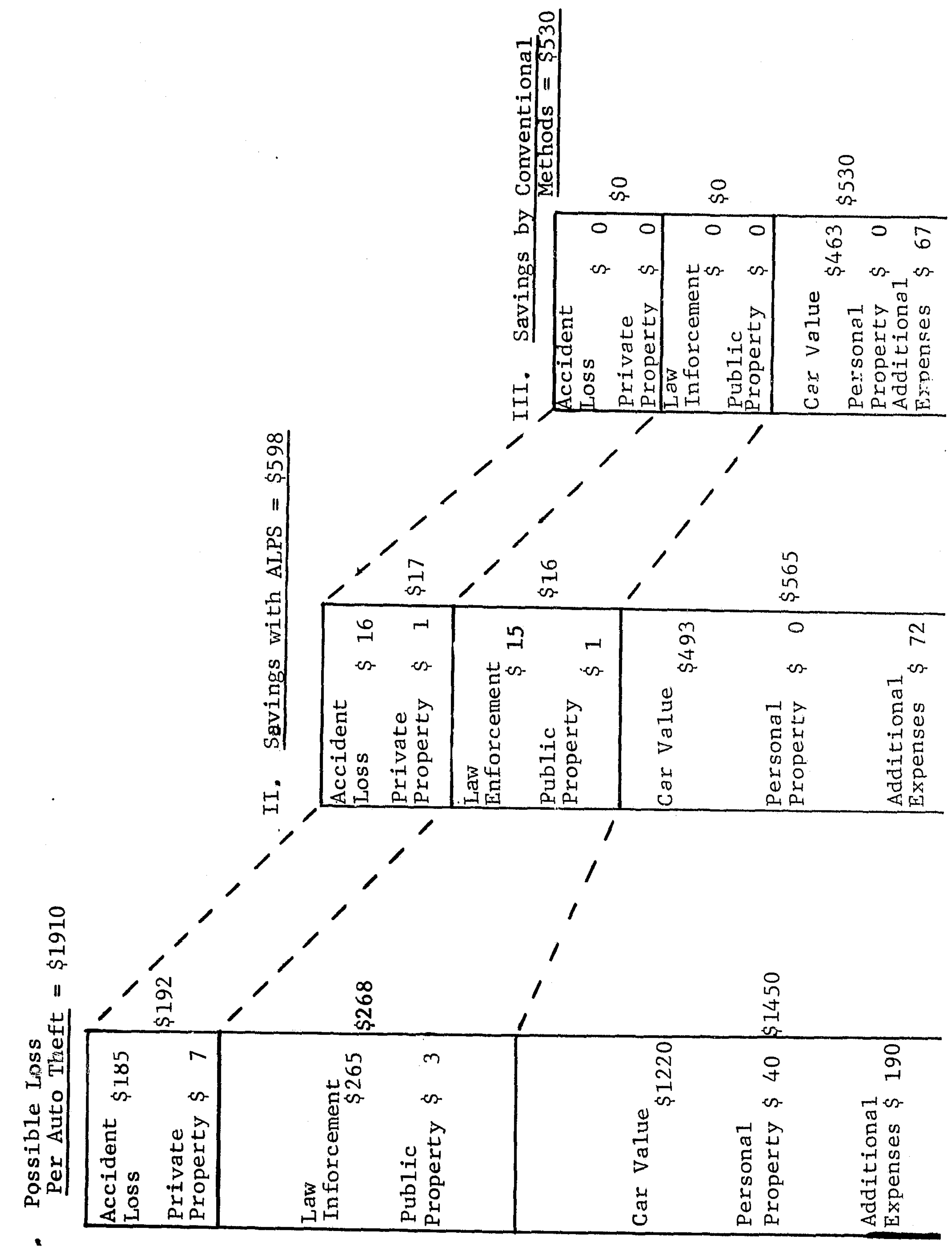

Figure C-3-1 Column I shows the possible loss which could be sustained per theft ($1910). Column II shows the savings resulting with ALPS ($598). Column III shows the savings using conventional methods ($530). The ALPS system initiates a savings of $68.00 per car.

which now equal $265 per theft. Damage to public property will represent an additional public loss of $3.

A total direct loss of $1910 will be realized if a car is stolen and never recovered. This happens 45 percent of the time in New York City and to a lesser extent in the rest of the state. Figure C-3-1 indicates that under the current method of law enforcement each theft of a $1220 vehicle actually results in an average direct loss of $1380. (This loss figure was obtained by averaging the loss for all cars stolen whether they were recovered or not.) Under simulated conditions the average direct loss with ALPS was estimated to be $1312 per theft; a difference of $68 per vehicle.

Most of the saving engendered by ALPS occurred in three areas. Thirty dollars per stolen vehicle was saved by either recovering a car early or by recovering a car that would not have been recovered using conventional procedures. Fifteen dollars was saved in law enforcement costs through the efficient operation of the ALPS system. Finally an average of sixteen dollars in accident losses was prevented because ALPS recovered many vehicles before they could be driven any great distance.

This study concluded that the aggregate monetary and non-monetary benefits gained by society from ALPS exceeded the system's estimated five-year cost of $10,500,000, and therefore the system was deemed economically feasible to deploy. On a per car basis the cost and benefit figures are as follows: ALPS will cost, depending upon the projections used, an average

of $10 to $16 for each car stolen over the next five years. This compares to the direct saving of $68 per vehicle.

The net direct benefit derived from ALPS is therefore $52 to $58 for each stolen auto.

It should be noted that Figure C-3-1 also serves to illustrate the potent value of a positive deterrent effect. Once a car is stolen, ALPS, through its operations, saves only $68 per vehicle. However, each time the presence of ALPS deters a theft, $1380, representing the average loss per theft, is saved. This phenomenon explains the extremely high benefits assigned to ALPS once a deterrent effect was assumed in the simulation model.

PART II - TECHNICAL REPORT

D. Report Findings and Considerations

D-1. Options for Police Jurisdictions

Since ALPS is readily adaptable to both large and small metropolitan areas, there are two options available. The municipalities can own and operate their own system (if they are big enough and desire to do so) or they can subscribe to a centrally operated network run by a state agency such as NYSIIS. Participation is on a voluntary basis. Distance is not likely to be a problem since the basic communications link is the telephone line. The system is independent and secure.

Cities with their own computerized wanted plate files and A.D.P. units may choose to forego the economies of scale afforded by centralization in order to gain flexibility control and a tailor-made system.

However in the long run the centralized network provides the most benefits. Specialists, programmers, operators, maintenance and supportability experts can be brought in to work on specific projects for a fraction of the original costs. The centralized system can provide a greater variety of specialized units--bridge and toll booth systems, overhead units, mobile units and side of the road installations. The commonwealth agency would also provide the financing for expensive updating. The state-managed concept is readily suited for state and local government sharing of functional responsibilities. The state can maintain the detection system while the local government is responsible for the arrest functions (about 4/5 of the cost). However the local government would not have to provide any additional expenditures since they have already capitalized their police functions.

