THE CRIMINAL CAREERS OF PLACES: A LONGITUDINAL STUDY

EXECUTIVE SUMMARY

David Weisburd, Ph.D.
Principal Investigator
University of Maryland, College Park &
The Hebrew University, Jerusalem

Cynthia Lum, Ph.D.
Project Director
Northeastern University, Boston

Sue-Ming Yang, M.A.
Research Assistant
University of Maryland, College Park

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Recent studies of the concentration of crime at crime "hot spots" point to the potential theoretical and practical benefits of focusing research on micro crime places (Eck and Weisburd, 1995; Sherman, 1995; Taylor, 1997; Weisburd, 2002). The first use of this term in the case of crime places was brought by Sherman et al. (1989), though the basic idea that crime events were clustered in specific places was documented in earlier studies (e.g., see Abeyie and Harries, 1980; Crow and Bull, 1975; Pierce et al., 1986) and suggested by work in the area of environmental criminology (Brantingham and Brantingham, 1975, 1981). Sherman et al. (1989) found that only three percent of the addresses in Minneapolis produced fifty percent of all calls to the police. His proposal that crime was concentrated in hot spots in urban areas has now been confirmed in a series of studies conducted in different cities using different definitions of hot spot areas (e.g., see Brantingham and Brantingham, 1999; Eck et al., 2000; Roncek, 2000; Spelman, 1995; Weisburd et al., 1992; Weisburd and Green, 1994, 2000). In turn, there is now strong empirical evidence supporting hot spots policing tactics that draw upon the notion that crime is concentrated at specific places in urban areas (Sherman and Weisburd, 1995; Weisburd and Braga, 2003; Weisburd and Eck, 2004).

Despite these basic and applied research findings on the concentration of crime in urban areas and its utility for crime prevention applications, there continues to be substantial gaps in our knowledge about patterns of crime at places. In particular, in contrast to the wide array of studies concerning the development of crime within individuals and communities, we have so far developed little basic knowledge about the development of crime at place. For example, there

have been only a handful of longitudinal studies of crime places, and these have generally examined change over a few years or across specific crime categories (e.g. see Block and Block, 1980, 1985; Spelman, 1995; Taylor, 1999). Moreover, scholars who have examined change in crime patterns at places over time have not systematically examined the link between these changes and the changes in the social structure of places.

These issues in our view are not just important for academic inquiry into the problem of crime at place, they also have strong policy relevance. The empirical findings of concentration for example established in earlier works do not necessarily provide a solid empirical basis for either refocusing crime prevention resources or calling for significant theorizing about why crime is concentrated at places. For example, if "hot spots" of crime shift rapidly from place to place it makes little sense to focus crime control resources at such locations, since they would naturally become free of crime without any criminal justice intervention (see Spelman, 1995). These hot spots would simply be subject to a type of statistical "regression to the mean" which may or may not be predictable by criminologists. Similarly, if crime concentrations can move rapidly across the city landscape, it may not make much sense to focus our understanding of crime events on the characteristics of places. In this study we use official crime data to examine the distribution of crime at street segments in Seattle, Washington, over a 14 year period to better understand how crime develops over time at micro places.

SITE SELECTION

For the purposes of identifying longitudinal changes of crime at place, we conducted a national search to identify a police agency that had computerized crime data available over a long period of time and data that could be reliably linked to spatial coordinates. We also sought

to identify a study site that would have a large enough geographic area, high enough rate of crime, and large enough population to allow for a robust examination of criminal careers at places. Utilizing the 1987 and 1997 Law Enforcement Management and Administrative Statistics (LEMAS) survey (Bureau of Justice Statistics, 1987, 1997), we selected only those departments in jurisdictions with a population over 200,000 that also reported some form of computerized record keeping and crime analysis functions. After further eliminating jurisdictions that could not qualify for our study, forty-nine police departments remained as possible candidates.

Each of the 49 police departments were individually called and the researchers spoke with members from the crime analysis units and records divisions about the age of their data. The 49 departments were ranked in terms of the year in which those interviewed claimed that computerized data was available. After further reducing our choices to eight departments who had claimed to have computerized crime incident report data at least available since 1980, we contacted each department and probed more thoroughly as to access to their data and the quality and reliability of the information. We excluded six more departments because of potential data unreliability and lack of cooperation, we were left only with Seattle and San Jose as potential study sites. San Jose was eliminated as its crime rate was unusually low as compared with other police departments in cities with similar populations.

THE DATA AND UNIT OF ANALYSIS

Prior to pursuing this grant, we confirmed with the Seattle Police Department Records Unit that they indeed had computerized databases of crime incidents at least from 1980 onwards. However, we were later informed after the start of the grant that although crime information had

been computerized from 1980, the police department had converted records from 1989 from an RMS data frame, or tape system, to a computerized database (ORACLE). Despite the fact that data before 1989 could not be interpreted for our study, the data available to us still provided the most extensive information regarding micro crime places over time presently available.

We used computerized records of written reports or "incident reports" to examine crime trends at street segments. The street segment in this research is specifically defined as the two block faces on both sides of a street between two intersections. We chose the street segment as our unit of analysis for a number of reasons. Scholars have long recognized the relevance of street segments (sometimes referred to as street blocks) in organizing life in the city (Appleyard, 1981; Jacobs, 1961; Taylor, 1997; Smith et al., 2000). The choice of street segments as a base unit of analysis as contrasted with a smaller unit such as addresses (see Sherman et al., 1989) also minimizes the error that is likely to develop from miscoding of addresses in official data. Prior studies using official crime data in other cities suggest that street level crime is often difficult to define at the address level, and is often reported by police and citizens with a significant degree of error (see Klinger and Bridges, 1997; Weisburd and Green, 1994).

To analyze the development of crime at segments specifically, we also decided at the outset to exclude from our analysis those incidents that occurred at an intersection or which could not be linked to a specific street segment. Of the 2,028,917 crime records initially obtained from the City of Seattle from 1989 to 2002, 19% were linked to an intersection in Seattle and 2% to places without a specific geographic identifier (i.e., the "University of

Washington" or "Hay Street Market"). Our "hit rate" for geocoding addresses was 97.5%, leaving 1,490,725 records that could be matched to a legitimate address and used for this study.[1]

DEVELOPING INITIAL PARAMETERS FOR THE CRIMINAL CAREERS OF PLACES

While our main interest is in describing the development of crime at places over time, it is important at the outset to describe the basic parameters of our data base. Table 1 provides a summary of the overall distribution of the geocodable 1,490,725 incident reports from Seattle in our fourteen observation years. As can be seen from Table 1, there is a good mix of different categories of events in the data.

Table 1. Overall Distribution of Incident Reports

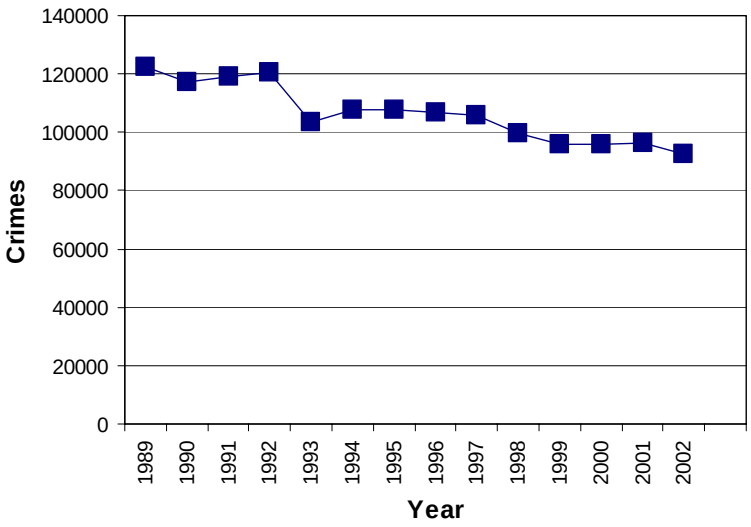
Type of Incident Report	%
Property Crimes (all theft, burglary, property destruction)	49.3%
Disorder, Drugs, Prostitution	17.0%
Person Crimes (homicide, all assault, rape, robbery, kidnapping)	11.4%
Other Non-Traffic Crime Related Events (for example, weapon offenses, violations, warrants, domestic disputes, missing persons, juvenile-related offenses, threats and alarms)	16.6%
Traffic-related (hit and run, drunk driving, accidents with injuries)	4.7%
Unknown	1.0%
Total	100%

Figure 1 illustrates the overall crime trends in Seattle throughout the fourteen year study period. Overall Seattle appears to have followed the national pattern (see Blumstein and

[1] It should be noted that street segments could have been added or removed from the Seattle street map over the fourteen year period. While the City of Seattle could only provide us with their most recent up-to-date street map as of the year 2001, we recognize that this issue could be a small source of error.

Wallman, 2000), with a decline in incident reports at least since 1992. Between 1989 and 2002, Seattle experienced a 24% decline in the number of incident reports recorded.

Figure 1. Seattle Street Segment Crime Trends

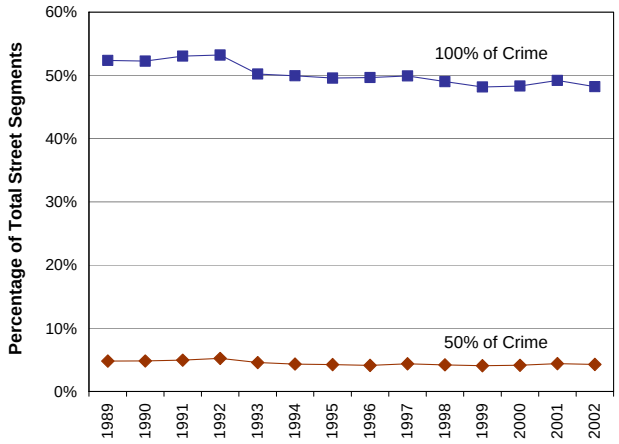


One approach we took in understanding variations in the frequency of crime events at places over time was to extend Sherman et al.'s (1989) measure of concentration at one year to our fourteen years. Sherman and his colleagues reported that over a period of a year 50.4% of all calls for service in Minneapolis occurred at 3.3% of all addresses and intersections and that 100% of such calls occurred at 60% of all addresses, a finding confirmed by a number subsequent studies.