The local systems would receive the ALPS service either as a direct subsidy or pay for or share the cost of the services as it is used. In the former case the ALPS would probably be allocated in accordance to the ratio of requirements to benefits. However, in the latter example all services would be supplied in demand. A fourth consideration is to manage the system as a self-supporting operation. The local governments could reimburse that state for services provided out of the direct benefits received.

The local installations will contain options best suited for the needs of the given police jurisdiction. For example, the large metropolis hard pressed by an alarming number of unreturned vehicles may wish to concentrate on the apprehension of the professional auto thief. However some of the smaller cities plagued by joy riders (the major cause of auto related crime deaths and the major training experience for delinquents and career criminals) may wish to deploy for the deterrence of this crime. Other municipalities both small and large may simply want to expand their police functions and use the system for all criminal activities, scofflaws, uninsured vehicles, traffic citations, emergency notification, organized crime surveillance and warrant serving.

D-2. Systems Development and Growth Plan

The initial deployment of ten ALPS installations in New York City is suggested as the minimum necessary to have a significant deterrent effect on the state's auto theft growth rates. As the system is tested and proven it will become desirable and even necessary to expand both the number of installations as well as their functions. Buffalo and the N. Y. State Police might do well with one experimental system each. Also it appears very likely that the Rochester and the Albany-Schenectady-Troy SMSA's could share one experimental unit during the initial deployment phases.

A system of mass scanning appears to be economically and socially feasible only when a relatively large number of vehicles can qualify as "wanted" and where the traffic patterns are such that a measurable percentage of these vehicles can be expected to pass by an installation. The initial number of ALPS installations and the geographic locations were based primarily upon the need to scan for stolen cars and warrants. The New York SMSA is considered to be the most appropriate location for the first test deployment because this is where most of the state's auto related crimes occur and this is where the majority of the wanted plates are. If the New York SMSA demonstration is successful then the system will be expanded to encompass the other areas mentioned above.

It would be premature at this stage to attempt to lay down guidelines for future implementation and growth. Experience with the initial system on a real time basis will provide the basic information relating to the detailed cost and deterrent effectiveness of the system and its prospects for further applications in law enforcement.

One basic attribute of ALPS is that it is already essentially in modular form. Additions to the system and changes in function can be easily accommodated without the loss of performance in the field and without the incursion of high changeover expenditures.

Section D-3, which follows, suggests some other applications of ALPS which may provide some new and fruitful paths along which the system may expand and mature.

D-3. Other Applications

Aside from its use as a law enforcement system, ALPS also may have a wide spread governmental and commercial use.

Figure D-3-1 describes some of the possible applications of ALPS to the Federal, State and Local government agencies. Departments such as the Bureau of Motor Carrier Safety, Bureau of Public Roads, National Highway Safety Bureau, Urban Transportation Administration, Port Authority, Department of Motor Vehicles and Municipal Parking Systems have tasks which are applicable to a mass scanning system.

The scanner could provide the various agencies with information on owner identification and vehicle classification, traffic density and traffic flow patterns, road use statistics and on-line data on traffic flow conditions; i.e., platooning, queuing, headway time, etc. The port authority could increase traffic flow through their tolls by several orders of magnitude and almost eliminate the cost of fare collections by having automatic billing lanes for New York vehicle owners.

The optical system as presented in the initial phase with only a few modifications can easily be adapted to tasks requiring the monitoring of rolling stock, planes, boats and cars.

FUNCTIONS

AGENCIES	Vehicle Regulations	Vehicle Detection	Highway Planning	Area Surveys	Traffic Density and Patterns	Vehicle Safety	Road Usage Statistics	Traffic Flow	Owner Identification	University Parking	Municipal Parking	Commercial Parking	Credit Checks	Automatic Billing
Bureau of Motor Carrier Safety	X	X	X		X	X	X		X					
Bureau of Public Roads	X	X	X	X	X		X	X	X					
National Highway Safety	X	X	X	X	X	X	X		X					
Urban Transportation Administration		X	X	X	X		X	X	X					
State Agencies	X	X	X	X	X		X	X	X	X	X		X	
Commercial Agencies	X	X		X			X	X	X	X		X	X	X
Port Authority Bridges and Tunnels	X	X							X				X	X

FIGURE D-3-1

FUNCTIONAL APPLICATIONS WITH OTHER AGENCIES

SUMMARY OF AUTOMATIC LICENSE PLATE SCANNER (ALPS) DESIGN

Prepared By: Bendix Research Laboratories
Southfield, Michigan
April 15, 1970

The objective of the ALPS project is to develop a system for automatically detecting automobiles bearing license plates which are "wanted" by law enforcement agencies. For this purpose, scanners are located at appropriate roadside positions so that they are able to view the license plates of all passing vehicles. The output of the scanners is fed to a data processor which automatically reads the license plate characters from the scanned data. The character data is then transmitted via telephone lines to a central computer where a wanted plate file is searched. If the license plate number matches a number in the file, an appropriate message is transmitted to an output station informing a law enforcement officer to apprehend the wanted vehicle. To ensure that the system is efficient, the elapsed time from the moment of scanning to initiation of the response at the output station does not exceed two seconds.

The basic components of the ALPS system are the scanner, the data processor, the communications system, and the central processor. The scanner is used to convert the optical scene into electrical signals which can be used by the recognition subsystem to read and recognize the characters from a license plate. Each scanner consists of a vidicon-type image converter tube, a shutter, and suitable electronics as required for the operation of the device. In operation, the shutter is operated so that the vidicon tube is exposed and erased once every 50 milliseconds. However, if the passage of an automobile is detected by a photocell, the next image which is exposed onto the vidicon tube is processed by the system.

An alternate but more expensive sensor, the silicon vidicon, is a recent development which allows operation in total darkness as well as in broad daylight using a single sensor. Because of its high sensitivity and ability to operate in the near infrared part of the spectrum, the silicon vidicon can be used in total darkness with an array of gallium arsenide emitters providing the necessary "illumination". Despite this high sensitivity, it can also operate in broad daylight and it can withstand direct exposure to sunlight. The difference between the standard vidicon and the silicon vidicon rests solely with how the gain of the system compensates for different illumination levels. Thus, even if a standard vidicon is used initially, the system can easily be modified to convert to the silicon vidicon tube. At this time, it is recommended that the initial prototype systems use the standard vidicon, with possible conversion to the silicon vidicon in later systems.

The data processor consists of a minicomputer which is programmed to execute the required character recognition algorithms for a multiple scanner system on a time-shared basis. Economic considerations indicate that the same type of computer be used for all installations. Therefore, the Supernova computer manufactured by the Data General Corporation is recommended only if the majority of installations consist of eight or more scanners. Otherwise, the Micro 800 manufactured by Micro Systems, Inc. should be chosen. The production price of either system using the standard vidicon is estimated at less than $10,000 per scanner. This price includes the scanner cost and a share of the minicomputer cost.

The communications system consists of standard telephone lines and modems which allow transmission of the license plate number to the central computer and return transmission to the output stations. The cost of the communications equipment and the output device are not included in the above price estimate.

The central processor is an existing computer which is used to store the wanted plate file and to carry out the search for wanted license plate numbers.

In summary, the ALPS system recommended by Bendix Research Laboratories consists of four parts:

(1) A scanner which uses a vidicon or silicon vidicon tube to convert the optical scene into electrical signals.

(2) A data processor consisting of a Micro 800 minicomputer for processing the output of the scanner. The character recognition algorithms implemented by the data processor read the license plate number from the plate data.

(3) A communications system for transmitting license plate numbers over telephone lines to a central computer and transmitting messages from the central computer to the output stations.

(4) A central computer for storing wanted license plate numbers and performing the search to determine if a number transmitted to it is contained in the wanted file.

The output station is not considered part of the ALPS system since any output terminal can be tied into the communications system. For example, a message system for in-car use can easily be tied into the system. In this case, the law enforcement officer is not tied down to a fixed output station but is completely mobile.

ATTACHMENT A

TECHNICAL DISCUSSION

AUTOMATIC LICENSE PLATE SCANNER - DESIGN REVISION STUDY

1. INTRODUCTION AND SUMMARY

This discussion summarizes the results of a study which was conducted by the Bendix Research Laboratories for the New York State Identification and Intelligence System (NYSIIS) under NYSIIS Contract No. 41706. The study was conducted during March, 1970. Its purpose was to review and update the design of the ALPS system originally presented in BRL Report No. 4128, dated July, 1967, based upon recent developments in the minicomputer field.

The results of the study have led to the conclusion that a minicomputer approach for the ALPS data processor is both technically and economically feasible. These results are presented in Section 2. Section 3 presents specific recommendations for the proposed Phase II prototype system.

2. SYSTEM DESCRIPTION

The ALPS system is composed of one or more vidicon scanners and a data processor, as described in Report No. 4128. The descriptions given in this report assume that the reader is familiar with that report. Therefore, only brief summary-type descriptions are presented except where new concepts are involved.

The major emphasis of this report is on the data processor. An investigation was performed to determine the technical and economic feasibility of using a minicomputer as a substitute for the originally proposed hard-wired logic data processor. Presentation of the results of this study constitutes the bulk of what follows.

2.1 Scanner

The scanner is used to convert the optical scene into electrical signals which can be used by the recognition subsystem to read and recognize the characters from a license plate. Each scanner consists of a vidicon-type image converter tube, a shutter, and suitable electronics as required for the operation of the device. As described in detail in Report No. 4128, the vidicon tube is exposed and erased once every 50 milliseconds. However, if an automobile is detected by a photocell, the next image which is exposed onto the vidicon is processed by the system. Use of the minicomputer may require a delay between the time of exposure of an image and the time when it is scanned out, as described in Section 2.3. However, this does not require a significant scanner modification.

Since the earlier report, a new type of tube, the silicon vidicon, has been developed. The silicon vidicon appears to have major advantages over the standard vidicon, as described in Appendix A. However, at this time, insufficient evidence exists to evaluate this device for the ALPS system. It appears that the tube can be incorporated into the system with little modification. Therefore, it will be evaluated when adequate information is available. If it should appear advantageous to use in the ALPS system, a suitable recommendation will be made at that time.

2.2 General Description of Data Processor

The original data processor design, as described in Report No. 4128, incorporates a hard-wired digital module to perform the following tasks:

(1) Detect location of license plate during scan of vidicon camera.
(2) Read plate data into memory for storage.
(3) Validate that the plate is from New York State.
(4) Separate the plate data into characters and use character recognition algorithms to determine the license plate number.

During the current study, two additional system configurations were studied. In one, a minicomputer is used to implement the character recognition algorithms while the detection and validation of the license plate is accomplished by hard-wired logic. In the other system, only the plate detection algorithms are implemented by hard-wired logic; the plate validation and character recognition are implemented in a minicomputer. In both of these systems, the minicomputer memory is used to store the plate data so that no external memory is required. For easy reference, the three systems will be assigned letter designations, as follows:

System A - Original system concept.
System B - Minicomputer system - plate detection and validation are both hard-wired, character recognition is accomplished by the computer.
System C - Minicomputer system - only the plate detection is hard-wired, both validation and character recognition are accomplished by the computer.

To select a minicomputer for Systems B and C, several system constraints were considered. Timing considerations for the scanner-computer interface are established in the next section. In addition to evaluating whether a particular computer can be used, these considerations also yield information on time-sharing of multiple scanners by a single computer. In Section 2.4, the plate detection and validation algorithms are examined to determine how they must be altered for implementation in System C. Comparison of the original and modified algorithms is also presented in Section 2.4. In Section 2.5, the character recognition algorithms are studied from the viewpoint of real-time implementation on a computer. This further narrows down the computer selection process and determines the ability of the system to time-share the recognition process. Finally, in Section 2.6, several computers which were considered and which meet the selection criteria are presented and compared, thus completing the selection process. Also included, in Sections 2.7 and 2.8, are complete comparisons of the three systems both as to operational characteristics and estimated production prices.

2.3 Timing and Interface Considerations

Figure 1, showing the idealized viewing and memory areas of the scan, is reproduced from Figure 4-1 of Report 4128 to aid in establishing the timing requirements for the vidicon-to-computer interface. Since each horizontal scan is completed in about 80 microseconds, the maximum bit rate from the vidicon is

$$\frac{400}{80} \times 10^6 = \underline{5 \times 10^6} \text{ bits per second}$$

This high transfer rate to the computer only occurs for about 21 microseconds of each of the 30 lines when the plate is being scanned. Thus, for a byte-oriented computer,* the byte transfer rate during this interval is

$$\frac{5 \times 10^6}{8} = \underline{625{,}000} \text{ bytes per second}$$

For a 1 microsecond byte-oriented memory, therefore, it is not possible to read more than one plate into the computer at a time without extensive and costly buffering. However, several schemes have been devised for multiplexing more than one scanner onto a single computer without additional buffering.

The total scan time for the complete viewing area is 20 milliseconds and the shutter exposes the vidicon for 1.4 milliseconds every 50 milliseconds. Thus, two complete scans can be executed every 50 milliseconds. If, in a two-vidicon system, vidicon Y is exposed while vidicon X is being read out, then the readout of vidicon Y can be delayed until the readout of vidicon X is completed. This allows two scanners to be connected to the input channels of a byte-oriented computer whose memory cycle time is about 1 microsecond. If the computer is modified so that the two halves of the memory behave independently, then a direct input channel can be connected to each half of the memory. This modification, in turn, allows two scanners to be connected to each channel so that up to four scanners can be serviced by a single byte-oriented computer. For a 16-bit word-oriented computer whose cycle time is 800 nanoseconds, up to eight vidicons can be multiplexed if four direct input channels are provided. Each pair of scanners is then treated as described above with at most four of the vidicons being read out in any time interval.