As Figure 2 illustrates, very similar findings for all reported incidents are found for each of the fourteen years observed in Seattle. Between 4 and 5 percent of all street segments account for about fifty percent of incident reports in our data in each of the years examined. 100% of all incident reports are found in between 48 and 53% of all street segments. Figure 2 suggests that a general concentration of crime in hot spots exists, which follows a consistent pattern over time.

Similarly, when we look at the percentage of street segments in each year with a specific number of incidents (0,1,2, …), we also find that although there is some variability, the overall distribution is fairly similar from year to year. Of course, it may be that although the proportions of street segments with specified thresholds of crime activity remain consistent year to year, the actual segments within each of these thresholds may change.

Figure 2. Percentage of Street Segments with 50% and 100% of Incident Reports from 1989 to 2002



CRIME TRAJECTORIES OF PLACES[2]

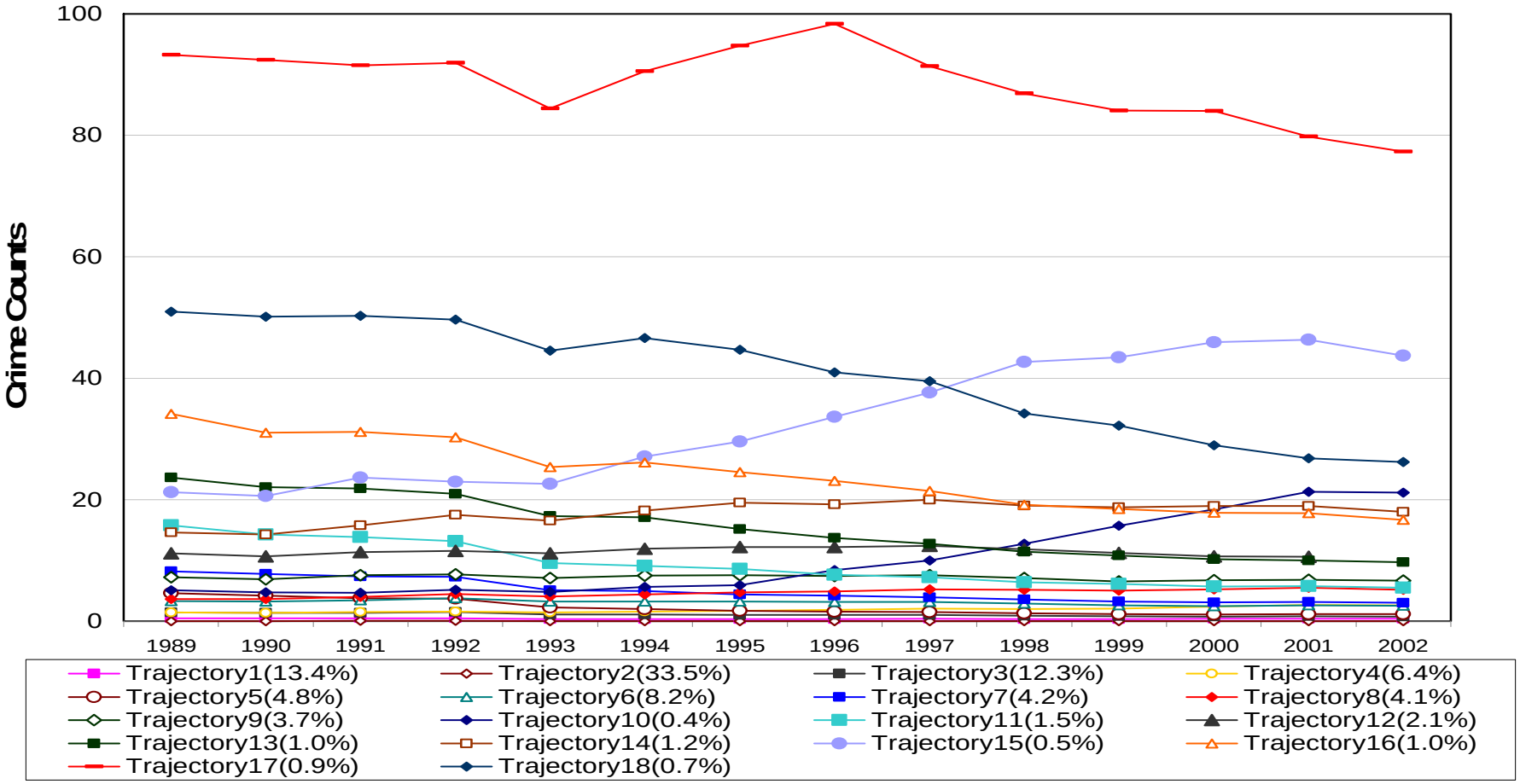
Because we were interested in specifying directly the changes at specific street segments over time, we turned to methods used by developmental criminologists. In particular, we believed that group based trajectory analysis might be especially helpful in understanding accelerations, decelerations, onset, desistance or stability of crime event occurrences at these places over time. The group-based trajectory model, first described by Nagin and Land (1993) and further elaborated in Nagin (1999, in press), is specifically designed to identify clusters of individuals with similar developmental trajectories and it has been utilized extensively to study

[2] We are indebted to Shawn Bushway of the University of Maryland for working with us on the development of trajectory models and for his writing of significant portions of this section of our report.

patterns of change in offending and aggression as people age (e.g., Nagin, 1999; Nagin and Tremblay, 1999). As such, we believed it would be particularly appropriate to our goal of exploring the patterns of change that exist in the development of crime at micro places over time.

Figure 3 illustrates the final eighteen trajectories we obtained with the percentage of segments that fall within each trajectory. The figure presents the actual average number of incident reports found in each group over the 14 year time period. The main purpose of trajectory analysis is to identify the underlying heterogeneity in the population. What is most striking, however, is the tremendous stability of crime at places suggested by our analysis. Looking at the trajectories, it is clear that although many have different initial intercepts in terms of the level of criminal activity observed, most evidence relatively stable slopes of change over time.

Figure 3. Eighteen Trajectory Solution for Seattle Street Segments



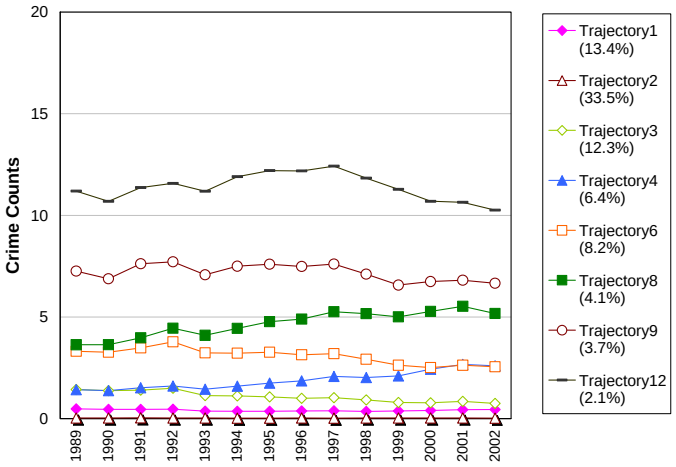
Note: The percentages in parentheses represent the proportion of street segments that each trajectory accounts for in the city of Seattle.

VARIABILITY AND INVARIABILITY OF CRIME AT PLACES

The stability of crime at place is one of the central findings of our study. However, we wanted to explore this stability and the instability evidenced in our trajectory analysis more carefully to understand more clearly the developmental trends evidenced in our data. For simplicity in defining the patterns of change over time in the trajectories we examined, we fit a linear curve to the average number of offenses at each time point for each group. We then divided the 18 trajectories into three groups: trajectories that evidenced little change in terms of their defined slopes during the study period; trajectories that evidenced decreasing developmental trends; and trajectories evidencing increasing developmental trends.

Figure 4 illustrates clearly the dominance of street segments with stable crime trajectories during the fourteen year study period. The stable trajectories were defined as those with slopes very close to 0. Importantly, eight of the 18 trajectories we identified fit this pattern, and they represent fully 84% of all the street segments we examined. It is important to note that these trajectories overall also had relatively low intercepts.

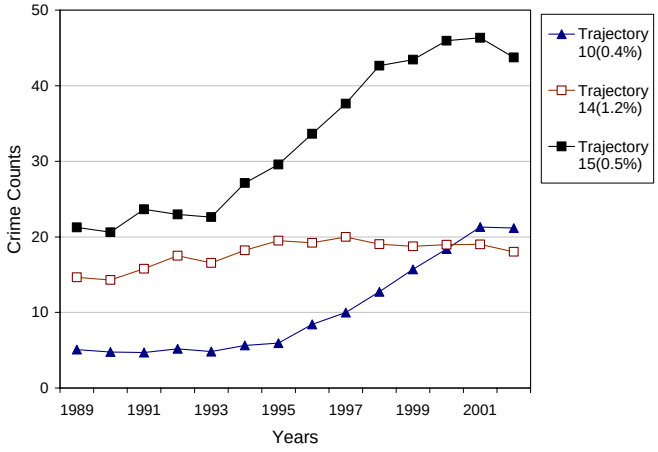
Figure 4. Stable Trajectories



Trajectory	Slope	Intercept
1	-0.0036	0.4382
2	-0.0004	0.0339
3	-0.0583	1.5181
4	0.1005	1.1367
6	-0.0779	3.6649
8	0.1412	3.6051
9	-0.0531	7.5848
12	-0.0353	11.652

Despite the overall stability in crime at place over the study period, there is evidence of both increasing and decreasing trends. Only about 2% of the street segments (609 segments) in the entire city exhibited trends opposite to the general trend (Figure 5). Nonetheless, despite only two percent of segments showing these developmental trends, the overall crime changes noted here are sometimes large. In criminal career or developmental vocabulary, these places are examples of *acceleration* or *escalation* of crime frequency. Overall these segments experienced a 42% increase in reported crime over this period.

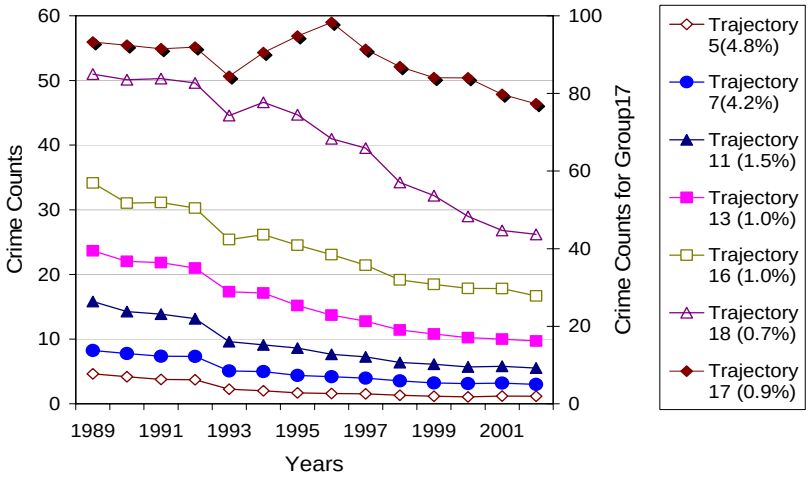
Figure 5. Increasing Trajectories



Trajectory	Slope	Intercept
10	1.4128	-0.3176
14	0.3306	15.345
15	2.3191	15.555

We also found seven *decreasing* trajectories identified in our analysis accounting for about 14% of the street segments in the city (Figure 6).[3] These trajectories represent segments which may have *de-escalated* in terms of their overall crime frequencies. The extent of the declining slopes varied a good deal across the segments identified here, as did the intercepts observed. Importantly, despite the variability of crime across these segments over time, it is still the case that the highest rate trajectories remain relatively high throughout the observation period, and the lower rate trajectories remain lower both in terms of their intercepts and final estimates.

Figure 6. Decreasing Trajectories (Low and High Rate)



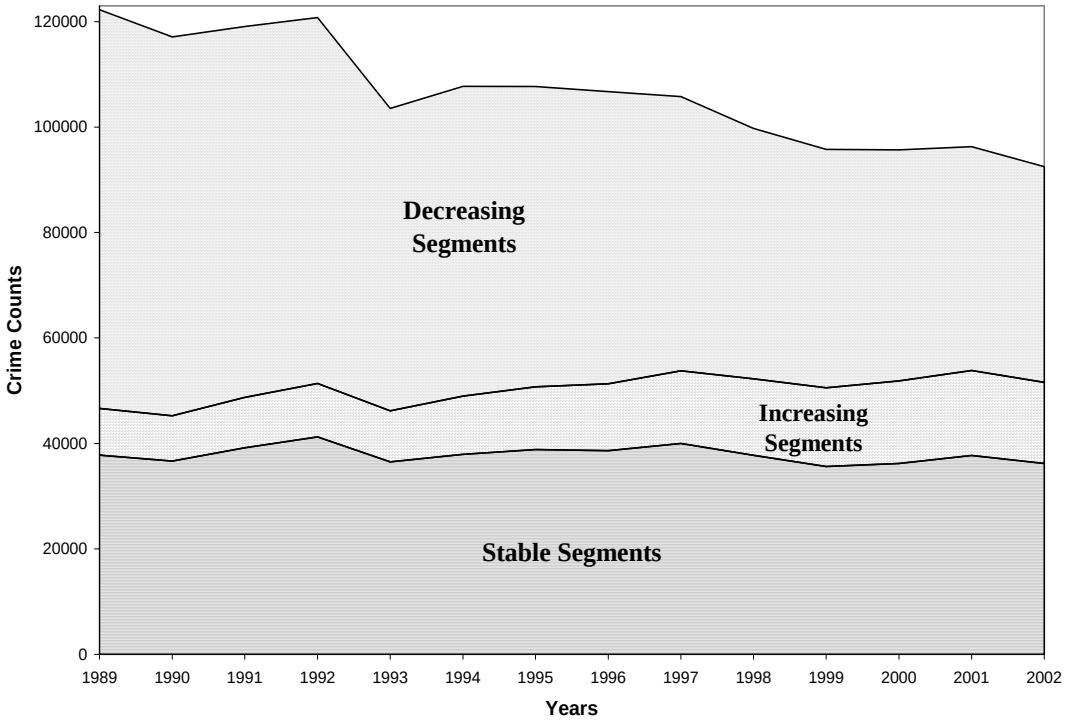
Trajectory	Slope	Intercept
5	-0.2782	4.3213
7	-0.4306	8.1892
11	-0.8166	15.333
13	-1.1729	24.287
16	-1.3664	34.337
17	-0.9911	96.048
18	-2.1302	56.391

[3] For visualization purposes, trajectory 17's scale is illustrated on the right side of the graph.

Crime Trajectories and General Crime Trends

One interesting observation that can be drawn from our examination of developmental trends of crime at street segments in Seattle is that the overall crime decline in Seattle is not general to the city, but rather concentrated in a small number of street segments that fall into groups that are associated with declining trajectories. This is illustrated in Figure 7, which shows the proportion of crime in our data base that is accounted for by each of the three trajectory types across the observation period. The area at the bottom of the figure represents crime that occurred in stable trajectories, and shows that their contribution to the overall number of incident reports in the city remains relatively stable throughout the 14 years examined in our study. The increasing trajectories, represented in the next shaded area, provide for a slight increase in crime. When combining both stable and increasing trajectories, representing about 86 percent of the street segments, we identify a small increase in crime between 1989 and 2002. In contrast, we can see that the shaded area associated with decreasing segments provides a fairly consistent degree of decline in the crime rate as measured by incident reports. Indeed, the decreasing trajectories, which show a decline of about 35,000 incidents between the first and last year of observation, can be seen as more than accounting for the overall crime drop in Seattle street segments of about 30,000 events during the study period.

Figure 7. Aggregation to the City Trend of Each Trajectory Grouping



THE GEOGRAPHY OF CRIME TRAJECTORIES

We think that the use of a micro place level of analysis has allowed us to examine crime trends at places with greater precision. It might be argued, however, that this choice has masked more general clustering of crime trends within neighborhoods or communities, or in terms of geographic analysis, that stable, increasing and decreasing trajectories may not be randomly distributed across space but rather exhibit some spatial dependence that might contribute to the trends. To examine this problem we developed kernel density maps for each of the three types of trajectories identified above (see Figure 8). Kernel density estimations provide a visual

interpretation of the number of events across a geographic area, estimated at every point in that area to create a "smooth" estimate of the terrain of event locations.

Figure 8. Kernel Density Estimations

a. Stable Trajectory Group b. Increasing Trajectory Group c. Decreasing Trajectory Group

We recognize that this is only a general estimate of the concentration of segments within each grouping.[4] Overall, though, Figure 8 suggests that street segments of each of the three defined types are spread throughout the city. At the same time there are places of concentration. Segments classified into stable trajectories, for example (see figure 8a), appear to have considerable diffusion across the entire city, but are especially prominent in more affluent and less densely populated areas in the north of the city. Similarly, though a relatively small proportion of the street segments are increasing trajectories (Figure 8b), we find concentrations in most areas of the city. There is even greater spread of decreasing segments (Figure 8c),

[4] While not the focus of this study, we are looking more carefully at the geography of crime trajectories in another paper (see Lum et al., in progress).

though this may be due in part to the larger number of segments in this grouping. At the same time, we do find that there are concentrations of increasing and decreasing trajectories in the urban center of the city. This is particularly interesting in part because it suggests that there may be similar causal processes underlying both types of trajectories.

SOCIAL AND DEMOGRAPHIC CHARACTERISTICS OF CRIME PLACE TRAJECTORIES

Our finding of distinct trajectories that represent stable as well as variant crime trends at places raises the question of whether such places evidence distinct social or demographic characteristics. While our data are limited in this case to census information available at the block group level for two census waves (1990 and 2000), we thought it important to take a preliminary look at such information on the social and demographic characteristics of crime places to see what they could tell us about the relationship between the characteristics of crime place trajectories and crime trends. We use the census block group for identifying characteristics of street segments because it is the smallest geographic unit for which detailed information is collected by the Census Bureau.

One commonly observed relationship in studies of the trajectories of individual offenders is that there is a direct negative relationship between measures of wealth and social stability and the initial intercepts, or initial crime frequencies, found for offender groupings (see Nagin et al., 1995). This finding is confirmed when we examine trajectories of crime places. As expected, trajectories with low intercepts (and thus low initial rates of crime) tend to score much higher on measures of wealth and educational standing, and much lower on those of poverty or minority concentration.

While the census data do not coincide directly with the years observed in our study, we tried to gain an overall portrait of the relationship between memberships in the different groups of trajectories that we described above and demographic trends by comparing the 1990 and 2000 census information across groups of trajectories (see Table 3).

Table 3. Average Percent Changes of Demographic Variables between the Three Trajectory Groupings [(2000-1990)/1990]

	Stable Trajectories	Decreasing Trajectories	Increasing Trajectories
Population	0.11	0.18	0.23
Median Income	0.19	0.21	0.24
Female Headed Households	-0.01	-0.10	-0.01
% Under Poverty	-0.01	-0.07	-0.06
College Degree	0.28	0.27	0.33
Square Miles	N/A	N/A	N/A
Population Density	0.10	0.14	0.29
% African American	-0.18	-0.25	-0.12
Heterogeneity	0.40	0.24	0.61
Unemployment	0.05	0.04	0.24

Our analysis here is of course exploratory, and we think it is important to be careful in drawing any causal inferences. In turn, we do not find clear and consistent patterns in expected directions. Those trajectories which evidenced an increasing frequency of crime also experienced, compared to stable or decreasing crime segments, the highest increases in population, population density and racial heterogeneity. However, these segments also evidenced the greatest increases in median income and the percentage of individuals with college

degrees. Decreasing trajectories on the other hand, compared only with stable crime segments also had, in the ten year period measured, increases in population, median income, population density and the percentage of individuals *not* under the poverty line. Segments with decreasing crime frequencies during the fourteen years also had the greatest decline of African Americans or single females with children living within those segments.

Perhaps the most significant pattern observed in the data is that rapid social change appears to be associated with changes in crime frequencies. Overall, with the exception of the percent of African American residents and general racial homogeneity, decreasing and increasing trajectory street segments commonly evidence more social change than street segments in the stable trajectory grouping. This finding is consistent with research regarding crime changes over time in communities carried out by Bursik and Webb (Bursik, 1986; Bursik and Webb, 1982).