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*One byte is equivalent to eight bits.

Figure 2 is a flow chart showing the action taken by the computer of a two scanner processor on receiving an interrupt from one of the automobile detection photocells. The computer decides which scanner is to be serviced and initiates the necessary block transfer. Postponement of additional interrupts is assured by temporarily inhibiting their action as shown in the flow chart. The flow chart in Figure 3 shows the sequence of events which takes place when the transfer-complete interrupt is received. The plate data is tested for validity and a flag is set to binary ONE if the data is found to be valid. The interrupt which was inhibited is then enabled to allow the other scanner to be read out when required. Finally, Figure 4 is a flow chart of the plate processing sequence. In the absence of any interrupts and when data is not being processed, the two flags are continuously checked and this constitutes a wait loop. When one of the flags becomes a ONE, having been set by the interrupt subroutine of Figure 3, then the computer leaves the wait loop and proceeds to process the received data.

The real-time requirements of the plate detection and validation algorithms and the character recognition algorithms are considered in the next section.

2.4 Plate Detection and Validation Algorithms

The plate detection and validation algorithms which were described in Section 4 of Report 4128 were re-examined to determine if the sequence of plate detection and validation tests could be performed in a minicomputer. It was found that the real-time tests, 1, 2, 3, and 4, could not be performed rapidly enough in the minicomputer. It takes only 80 microseconds to read one scan line from the vidicon tube. The time required to store one scan line of data in a byte-oriented minicomputer is approximately 50 microseconds, which does not leave enough time to perform the real-time tests in the computer. Thus, for System B, the plate detection and validation tests are performed outside the computer.

An alternate approach was considered for System C, in which the plate detection tests are performed by simplified hard-wired logic operating in conjunction with the computer. This approach works on the premise that, if the license plate characters and numerals can be identified, the plate is a New York plate. The identified characters are then sent to the master computer for the wanted plate search. It is recognized that some plates from other than New York State may occasionally be recognized; however, it is very improbable that such plates will be on the New York wanted plate list. Figure 5 is a functional block diagram showing the relationship between the hard-wired tests and the computer. In operation, the logic

looks for a high density of ONE-ZERO changes in the scanner signal. When a high density of ONE-ZERO transitions is observed, the computer is interrupted and the contents of the horizontal position counter is transferred to the computer. This data is compared to the counter contents when the next set of high density changes is encountered, to determine if the two sets of changes occur at approximately the same horizontal position. If this test is satisfied for two or three consecutive scans, which is equivalent to test 5, then it is tentatively decided that the license plate has been detected in the field of view. In this system, tests 2, 3, and 4 are not used, and thus it proceeds to test 6. Test 6 examines the plate for a blank area above the words "New York" and below the identification characters of the license plate. If this test is satisfied, the quantized signal from the scanner corresponding to the area where the license plate identification numbers are located is entered and stored in the computer, as shown in Figure 6.

A larger storage area is required for System C than for either System A or B. More storage is required because the edges of the license plate are not as well defined by the logic of System C. It is estimated that an area 15 inches long by 4 inches high would be stored as shown in Figure 6.

2.5 Character Recognition Algorithms

The actual recognition of the license plate characters does not have to be performed during the real-time scan, and so it can easily be implemented in a minicomputer. The technique, however, must be carefully programmed to ensure that all processing for one scanner is completed within one-half second for a two-scanner system. If more than two scanners are connected to a single computer, then the total character recognition time for each plate must be reduced proportionately. The proposed character recognition algorithm was examined to see how it could best be programmed for a minicomputer. It turns out that the procedure which was developed for System A can be used with a minicomputer with almost no modification. A flow chart of the program used for recognizing the license plate characters is shown in Figure 7. To expedite the bit handling requirements imposed on the computer, all of the columns of the memory area are summed concurrently and the sums stored for later processing. At the same time, the columns are examined for the occurrence of two or more consecutive bits in a column. Whenever this condition is found, a flag is set in a flag matrix. By summing the columns first, the number of memory-to-register operations required is reduced and the overall processing time is decreased.

By using the minicomputer for character recognition, constants and thresholds can easily be modified to optimize system performance. This provides a great advantage over the hard-wired implementation and allows the check-out and final adjustment of the prototype system to be performed in the field. In addition, the same programs are useable for multiple scanner systems and so the problem of connecting a variable number of scanners to a single computer is greatly simplified.

2.6 Minicomputer Selection

Based on the requirements for the character recognition algorithms, as presented above, running time estimates were made for several minicomputers. It was found that only computers which had a microprogramming capability or some reasonably equivalent capability could be used. Thus, the number of computers which were examined was narrowed down considerably. Of the byte-oriented computers, the Micro 800, manufactured by Micro Systems, Inc., was found to be a good choice both because of its low cost and its relatively high power. Another possible candidate is the Digital Equipment Corporation PDP-8/L, a 12-bit machine which is slightly more expensive than the Micro 800. Because it possesses no additional computing power and has less flexibility than the Micro, it was not selected as the prime choice. If more than four scanners are attached to a single computer, a 16-bit machine is required. The Supernova, manufactured by Data General Corporation, is representative of a modern 16-bit minicomputer both in cost and performance.

To obtain reasonable cost estimates, both the Micro 800 and Supernova were examined in detail. The results of the performance evaluation of the three systems is presented in the next section while estimated production prices are presented in Section 2.8.

2.7 Operational Comparison of Proposed Systems

All three systems perform the plate detection and character recognition functions required of the ALPS system. Because System B merely replaces some hard-wired logic with a minicomputer, the performance of Systems A and B are identical. The major advantage of System B over System A is the ability to easily make changes in the character recognition algorithms should such a need arise. System C, however, uses a simplified plate detection algorithm and as a result, it is possible that some plates which are not from New York State will be detected. The ability to make changes easily also applies to this latter system.

2.8 Production Comparison of Proposed Systems

Two types of production price estimates were made:

(1) Comparative production prices of Systems A, B, and C, and
(2) Per unit production price of System C with different levels of multiplexing.

In both cases, it was assumed that 50 systems were to be manufactured in order to attain reasonable quantity discounts on component and production costs.

Table 1* compares the prices for a two-scanner system using each of the three proposed schemes. It was assumed that a computer of the complexity of the Micro 800 is used in Systems B and C. The first price covers the data processor and the cabinet. The scanner price is fixed at $5700 per station throughout, and is added in separately.

Table 2 shows the per-scanner price of System C as a function of the number of scanners which are multiplexed into a single computer. Two computers were used for this comparison: the Micro 800 and the Supernova. It was assumed that a single Micro 800 could handle two scanners without modification or four scanners with the modification described in Section 2.3. For 6 or 8 scanners, two Micro computers would be used. The Supernova requires no modifications, and a single machine could be configured to handle up to 8 scanners. As before, the per-scanner price of $5700 is added in separately in the table. Figure 8 shows the data of Table 2 plotted as a graph for easy comparison.

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*The total prices shown in Tables 1 and 2 include the complete scanner subsystem and the data processor, suitably packaged for outdoor use. Data link and communication equipment are not included.

3. PROTOTYPE SYSTEM -- CONCLUSIONS AND RECOMMENDATIONS

As a result of this study, it is recommended by Bendix Research Laboratories that System C, incorporating a minicomputer, be used for the prototype system. This approach has the advantage of lower per unit cost and higher flexibility. It is further recommended that the same computer be used for all installations regardless of the number of multiplexed scanners. Therefore, the Supernova computer is a reasonable choice only if the majority of installations consist of eight or more multiplexed scanners. Otherwise, the Micro 800 should be chosen for the ALPS system. To repeat, a major advantage of the System C prototype is the ease with which design modifications can be made during testing and evaluation. It is much easier to make extensive changes in the computer software than to make even a simple change in the hard-wired logic.

APPENDIX A

SILICON VIDICON

The silicon vidicon is a recent development which allows operation in total darkness as well as broad daylight using a single sensor. Because of its high sensitivity and ability to operate in the near infrared part of the spectrum, the silicon vidicon can be used in total darkness with an array of gallium arsenide emitters providing the necessary "illumination." An array of six 200 milliwatt GaAs diodes consumes about 9 watts of power and provides sufficient infrared illumination to operate the silicon vidicon at a distance of 50 feet at f/2. This compares favorably with the 1000 watts of incandescent illumination required for the vidicon system. Moreover, the silicon vidicon can also operate in broad daylight and it is virtually impossible to destroy the tube by direct exposure to sunlight. Finally, the tube does not bloom if exposed to high intensity points of light such as glare reflected from an automobile bumper. The tube is compatible with standard vidicons in both size and electrical connections. The tubes differ in that the AGC must be applied to the video amplifier for the silicon vidicon rather than to the tube itself.

Commercially, the silicon vidicon tube is available from Texas Instruments under the trade name "Tivicon." It is made in several versions and some experimentation would be needed to determine which device would be best suited to the requirements of the ALPS system. TI also manufactures arrays of GaAs emitters for use with the Tivicon.

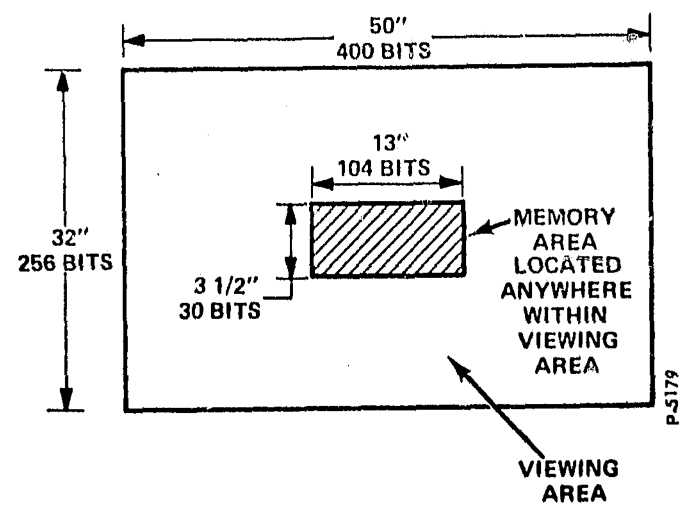

Figure 1. Idealized viewing and memory area.

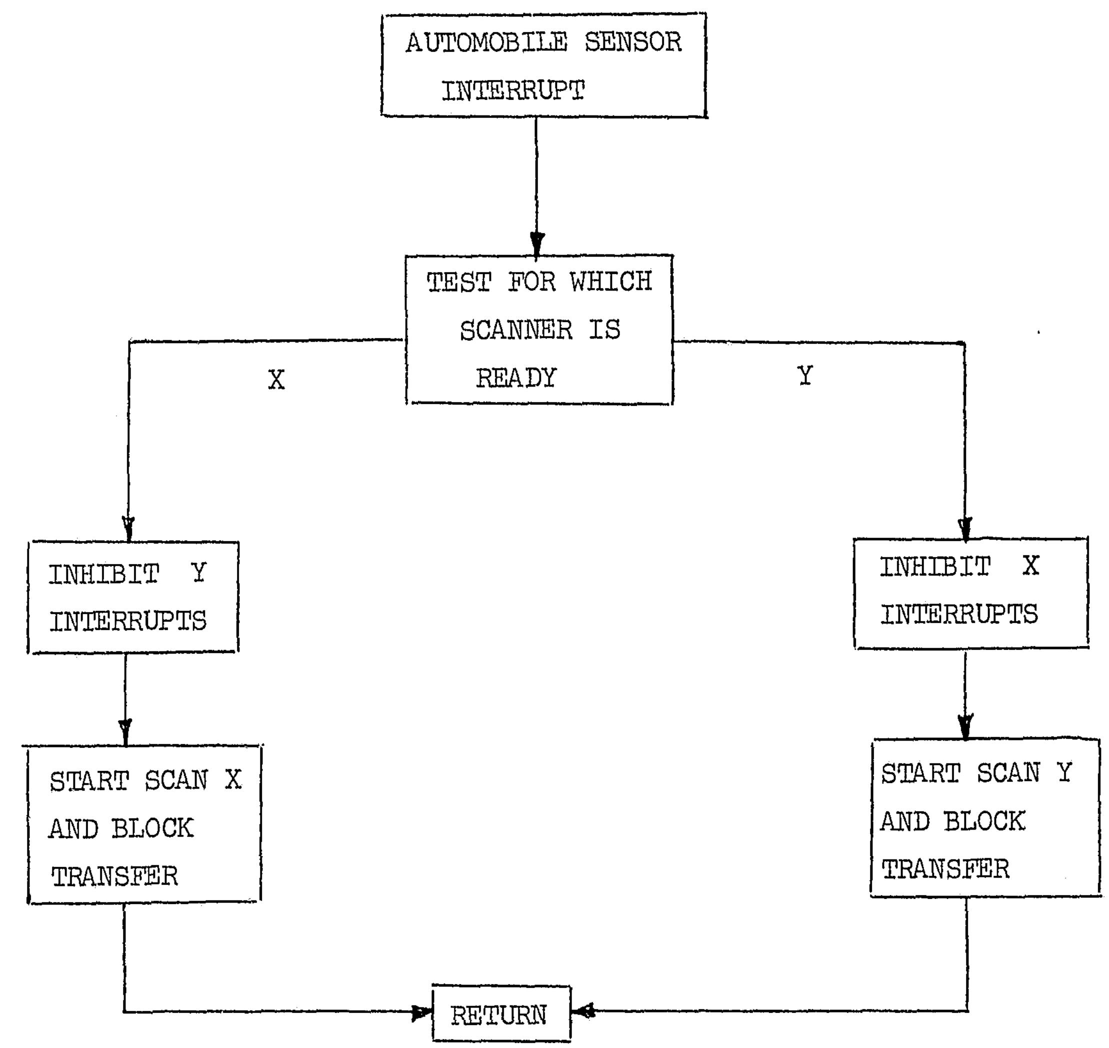

Figure 2. Flow chart for automobile sensor interrupt subroutine.