CONCLUSIONS

Our analysis of crime at street segments in Seattle over a 14-year period and our use of the trajectory approach allowed us to fill an important gap in our understanding of crime at micro places. Our study confirms prior research showing that crime is tightly clustered in specific places in urban areas, and that most places evidence little or no crime. But we also are able to show that there is a high degree of stability of crime at micro places over time. This stability is evident in the vast majority of street segments in our study of 14 years of official data. Moreover, for those trajectories that evidenced decreasing or increasing trends, we still found a stability of scale with the highest rate segments generally remaining so throughout the observation period.

Our data however, also suggest that crime trends at specific segments are central to understanding overall changes in crime. The crime drop in Seattle was confined to very specific groups of street segments with decreasing crime trajectories over time. If the trends in Seattle are common to other cities, the crime drop should be seen not as a general phenomenon common to places across a city but rather as focused at specific places.[5] Such places in our study are also street segments where crime rates are relatively high. This reinforces a public policy approach that would focus crime prevention resources on hot spots of crime (Braga, 2001; Sherman and Weisburd, 1995; Skogan and Frydl, 2003; Weisburd and Braga, 2003; Weisburd and Eck, 2004).

These observations are of course preliminary given the nature of our data. Our more general findings must be subjected to examination in other contexts and across other micro place units. To understand the etiology of crime trajectories at micro places we also need more insight into the nature of such places and their experiences across the periods of study. Nonetheless, our work provides the first examination of trajectories of crime at micro places over time, and suggests the importance of a developmental, criminal career perspective in the study of micro crime places (Sherman, 1995; Weisburd, 1997).

REFERENCES

Abeyie, Daniel and Keith D. Harries (eds.)
1980 Crime: A Spatial Perspective. New York, NY: Columbia University Press.

Appleyard, Donald
1981 Livable Streets. Berkeley, CA: University of California Press.

[5] One reviewer, Anthony Braga, has suggested that our finding that specific trajectories account for the overall crime drop in Seattle is consistent with broader trends in crime and violence across American cities. While the national trends illustrate an overall decrease in crime during the 1990s, there was a good deal of variability across cities (Blumstein, 2000; Travis and Waul, 2002). When looking at specific crimes there has also been acknowledgement of important differences across populations. For example, Cook and Laub (1998, 2002) observe that the youth violence epidemic was concentrated among minority males who resided in poor neighborhoods, used guns and engaged in high risk behaviors such as gang participation (see also Braga, 2003).

Block, Carolyn and Richard Block
1980 Patterns of Change in Chicago Homicide: The twenties, the sixties and the seventies, 2nd ed. Statistical Analysis Center, Illinois Law Enforcement Commission.
1985 Lethal violence in Chicago over Seventeen Years: Homicides Known to the Police, 1965-1981. Chicago, IL: Criminal Justice Information Authority.

Blumstein, Alfred and Joel Wallman (eds.)
2000 The Crime Drop in America. Cambridge, UK: Cambridge University Press.

Braga, Anthony A.
2001 The Effects of Hot Spots Policing on Crime. The Annals of American Political and Social Science 578:104-125.

Brantingham, Patricia L. and Paul J. Brantingham
1975 Residential Burglary and Urban Form. Urban Studies 12(3):273-284.
1981 Notes on the Geometry of Crime. In Paul J. Brantingham and Patricia L. Brantingham (eds.), Environmental Criminology. Beverly Hills, CA: Sage.
1999 Theoretical Model of Crime Hot Spot Generation. Studies on Crime and Crime Prevention Volume 8(1):7-26.

Bureau of Justice Statistics
1987 Law Enforcement Management and Administration Statistics. Washington D.C.: Department of Justice.
1997 Law Enforcement Management and Administration Statistics. Washington DC: Department of Justice.

Bursik, Robert J., Jr.
1986 Ecological Stability and the Dynamics of Delinquency. In Albert Reiss, Jr. and Michael Tonry (eds.), Communities and Crime. Crime and Justice: A Review of Research 8. Chicago, IL: The University of Chicago Press.

Bursik, Robert J., Jr. and Jim Webb
1982 Community Change and Patterns of Delinquency. American Journal of Sociology 88(1):24-42.

Crow, W. and J. Bull
1975 Robbery Deterrence: An Applied Behavioral Science Demonstration - Final Report. La Jolla, CA: Western Behavioral Science Institute.

Eck, John E and David Weisburd (eds.)
1995 Crime and Place: Crime Prevention Studies 4. Monsey, NY: Willow Tree Press.

Eck, John, Jeffrey Gersh, and Charlene Taylor
2000 Finding Crime Hot Spots Through Repeat Address Mapping. In Victor Goldsmith, Philip McGuire, John Mollenkopf and Timothy Ross (eds.), Analyzing Crime Patterns: Frontiers of Practice. Thousand Oaks, CA: Sage.

Jacobs, Jane
1961 The Death and Life of Great American City. New York: Vintage Books.

Klinger, David and G. Bridges
1997 Measurement Error in Calls-For Service as an Indicator of Crime. Criminology 35(4):705-726.

Lum, Cynthia, David Weisburd, and Sue-Ming Yang
The Spatial Distribution of Trajectories of Crime Places. (In Progress)

Nagin, Daniel S.
1999 Analyzing Developmental Trajectories: A Semiparametric, Group-Based Approach. Psychological Methods 4:139-157.
In Press Group-based Modeling of Development Over the Life Course, Cambridge, MA: Harvard University Press.

Nagin, Daniel S., David P. Farrington, and Terrie E. Moffitt
1995 Life-Course Trajectories of Different Types of Offenders. Criminology 33(1):111-139.

Nagin, Daniel and Kenneth C. Land
1993 Age, Criminal Careers, and Population Heterogeneity: Specification and Estimation of a Nonparametric, Mixed Poisson Model. Criminology 31(3):327-362.

Nagin, Daniel and Richard Tremblay
1999 Trajectories of Boys' Physical Aggression, Opposition, and Hyperactivity on the Path to Physically Violent and Nonviolent Juvenile Delinquency. Child Development 70:1181-1196.

Pierce, Glenn, S. Spaar, and L.R. Briggs
1986 The Character of Police Work: Strategic and Tactical Implications. Boston, M.A: Center for Applied Social Research, Northeastern University.

Roncek, Dennis
2000 Schools and Crime. In Victor Goldsmith, Philip McGuire, John Mollenkopf, and Timothy Ross (eds.), Analyzing Crime Patterns Frontiers of Practice. Thousand Oaks, CA: Sage.

Sherman, Lawrence
1995 Hot Spots of Crime and Criminal Careers of Places. In John Eck and David Weisburd (eds.), Crime and Place: Crime Prevention Studies 4. Monsey, NY:

Willow Tree Press.

Sherman, Lawrence and David Weisburd
1995 General Deterrent Effects of Police Patrol in Crime "Hot-Spots": A Randomized Controlled Trial. Justice Quarterly 12:626-648.

Sherman, Lawrence, Patrick R. Gartin, and Michael E. Buerger
1989 Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place. Criminology 27(1):27-56.

Skogan, Wesley and Kathleen Frydl
2003 Effectiveness of Police Activity in Reducing Crime, Disorder and Fear. In Wesley Skogan and Kathleen Frydl (eds.), Fairness and Effectiveness in Policing: The Evidence: 217-251. National Research Council.

Smith, William, Sharon Frazee, and Elizabeth Davidson
2000 Furthering the Integration of Routine Activity and Social Disorganization Theories: Small Units of Analysis and the Study of Street Robbery as a Diffusion Process. Criminology 38(2):489-524.

Spelman, William
1995 Criminal Careers of Public Places. In John E. Eck and David Weisburd (eds.), Crime and Place: Crime Prevention Studies 4. Monsey, NY: Willow Tree Press.

Taylor, Ralph
1997 Social Order and Disorder of Street Blocks and Neighborhoods: Ecology, Microecology, and the Systemic Model of Social Disorganization. Journal of Research in Crime and Delinquency 34 (1):113-155.
1999 Crime, Grime, Fear, and Decline: A Longitudinal Look. Research in Brief. Washington, DC: National Institute of Justice.

United States Bureau of the Census
1990 Website: www.census.gov
2000 Website: www.census.gov

Weisburd, David
1997 Reorienting Crime Prevention Research and Policy: From the Causes of Crime to the Context of Crime. National Institute of Justice Research Report. Washington, DC: U.S. Government Printing Office.
2002 From Criminals to Criminal Contexts: Reorienting Criminal Justice Research and Policy. Advances in Criminological Theory 10:197-216.

Weisburd, David and Anthony Braga
2003 Spots Policing. In H. Kury and J. Obergfell-Fuchs (eds.), Crime Prevention: New Approaches. Manz: Weisser Ring.

Weisburd, David and John E. Eck

2004 What Can Police Do to Reduce Crime, Disorder and Fear? Annals of American Political and Social Science 593: 42-65.

Weisburd, David and Lorraine Green (Mazerolle)

1994 Defining the Drug Market: The Case of the Jersey City DMA System. In Doris Layton MacKenzie and Craig D. Uchida (eds.), Drugs and Crime: Evaluating Public Policy Initiatives. Newbury Park, CA: Sage.

2000 Crime and Disorder in Drug Hot Spots: Implications for Theory and Practice in Policing. Police Quarterly 3(2):152-170

Weisburd, David, Lisa Maher, and Lawrence Sherman

1992 Contrasting Crime General and Crime Specific Theory: The Case of Hot-Spots of Crime. Advances in Criminological Theory 4:45-70.

THE CRIMINAL CAREERS OF PLACES: A LONGITUDINAL STUDY

FINAL REPORT

David Weisburd, Ph.D.
Principal Investigator
University of Maryland, College Park &
The Hebrew University, Jerusalem

Cynthia Lum, Ph.D.
Project Director
Northeastern University, Boston

Sue-Ming Yang, M.A.
Research Assistant
University of Maryland, College Park

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CONTENTS

I. STUDYING CRIME AT PLACES

Traditionally, research and theory in criminology have focused on two main units of analysis: individuals and communities (Nettler, 1978; Sherman, 1995). In the case of individuals, criminologists have sought to understand why certain people as opposed to others become criminals (e.g., see Akers, 1973; Gottfredson and Hirschi, 1990; Hirschi, 1969; Raine, 1993), or to explain why certain offenders become involved in or cease criminal activity at different stages of the life course (e.g., see Moffitt, 1993; Sampson and Laub, 1993). In the case of communities, criminologists have often tried to explain why certain types of crime or different levels of criminality are found in some communities as contrasted with others (e.g., see Agnew, 1999; Bursik and Grasmick, 1993; Sampson and Groves, 1989; Shaw and McKay, 1942), or how community-level variables, such as relative deprivation, low socioeconomic status, or lack of economic opportunity may affect individual criminality (e.g., see Agnew, 1992; Cloward and Ohlin, 1960; Merton, 1968; Wolfgang and Ferracuti, 1967) In most cases, research on communities has focused on the "macro" level, often studying larger geographic units such as states (Loftin and Hill, 1974), cities (Baumer et al., 1998) and neighborhoods (Bursik and Grasmick, 1993; Sampson, 1985).