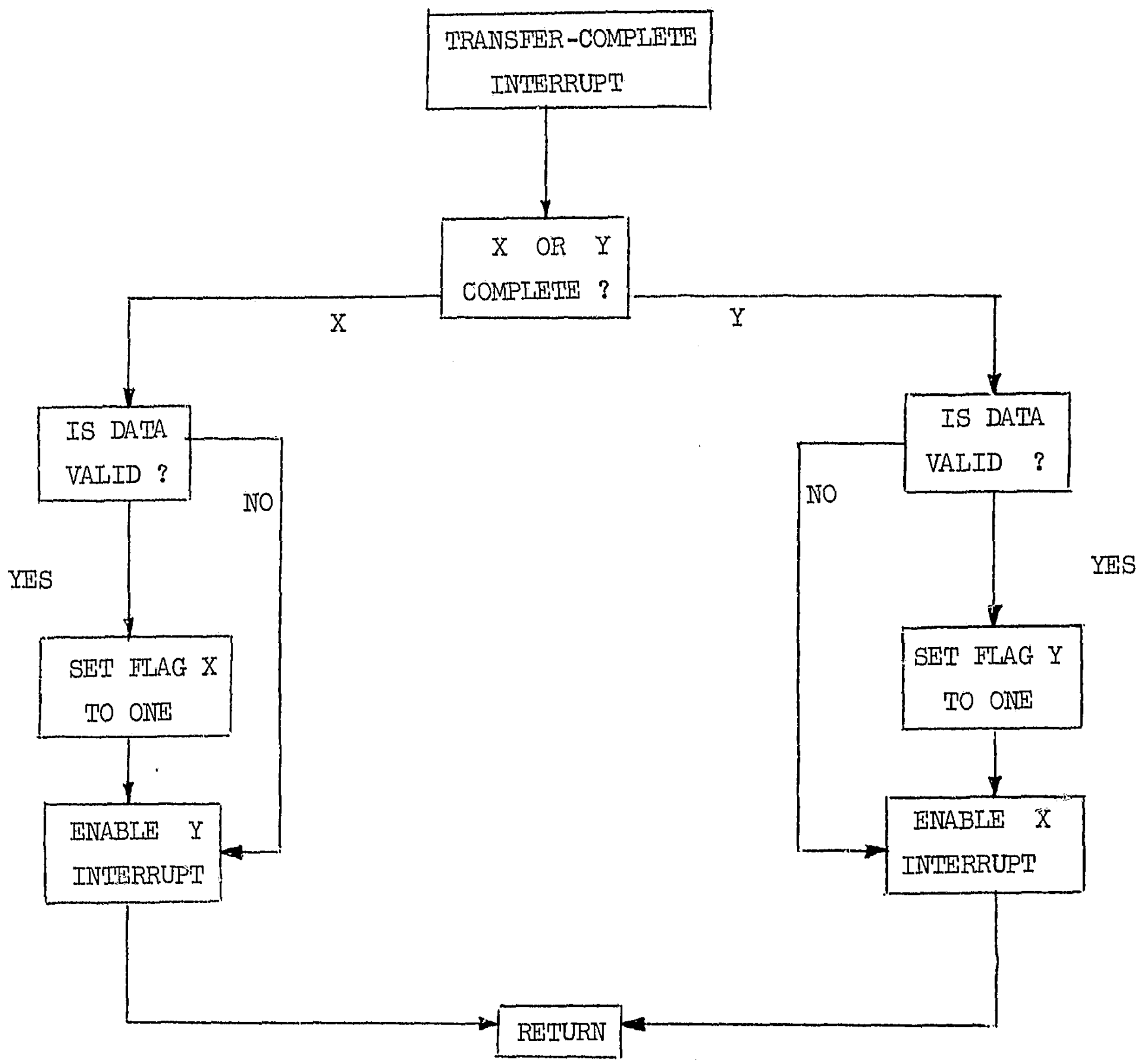

Figure 3. Flowchart for transfer-complete interrupt subroutine.

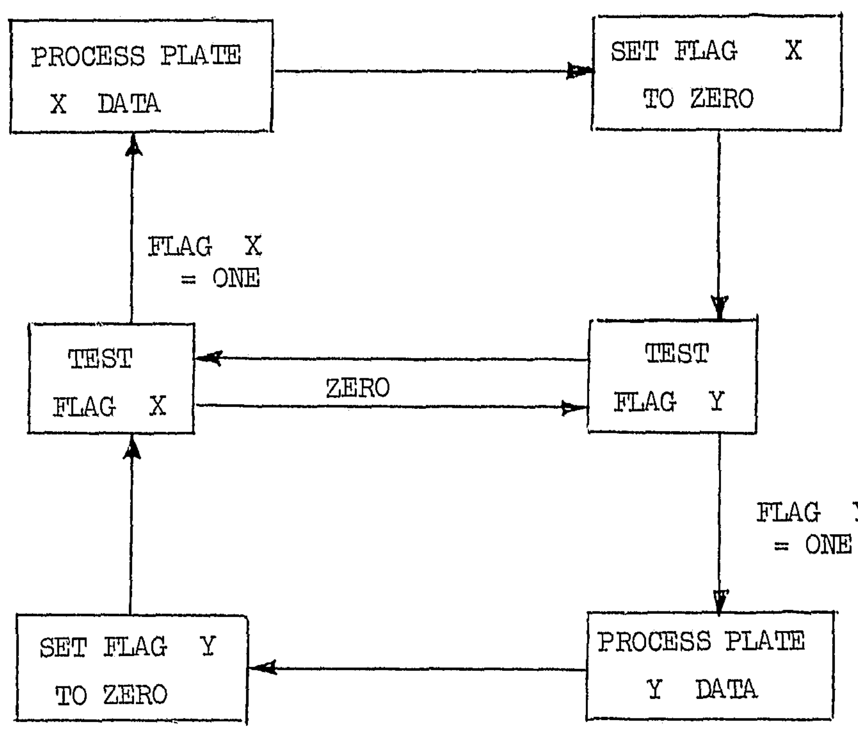

Figure 4. Flowchart showing relation between plate processing and wait loop routines.

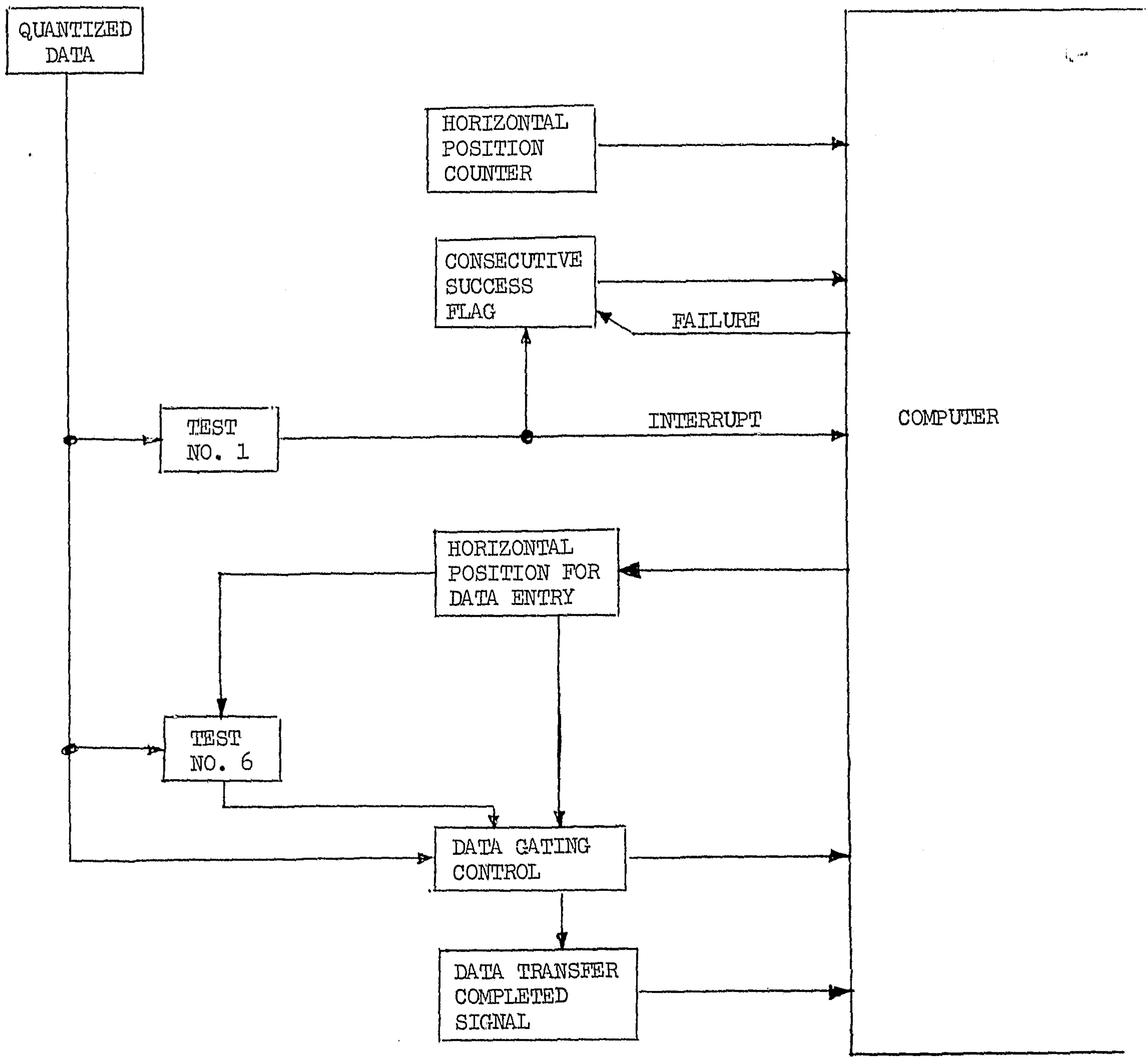

Figure 5. Functional relationship between hard-wired tests and computer.

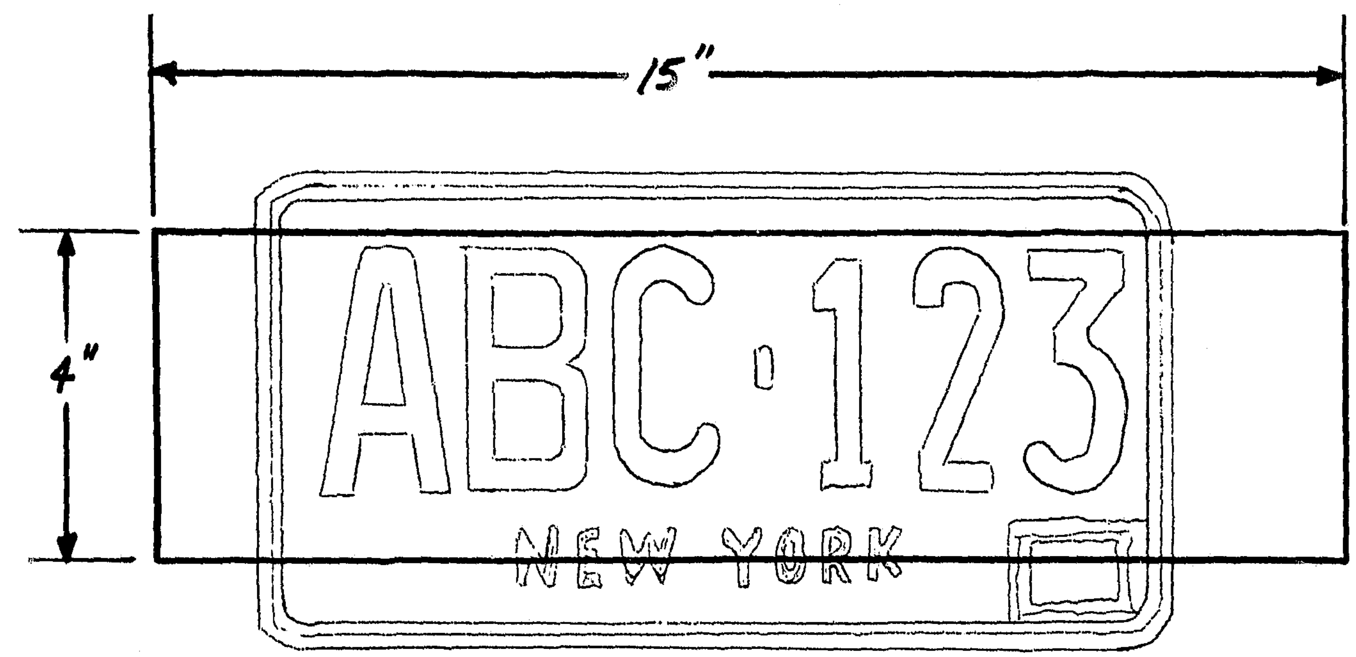

Figure 6. Memory entry area shown relative to a typical license plate.