In the same regard, crime prevention research and policy have also been focused primarily on offenders or the communities in which they live. Scholars and practitioners have looked to define strategies that would deter individuals from involvement in crime (see Nagin, 1998), or that would rehabilitate them away from criminality (e.g. see Andrews et al., 1990). In recent years, crime prevention efforts have often focused on the incapacitation of high rate or dangerous offenders so that they are not free to victimize law abiding citizens (see e.g.,

Blumstein et al., 1986). Similarly, ideals of "community" have played a major role in the development of crime prevention programs. Whether looking to strengthen community bonds (Sherman et al., 1997; Skogan, 1990; Tierney and Grossman, 1995), or to enlist the community in crime prevention efforts (Skogan, 1996), the community has traditionally been viewed as an important context for crime prevention research and policy.

While the individual and the community have long been a focus of criminological research, only recently have criminologists begun to explore other units of analysis that may contribute to our understanding of the crime equation. An important catalyst for this work came from theoretical perspectives that emphasized the context of crime and the opportunities presented to potential offenders (Weisburd, 2002). In a groundbreaking article on routine activities and crime, for example, Cohen and Felson (1979) suggest the importance of recognizing that the availability of suitable crime targets and the presence or absence of capable guardians influence crime events. Researchers at the British Home Office in a series of studies examining “situational crime prevention” also challenged the traditional focus on offenders and communities (Clarke and Cornish, 1983). These studies showed that crime situations and opportunities play significant roles in the development of crime (Clarke, 1983).

One implication of these emerging perspectives is that micro crime places are an important focus of inquiry (Eck and Weisburd, 1995; Sampson and Groves, 1989; Taylor, 1997). While concern with the relationship between crime and place goes back to the founding generations of modern criminology (Guerry, 1833; Quetelet, 1842), the “micro” approach to places suggested by recent theories has just begun to be examined by criminologists.[1] Places in this “micro” context are specific locations within the larger social environments of communities

[1] It should be noted that a few early criminologists did examine the “micro” idea of place as discussed here (see Shaw et al., 1929). However, interest in micro places was not sustained and did not lead to significant theoretical or empirical inquiry.

and neighborhoods (Eck and Weisburd, 1995). They are sometimes defined as buildings or addresses (see Green, 1996; Sherman et al., 1989), sometimes as block faces or street segments (see Sherman and Weisburd, 1995; Taylor, 1997), and sometimes as clusters of addresses, block faces or street segments (see Block et al., 1995; Weisburd and Green, 1995). Research in this area began with attempts to identify the relationship between specific aspects of urban design (Jeffrey, 1971) or urban architecture (Newman, 1972) and crime, but broadened to take into account a much larger set of characteristics of physical space and criminal opportunity (see Brantingham and Brantingham, 1975, 1981; Duffala, 1976; Hunter, 1988; LeBeau, 1987; Mayhew et al., 1976; Rengert, 1980, 1981).

Resistance to a place focused approach to criminology and criminal justice policy has often been stated in reference to the problem of displacement (Farrington et al., 1993:94; Laycock and Tilley, 1995). Displacement refers to the shift of crime either in terms of space, time or type of offending from the original targets of crime prevention interventions (Repetto, 1976). Based on assumptions about the large number of crime opportunities available in modern societies, and the highly motivated nature of much offending, scholars have traditionally assumed that most of the crime control benefits of place based prevention strategies would be lost due to displacement. Some early studies of displacement appeared to support this position (e.g. Chaiken et al., 1974; Lateef, 1974; Mayhew et al., 1976; Press, 1971; Tyrpak, 1975). However, careful review of these findings as well as a series of more recent studies of displacement in the 1980s and 1990s has led to agreement that displacement of crime prevention benefits is seldom total and often inconsequential (Barr and Pease, 1990; Clarke, 1992; Clarke and Weisburd, 1994; Eck, 1993; Gabor, 1990; Hesseling, 1994).

Changing assumptions regarding displacement followed a more general set of findings

that challenged traditional objections to criminological study of crime places. For example, the idea that criminal opportunities are indiscriminately spread through urban areas has been challenged by a series of studies showing that crime is concentrated in time and space (Brantingham and Brantingham, 1981; Sherman et al., 1989; Weisburd and Green, 1994; Weisburd et al., 1992). Moreover, criminal opportunities are differentially distributed, both in terms of the benefits that they offer and the ease with which such opportunities can be seized. In one study of situational measures used to prevent bank robberies, for example, little displacement was noted to other types of targets (convenience stores and gas stations) primarily because they did not offer enough financial reward for the criminal gangs that had victimized the targeted banks (Clarke et al., 1991). Using the example of homes and cars, Clarke (1995:106) suggested that what appears at first glance as an endless quantity of criminal opportunities, may be bounded both by issues of guardianship and significant variation in the value of goods that can be stolen (see also Hesseling, 1994).

Recent studies of the concentration of crime at crime "hot spots" point to the potential theoretical and practical benefits of focusing research on micro crime places (Eck and Weisburd, 1995; Sherman, 1995; Taylor, 1997; Weisburd, 2002). The first use of this term in the case of crime places was brought by Sherman et al. (1989), though the basic idea that crime events were clustered in specific places was documented in earlier studies (e.g., see Abeyie and Harries, 1980; Crow and Bull, 1975; Pierce et al., 1986) and suggested by work in the area of environmental criminology (Brantingham and Brantingham, 1975, 1981). Lawrence Sherman (1995) argues that such clustering of crime at places is even greater than the concentration of crime among individuals. Using data from Minneapolis, Minnesota and comparing these to the concentration of offending in the Philadelphia Cohort Study (see Wolfgang et al., 1972), he notes

that future crime is "six times more predictable by the address of the occurrence than by the identity of the offender" (1995:36-37). Sherman asks, “why aren’t we doing more about it? Why aren’t we thinking more about whereduni t, rather than just whodunit?” His proposal that crime was concentrated in hot spots in urban areas has now been confirmed in a series of studies conducted in different cities using different definitions of hot spot areas (e.g., see Brantingham and Brantingham, 1999; Eck et al., 2000; Roncek, 2000; Spelman, 1995; Weisburd et al., 1992; Weisburd and Green, 1994, 2000). In turn, there is now strong empirical evidence supporting hot spots policing tactics that draw upon the notion that crime is concentrated at specific places in urban areas (Sherman and Weisburd, 1995; Weisburd and Braga, 2003; Weisburd and Eck, 2004).

Despite these basic and applied research findings on the concentration of crime in urban areas and its utility for crime prevention applications, there continues to be substantial gaps in our knowledge about patterns of crime at places. In particular, in contrast to the wide array of studies concerning the development of crime within individuals and communities, we have so far developed little basic knowledge about the development of crime at places. In part, such gaps have developed from the fact that this area of inquiry is still in an early stage of development. However, the fact that many of those who have pioneered this approach have had a strong practical crime prevention orientation (e.g. see Clarke, 1983, 1996; Felson, 1998) has also meant that many basic research questions have often been ignored (Weisburd, 1997). For example, there have been only a handful of longitudinal studies of crime places, and these have generally examined change over a few years or across specific crime categories (e.g. see Block and Block, 1980, 1985; Spelman, 1995; Taylor, 1999).

These issues in our view are not just important for academic inquiry into the problem of crime at place; they also have strong policy relevance. Crime concentration itself does not provide a solid empirical basis for either refocusing crime prevention resources or calling for significant theorizing about why crime is concentrated at places. For example, if "hot spots of crime" shift rapidly from place to place it makes little sense to focus crime control resources at such locations, because they would naturally become free of crime without any criminal justice intervention (Spelman, 1995). Similarly, if crime concentrations can move rapidly across the city landscape, it may not make much sense to focus our understanding of crime on the characteristics of places. Sociologists, for example, have long recognized that the "opportunity for a criminal act" influences the occurrence of crime (Sutherland, 1947:5). However, if such opportunity is widespread with little geographic stability, a focus on criminal motivation would likely be a more productive concern of criminological inquiry.

Thus, although we have learned much about concentration of crime at places at specific times in specific places, there are still important gaps in our understanding of the development of crime at place across time. For example, while there is strong evidence of crime clustering at a given time, we know little about whether such clustering evidences stability across time. Are hot spots stable across time in urban centers, or do hot spots shift from place to place across time? What of the development of crime at place? Are there places that evidence strong increasing crime trends and others that evidence strong decreasing trends? Or is there stability in the frequency of offending at crime at place? More generally, how can we approach "concentration" of crime at places as a longitudinal process rather than within a single block of time using cross-sectional analytic approaches? In this study we use official crime data to examine the

distribution of crime at street segments in Seattle, Washington, over a 14 year period to better understand how crime develops over time at places.

We begin our report with a discussion of what is known about the nature of the distribution of crime at place over time, providing a theoretical approach in framing our research questions. Here, we draw upon similar theoretical and methodological frameworks as developmental criminologists who study the "criminal careers" of individuals. We then turn to a description of our site selection, data and units of analysis in Chapters III and IV, outlining the choice and methods of our geographic and longitudinal approach. Beginning in Chapter V, we detail early approaches we used to explore changes in levels of crime at all street segments in Seattle (totaling 29,849 places). Early methods and the inability to accurately capture a description of the development of crime at these places over fourteen years led us to pursue an approach used by some developmental criminologists known as trajectory analysis, described in Chapter VI. Our use of this innovative approach revealed eighteen different crime trajectories representing the 29,849 segments.

The trajectories are then discussed in terms of the criminal career model as set out in Chapter II. In particular, what do we learn from our results in terms of the patterns of criminal careers of places? Interestingly, we discovered that despite some variation in levels of "offending" by places, remarkable stability over the fourteen-year period was present. Additionally, similar trajectories tended to concentrate geographically across the city. We then took this discussion further by examining characteristics of various trajectories (or groups of similar trajectories). In other words, aside from changes (or lack thereof) in frequencies over the fourteen year period, do these different offending paths also have varying "risk factors" (as is

suggested by study of individuals)? Here, we preliminarily examine social, economic and demographic risk factors associated with trajectory membership.

Our study allows us to go beyond prior research in this area in two ways. First, we are able to view crime trends over a much longer period than other studies that have examined micro crime places. Second, we utilize a group-based statistical technique drawn from developmental criminology that is tailor-made to uncover distinctive developmental trends in the outcome of interest (Nagin, 1999, in press; Nagin and Land, 1993). This technique has the added desirable characteristic of being easy to present in tables and graphs, not an insignificant feature given that our dataset has almost 30,000 units of analysis each with recorded crime for 14 years. While this approach, termed "trajectory analysis," has not been used to examine places in earlier studies, we think it particularly appropriate for gaining a fuller understanding of the development of crime at micro places over time. We end this report by focusing on the policy and research implications of our study.

II. STUDYING CRIME AT PLACES OVER TIME: THE "CAREER" PARADIGM

As already emphasized, although much work on "concentration" has found that crime tends to pattern non-randomly in space, these tend to be "snapshots" of concentration – measures of event frequency at places during one period of time (a year, for example). However, implied in terms such as "concentration", "specialization" or "crime patterns" of places are temporal elements suggesting that patterns or concentrations are the result of processes which occur over time. These "processes" involve both changes in the frequency of crime events that occur within those areas, as well as structural changes that might affect these variations. Viewing crime patterning as a process suggests that a longitudinal approach in studying crime at places may yield further insight into the phenomenon of crime concentration.

The use of longitudinal approaches in criminology has been strongly associated with the study of criminal offending of individuals, for example, in developmental, criminal careers or life course approaches (see e.g., Blumstein et al., 1986; Moffitt, 1993; Sampson and Laub, 1993). However, the idea that the developmental concept of criminal careers may also apply to micro crime places has recently been raised by Sherman (1995) and Weisburd (1997). They argue that a fuller understanding of crime places must examine the dynamics of change over time and look to innovations in developmental models of individual criminal careers for insights into the criminal careers of places. In particular, both theoretical and methodological advancements in developmental approaches may help us understand how crime develops at places over time.

Despite this emerging interest in the criminal careers of places, scholars have directed little attention so far to the question of the distribution of crime at micro places over time. We could identify only two published studies that specifically examined this issue longitudinally.

One study conducted by Spelman (1995), looks at specific places such as high schools, public housing projects, subway stations and parks in Boston, using 3 years of official crime information. Dividing his data set into 28-day periods, Spelman used a pooled time series cross-sectional design to examine the sources of variability over time and across the types of sites examined. His findings again replicate the more general assumption of a concentration of crime at specific hot spots, with the "worst 10 percent of locations and times accounting for about 50 percent of all calls for service" (Spelman, 1995:129). But he also finds evidence of a very high degree of stability of crime over time at the places he examines. Long-run differences among locations were responsible for the largest source of variation in each of the analyses Spelman conducted, leading him to conclude that it "makes sense for the people who live and work in high-risk locations, and the police officers and other government officials who serve them, to spend the time they need to identify, analyze and solve their recurring problems" (1995:131).

Taylor (1999) also reports evidence of a high degree of stability of crime at place over time, examining crime and fear of crime at ninety street blocks in Baltimore, Maryland using a panel design with data collected in 1981 and 1994 (see also Robinson et al., 2003; Taylor, 2001). Data included not only official crime statistics, but also measures of citizen perceptions of crime and observations of physical conditions at the sites. Although Taylor and his colleagues observed significant deterioration in physical conditions at the blocks studied, they found that neither fear of crime nor crime showed significant or consistent differences across the two time periods.

While these studies provide preliminary insight into the development of crime at place, they do not allow us to identify patterns of offending over time, and the samples used were limited to specific locations and specific contexts. In our work we sought to provide greater

complexity to our understanding of the development of crime at place across time by drawing from theoretical and methodological approaches that have been used to understand the criminal careers of individuals. Although a number of debates, different vocabularies and policy goals surround developmental research, the primary concerns of developmental criminologists lie in exploring differences and changes in the levels or "frequency" of offending across the life course of an individual. For example, some researchers focus on risk factors during the early periods of an individual's life which might predict future criminal careers (see e.g., Elder, 1986; Patterson et al., 1989; Robins, 1978). Others, such as Moffitt (1993), have studied whether we can categorize youths in terms of whether the frequency of their offending persists into adulthood (she calls these individuals "life-course persisters") or dramatically declines at age 18 ("adolescent limited"). Some have discussed the possibility of multiple categories of offending over time. For example, Laub et al. (1998), Nagin and Land (1993) and Nagin et al. (1995) argue that there may be multiple "trajectories" of offending paths for a population, perhaps predicted by different risk factors. Still others, such as Sampson and Laub (1993; see also Laub and Sampson, 2003) have studied "turning points" in individual lives which may explain changes in the levels of frequency of crime commission over the lifecourse. From these theoretical advances have also come new ways in thinking about how best to describe, measure, and analyze the development of offending over time.

Similarly, important parallels might be hypothesized between understanding changes in the frequency of offending among individuals and changes in the frequency of crime events that occur at places. For example, places might be perceived as having a "lifespan," affected by a number of negative and positive stimuli, succumbing to both internal and external controls and having both natural and nurtured characteristics that might increase the risk of crime

occurrences. We might also measure, at successive intervals (such as months, years or decades), the frequency of "offending" of a place. Similarly, temporal-relational measures of frequency may also be calculated. These relational measures have been differently labeled in the developmental literature, but if we take vocabulary from Loeber and LeBlanc (1990), we can draw similarities. For example, the "onset" of offending of a place may be the moment when the first crime (frequency=1) occurs, while "desistance" might be when crime frequencies consistently, over a longer period of time remain at zero. Such terms as "aggravation" or "escalation" may point to rapid increases in the frequency of offending over time while "de-escalation" or "deceleration" may suggest the opposite.

Thus, we sought in this project to analyze crime at places as a process of change in the frequency of "offending" over time, drawing from these theoretical constructs. While some developmental concepts will be difficult to test and discuss with the limitations that we faced with our data, much can be learned from this approach. Additionally, we sought a developmental approach not only to describe changes in levels of frequency of offending over time, but also to determine whether social and demographic variables and changes over time of these area characteristics are related to changes over time in crime frequencies. Criminologists studying individual offending careers have been concerned about what risk factors lead to variations in careers or whether changes in social characteristics can influence change at specific points in the life course (e.g. see Laub and Sampson, 2003; Laub et al., 1998; Sampson and Laub, 1993). Similar questions can be asked in terms of the criminal careers of crime places. For example, what type of places evidence increasing levels of offending and how do these places differ from those which do not develop crime careers or have decreasing trends? How does the social context of a place, or the criminal contexts of places nearby affect the patterns of a criminal

career? Are there factors that seem to inhibit acceleration or onset of criminality?

We want to note at the outset that while we think much can be learned by applying developmental approaches to crime places, we recognize that there are inherent limitations of this approach. There are important differences between places and people. For example, the "lifespan" of a place such as a street segment, a neighborhood, a building or a city may vary widely and unexpectedly compared to what we know about the human lifecourse. In particular, the "life" of a place may be much longer or shorter in years (most likely longer) than the seventy five or so years we expect a human to live. Additionally, in reference to crime, while we know that crime tends to peak during the early years of an individual's life around the ages of 16-18 (Blumstein, 2000; Gottfredson and Hirschi, 1990); the same may not be true for places. Crime may occur towards the end of a place's life, perhaps providing a hint that the lifespan may soon come to an end. On the same lines, the "death" of an individual is clear, while the "end" of a place may be less so. Places can be rebuilt in the context of urban renewal or redesigned by single house owners.

Despite these limitations, as outlined in the remaining chapters of our report, we found that theoretical and methodological tools and constructs used by developmental criminologists were helpful in expanding our knowledge about the development of crime at places over time. In particular, the developmental approach provided a framework for understanding the concentration of crime at hot spots within a broader conceptual framework. As detailed below, we are concerned primarily with "concentration"[2] (or "frequency") as it varies across time, rather than with a static understanding of crime hot spots as has been common with hot spots studies to date. We also draw from developmental approaches in informing our understanding of the

[2] The term "concentration" throughout the report points to the frequency or intensity of events, rather than the spatial dependence of events as differentiated in Bailey and Gatrell (1995).

development of crime over time at places and the risk factors that are associated with changes in crime at place. As the report will detail, one advantage of approaching our study from a developmental perspective was methodological. Our early attempts at organizing and typologizing career paths of places over fourteen years with traditional descriptive methods proved limiting. However, trajectory methods recently developed by developmental researchers (Jones et al., 2001; Nagin, 1999, in press; Nagin and Land, 1993) helped us identify different types of offending paths in the life course of places. We now turn to our site selection, data, analysis and findings.

III. SITE SELECTION

To study the development of crime over time at places, we focused on analyzing fourteen years of crime data in Seattle, Washington. Our site selection was primarily determined by our data needs to conduct a geographic-longitudinal study of crime as described in Chapter II. Specifically, we sought a site that would have a long history of collecting, in some systematic format, records of crime events that specified the date, time and location of those incidents. There are two main data sources of crime which may be, in theory, useful in analyzing crime patterns geographically, temporally, or both – crime victimization surveys or official crime data from the police or criminal court systems. However, in practice, victimization surveys are rarely conducted each year and specific locations of crime are rarely (if ever) recorded. Moreover, the cost of survey research has limited the samples that are collected in such surveys, and it is generally not possible to examine the universe of crime places in large geographic areas. For these reasons, official crime data collected by police are generally used to examine the distribution of crime at places.

Given this data preference, our first task was to find a police department with reliably recorded computerized crime data collected over a long period of time. American police departments have only recently begun to collect such data in ways that allow for a reliable matching between criminal events and crime places (see Weisburd and McEwen, 1997). Additionally, although many police departments in the United States currently use computer automation to collect crime data, many departments do not retain computerized records for more than a few years. In our selection of the site, our initial discussions with a number of individuals from records divisions of police departments throughout the country revealed the discarding of

automated data has been a regular practice. This is done for a variety of reasons, from technical concerns such as the lack of computer memory to store data, to personnel or organizational concerns regarding the perceived uselessness of old data. Indeed, the one type of record often kept for years was the actual written report, while the most often discarded were calls for service records collected within an automated computer mainframe.