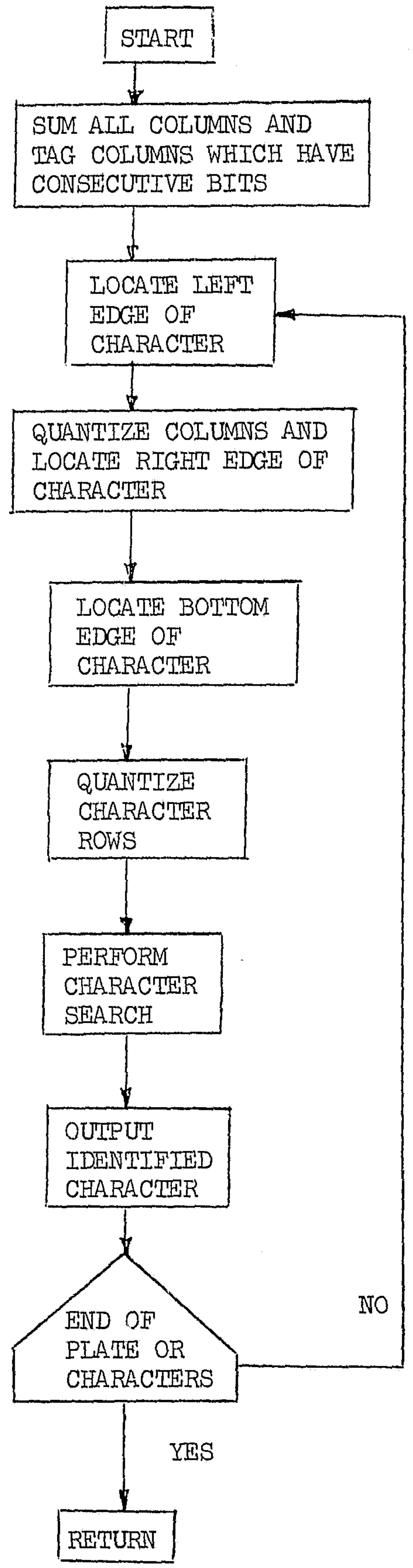

Figure 7. Flow chart for character recognition program.

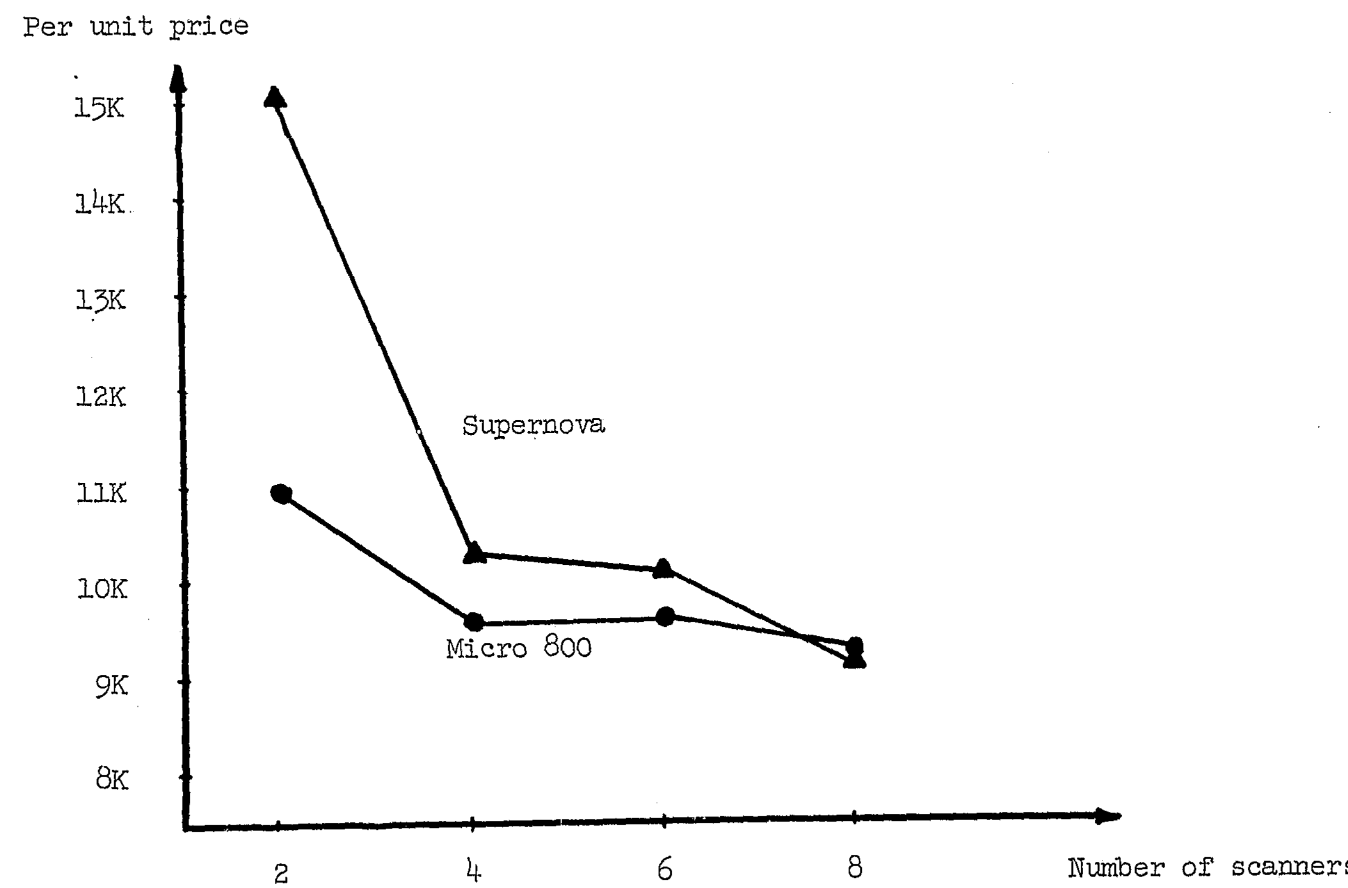

Figure 8. Graphical representation of data presented in Table 2.

	SYSTEM		
	A	B	C
Price of Data Processor	18 000	13 400	10 600
Per unit price of Data Processor	9 000	6 700	5 300
Scanner price	5 700	5 700	5 700
Total per unit price	14 700	12 400	11 000

Table 1. Per unit price comparison for a two-scanner system.

	Micro 800				Supernova			
	2	4	6	8	2	4	6	8
Price of Data Processor	10 600	15 660	24 140	29 160	19 000	20 560	27 070	28 640
Per unit price of Data Proc.	5 300	3 915	4 024	3 645	9 500	5 140	4 512	3 580
Scanner price	5 700	5 700	5 700	5 700	5 700	5 700	5 700	5 700
Total per unit prices	11 000	9 615	9 724	9 345	15 200	10 840	10 212	9 280

Table 2. Per unit price comparison of System C as a function of the number of scanners which are multiplexed onto the system. Both the Micro 800 and the Supernova are shown for additional comparison.

END