Thus, we set out in designing our study to systematically identify potential sites that would have both computerized crime data available over a long period of time and data that could be reliably geocoded.[3] We also sought to identify a study site that would have a large enough geographic area, high enough rate of crime, and large enough population to allow for a robust examination of criminal careers at places. We decided to select only one site, as we recognized at the outset that the task of cleaning, geocoding and analyzing data over a very long period of time would likely be a difficult one. Moreover, an individual site meeting our criteria for selection was likely to yield a sample with a large number of places and a very large number of crime events.

At the time of the development of this project, we began our site selection process by reviewing data from the 1987 and 1997 Law Enforcement Management and Administrative Statistics (LEMAS) survey (Bureau of Justice Statistics, 1987, 1997). The LEMAS survey has been conducted every three years by the Bureau of Justice Statistics since 1987. All state, city and township law enforcement agencies with 135 or more sworn employees are included in the LEMAS survey with certainty.[4] The response rate for the survey was 95.4% in 1987. Drawing from the certainty sample in 1987, we selected only those departments in jurisdictions with a

[3] The term "geocode" refers to the process of linking data that include some form of geographic indicator such as an address with latitude and longitude coordinates which can be understood by mapping software.
[4] The remaining agencies with less than 135 sworn employees are chosen in a two stage process using a randomized sampling design. We could not identify a single city with a population of less than 200,000 that did not fall in the certainty sample.

population over 200,000 that also reported some form of computerized record keeping. Most likely, in 1987, this pointed to the use of a mainframe computer system to collect data on reel to reel tapes, as well as the use of some personal computers. We found only 137 of the 2907 police departments which fell in the certainty sample in 1987 and met these criteria.

We then limited our selection sample further by identifying those departments that reported that they had computerized data as well as crime mapping and analysis functions in the 1997 LEMAS survey (these questions were not included in the 1987 survey). We decided to use crime analysis/mapping as a requisite for a number of reasons. As we needed to know the specific location of crime events (down to the level of an address or address-like location), we anticipated that police departments who engaged in crime analysis or crime mapping would most likely have records with this type of specificity (as geocoding of crime events often uses address-level data). Secondly, as the obtaining and cleaning of the data would require a high level of collaboration between researchers and technicians helping to physically provide the data as well as supporting geographic data, we were searching for a police department who had institutional resources and personnel well aware of the extent of and limitations of their own data capabilities. From personal experience of the principal investigator and project director, this prerequisite was deemed to be an advantage. This left us with sixty-eight potential study sites. After further eliminating jurisdictions that could not qualify for our study,[5] forty-nine police departments remained as possible candidates.

Each of the 49 police departments were individually called and the researchers spoke with members from the crime analysis units and records divisions. The main preliminary

[5] Nineteen of these departments were excluded for primarily jurisdictional reasons. For example we excluded sheriff's departments whose function was more correctional than police-related (and thus would be unlikely to have comprehensive data on crime generally in the community). We also excluded departments who spanned jurisdictions already handled by a single police department or multiple departments on the list.

question we asked each of these departments was how far back in time they kept computerized records of their incident reports (we then asked about computerized records of other official crime data such as emergency calls for service). Each of the 49 departments were ranked in terms of the year in which those interviewed claimed that computerized data was available. We retained in our selection frame, only eight departments[6] who had claimed to have computerized crime incident report data available since at least 1980.

Each of these departments were again contacted and asked specific questions about access to the data, the nature of geocoding for geographic analysis, and the quality and reliability of the information (see Appendix B). Four departments (Washington D.C., Louisville, Mobile, and New Orleans) were not cooperative in providing additional information regarding their data and computer systems and were dropped from consideration. Beyond the fact that we were not able to collect sufficient information regarding their computer records systems, we believed that their non-responses suggested that they were unlikely to be fully cooperative in providing data in the future. We also eliminated Portland and Buffalo because their surveys revealed that data in earlier years was likely to be unreliable or incomplete. This left us with only Seattle and San Jose as potential study sites. San Jose was eliminated as its crime rate was unusually low as compared with other police departments in cities with similar populations.[7]

Seattle spans approximately 84 square miles. According to the 2000 U.S. Census, it is the 22nd most populous city (563,374) in the United States and its population has remained relatively constant from 1970 to 2000. Although Seattle's population is primarily Caucasian

[6] Metropolitan Police Department, Washington, DC; Buffalo Police Department, Buffalo, New York; Louisville Police Department, Louisville, Kentucky; Portland Police Department, Portland, Oregon; Seattle Police Department, Seattle, Washington; Mobile Police Department, Mobile, Alabama; San Jose Police Department, San Jose, California; New Orleans Police Department, New Orleans, Louisiana.

[7] The average crime rate per 100,000 residents in the United States for cities between 100,000 and 1,000,000 inhabitants is approximately 6,650. San Jose falls well below this average at 2,944, which is also well below Seattle's rate of 9,264.

(70.1 percent), it has a substantial ethnic mix of African Americans (8.4 percent), Asians (13.1 percent), Hispanics (5.3 percent) and Native Americans (1.0 percent). The number of crimes per 100,000 people in Seattle was 8,004 in 2002, 1.4 times the average for cities with populations between 100,000 and 1,000,000 (Federal Bureau of Investigation, 2002). Compared with cities in a narrower population range (±100,000 of Seattle's population), Seattle's crime rate was slightly higher than the average (7,640) and ranked eighth in sixteen jurisdictions in this category. Importantly, we gained from the outset full cooperation from the Seattle police department. The Chief of Police, Gil Kerlikowski, was very interested in research in his jurisdiction and promised and indeed ensured throughout the project that we would be given full access to data and the assistance of crime analysis personnel in the department (see appendix B, letter of support).

IV. THE DATA AND UNIT OF ANALYSIS

We believed that Seattle offered a unique opportunity for examining criminal careers at places over a long period of time and all available crime data from Seattle was initially sought, even though it was anticipated that some would not be used for this specific longitudinal study.[8] Prior to pursuing this grant, we confirmed with the Seattle Police Department Records Unit that they indeed had computerized databases of crime incidents from at least 1980 onwards. However, we were later informed after the start of the grant that although crime information had been computerized from 1980, the police department had converted records from 1989 from an records management system (RMS) data frame, or tape system, to a computerized database (ORACLE). Data prior to 1989 were retained on reel-to-reel tapes.

Because of the difference in data formats before and after 1989 and the fact that the data prior to 1989 could not be directly accessed we considered reexamining our choice of Seattle as a research site. However, after discussions with NIJ staff we decided to continue our research in Seattle beginning with the data available from 1989. Our decision was based in part on the fact that Seattle still offered one of the longest existing databases on crime that has been reliably recorded in a consistent fashion over a long period of time. Indeed, even with the fourteen years of data available to us, our study remained to our knowledge the most extensive examination of micro crime places over time presently available. But we were also impressed by the level of cooperation of the Seattle police department and could not be assured that other agencies would provide the same level of assistance to our research efforts. When the Seattle Police Department eventually located and provided us with the tapes, it was confirmed that the tapes were created using PDP data frame machines running RSX and BRU operating systems. These tapes

[8] See Lum (2003) for an in-depth discussion of data sources available from Seattle.

therefore could not be read using a modern computerized system, nor did the police department have the older technology to read the tapes. A private contractor was hired to attempt to extract data from the tapes. However, the structure of the data (the "key" in deciphering the data) could not be located, nor was any personnel at the Seattle Police Department (SPD) familiar with the original structure created. As of the time of this report, the data from 1980 to 1988 could not be analyzed.

The data that could be analyzed (1989-2002) were obtained in plain text format and then transformed into a database using a system known as Visual Foxpro.[9] Three types of data were collected, including calls for service, crime incident reports and arrest reports. Calls for service records included all 911 calls to the police, regardless of whether or not a report was written or an arrest made. Only basic information about the call was retained by the police department, including the date, time, and location of the call as well as the initial determination of the type of problem as perceived by the dispatcher and then later by the responding officer. Written report data, also commonly known as "incident report data" consisted of computerized entries of all police reports written in the study period. This incident report database included related tables which contained information about the date, time, address-level location, type of crime, further police action taken if any, and other information such as the modus operandi of the crime. The arrest data contained all records of arrest in Seattle for crimes that occurred during the specified study period (1999-2002). SPD provided this data in its entirety; all incidents, from traffic and parking offenses to homicides were included.[10]

[9] Visual FoxPro 6.0© is a product of the Microsoft Corporation.
[10] Many fields in all of these databases were not entered consistently, in particular, information about the final sentencing of offenders or the modus operandi. However, the fields of interest for this analysis were normally entered, specifically, the date, time, location, unique numerical identifiers, and crime classifications.

For this investigation, we chose to use computerized records of written reports or "incident reports" to examine crime trends as opposed to calls for service or arrest records. Incident reports are generated in the Seattle Police Department by police officers or detectives after an initial response to a request for police service and were available for the entire 14 years of interest. While calls for service data may have also been useful, Seattle Police Department only kept four of the most recent years of data which would not serve our research goals. Generally, in our initial search and survey of police department data it was not uncommon for police departments to "purge" its calls for service data. Also, in a separate analysis on these data, Lum (2003) found that calls for service and crime reports often generate very similar distributions of crime across place. Although arrest reports were available for the entire fourteen year period, we chose not to use this data as arrests only represent a small subset of crime reported to the police. The vast majority of crime never results in arrest, and to use the arrest data would have inaccurately measured the frequency of crime at places. We therefore did not use arrest reports because we thought they would exclude too much crime from our field of observation.

The geographic unit of interest for this study is the street segment (sometimes referred to as a street block or face block) defined as the two block faces on both sides of a street between two intersections. We chose the street segment for a number of reasons. Scholars have long recognized its relevance in organizing life in the city (Appleyard, 1981; Jacobs, 1961; Smith et al., 2000; Taylor, 1997). Taylor, for example, argues that the visual closeness of block residents, interrelated role obligations, acceptance of certain common norms and behavior, common regularly recurring rhythms of activity, the physical boundaries of the street, and the historical

evolution of the street segment make the street block or street segment a particularly useful unit for analysis of place (see also Hunter and Baumer, 1982; Taylor et al., 1984).

The choice of street segments over smaller units such as addresses (see Sherman et al., 1989) also minimizes the error likely to develop from miscoding of addresses in official data (see Klinger and Bridges, 1997; Weisburd and Green, 1994). We recognize however, that crime events may be linked across street segments. For example, a drug market may operate across a series of blocks (Weisburd and Green, 1995; Worden et al., 1994), and a large housing project and problems associated with it may transverse street segments in multiple directions (see Skogan and Annan, 1994). Nonetheless, we thought the street segment a useful compromise because it allows a unit large enough to avoid unnecessary crime coding errors, but small enough to avoid aggregation that might hide specific trends.

We decided at the outset to exclude those incidents that occurred at an intersection or could not be linked to a specific street segment. Of the 2,028,917 crime records initially obtained from the city from 1989 to 2002, 19 percent were linked to an intersection. Our decision to exclude these events was primarily technical. Intersections could not be assigned to any specific street segment because they were generally part of four different ones. However, it is also the case that incident reports at intersections differed dramatically from those at street segments. Traffic-related incidents accounted for only 4.5 percent of reports at street segments, but for 44 percent of reports at intersections. Places without specific geographic identifiers (for example, “University of Washington” or “Hay Street Market”) that could not be linked to a specific street segment were also excluded. Such geographically undefined places accounted for 2 percent of the incident reports in our data base. After excluding intersections, generally

defined places, and records without locations, we were left with 1,544,604 incident reports across the 14-year period requiring conversion into a Seattle street segment.

Linking of incident reports with street segments was a two step process – ensuring that the location recorded was legitimate and recognizable, and then converting it to its corresponding street segment. We identified 29,849 street segments from the street map of Seattle. Normally, a street segment in Seattle is delimited in multiples of 100. For example, addresses from 100 to 199 Main Street would most likely occur on one street segment, between two intersections or other divisions. However, there are cases in Seattle where segments could potentially extend from 100 to 299, without an intersection break. To ascertain which Seattle segments were within the scope of a "hundred block" and which extended further would have required examining each street in Seattle by hand, a task beyond the scope of this research. Even the computerized map used (from the City of Seattle's Information Technology Division) did not provide any clues regarding the extent of this problem. The database supporting the shape file (computerized map) of Seattle's streets simply gave the street name and the beginning and ending house numbers for each street on the odd and even sides. To overcome this issue, the database supporting the Seattle street map was used to develop "hundred blocks" for each city street in Seattle. For example, if the base map listed a street as spanning house numbers 1 through 399, we created four segments from this range: 1-99, 100-199, 200-299, and 300-399.

To convert event locations into a corresponding segment, both a geographic information system (ARCGIS 8.2[11]) as well as data manipulation software (Visual FOXPRO) were used. Geographic information systems (GIS) are designed to find the positions (e.g., latitude and longitude coordinates) on the earth's surface of addresses in a database (a process known as "geocoding") which can then be mathematically analyzed or electronically mapped. Although

[11] ARCGIS 8.2 is a product of Environmental Systems Research Institute.

the process of geocoding has many uses, in this analysis it was specifically used to help identify addresses that could not be matched to a computerized street map in Seattle for further cleaning. Before an event location could be converted to a street segment, it would have to be a legitimate, "geocodable" address. An initial assessment of the data after excluding intersections, undefined places and records without locations revealed that approximately 7% of the 1,544,604 did not geocode to a legitimate address.

These addresses were then cleaned for errors through both systematic mechanisms using Foxpro as well as by hand. In the end, we increased our 93% geocoding "hit rate" to 97.5%, leaving approximately 2.5% of the 1,544,604 records that could not be matched to a legitimate address.[12] We chose to exclude these 2.5% of events from our analysis, along with two other types of records. First, records whose location was given as a police precinct or police headquarters were excluded. The use of a police precinct's address as a location of a crime is common, according to the police department, when no other address can be ascertained by the reporting officer. Additionally, some reports were written for crimes that had occurred outside of the City of Seattle and these were also excluded. This left 1,490,725 crime records that were then converted into their corresponding street segments so that crime frequencies for each of the 29,849 segments for each year could be calculated.

[12] It should be noted that street segments could have been added or removed from the Seattle street map over the fourteen year period. While the City of Seattle could only provide us with their most recent up-to-date street map as of the year 2001, we recognize that this issue could be a small source of error.

V. DEVELOPING INITIAL PARAMETERS FOR THE CRIMINAL CAREERS OF PLACES

While our main interest is in describing the development of crime at places over time, it is important at the outset to describe the basic parameters of our database. Table 1 provides the overall distribution of incident reports in our 14 observation years. The most common was property crime (49.3 percent) followed by disorder, drug and prostitution offenses (17 percent) and violent person-to-person crime (11.4 percent). Another 16.5 percent of the incident reports were defined in various related categories such as weapon offenses, violations, warrants, domestic disputes, missing persons, juvenile-related offenses, threats and alarms. The remaining events were coded as traffic-related or unknown. It is important to note at the outset that we were not able to distinguish for "traffic" and "unknown" cases whether incidents were crime related because the incident report database does not include details of the events recorded. According to the Seattle Police Department, traffic incident reports were most likely not traffic citations, but rather hit and run crimes, drunk driving and accidents involving injuries. In cases where events were clearly not crime related, such as reports of assistance or administrative activities of police, we excluded them.

Table 1. Overall Distribution of Incident Reports

Type of Incident Report	%
Property Crimes (all theft, burglary, property destruction)	49.3%
Disorder, Drugs, Prostitution	17.0%
Person Crimes (homicide, all assault, rape, robbery, kidnapping)	11.4%
Other Non-Traffic Crime Related Events (for example, weapon offenses, violations, warrants, domestic disputes, missing persons, juvenile-related offenses, threats and alarms)	16.6%

Traffic-related (hit and run, drunk driving, accidents with injuries)	4.7%
Unknown	1.0%
Total	100%

Before we turn to our analysis of the dynamic patterns of crime at place over time, we wanted to examine our data in the context of the more general assumption of the concentration of crime at place. Of the 29,849 existing streets segments in Seattle, 23,135 had at least one incident over the 14-year period, leaving 6,714 segments with none. The mean number of incidents per segment was approximately 3.6 (sd = 11.8). Crime trends in Seattle overall followed the national pattern (see Blumstein and Wallman, 2000), with a decline in incident reports at least since 1992 (see Figure 1). Between 1989 and 2002, Seattle street segments experienced a 24-percent decline in the number of incidents recorded. And, when examining only Part I Uniformed Crime reports for Seattle over a longer period of time, the mimicking of the national trend is also clearly evident (Figure 2).

Figure 1. Seattle Street Segment Crime Trends

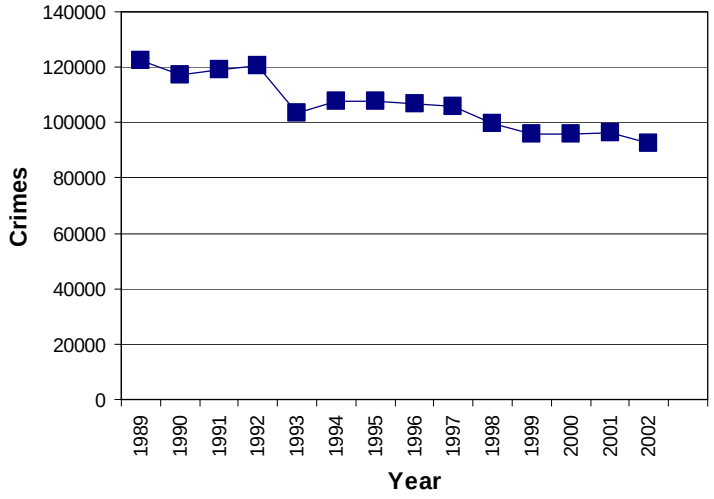
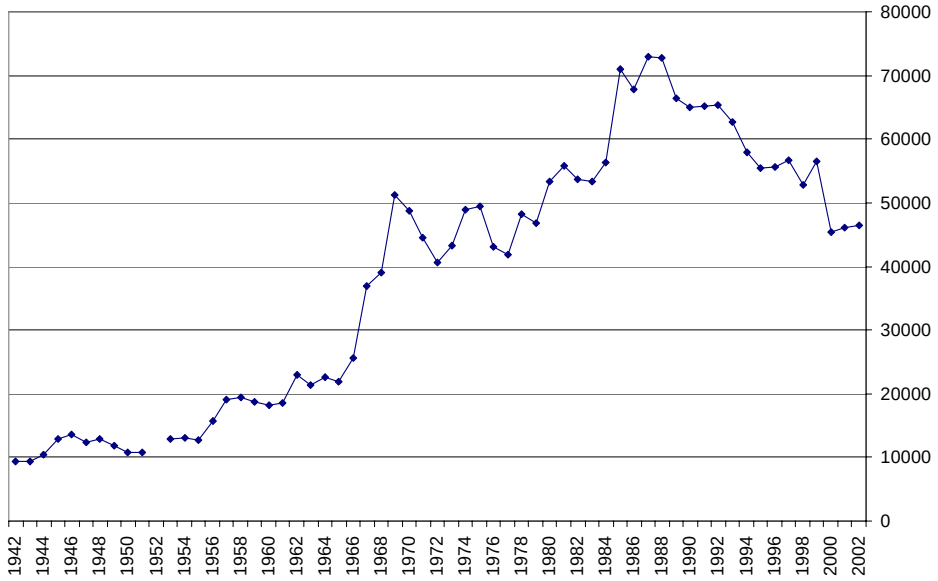


Figure 2. Seattle UCR Part I Crime Trends, 1942 – 2002[13]



Figures 1 and 2 provide the overall path of offending from 1989 to 2002 for one geographic unit – the City of Seattle. However, our interest was in much smaller geographic units within Seattle and changes (or the lack of changes) in the frequency of crime events (or "offending") over the fourteen years for each of those units. Specifically, although crime trends over time illustrated in Figures 1 and 2 only show the general intensity or frequency of crime in Seattle, they do not provide answers as to specific variations in the crime trends over time across each of our 29,849 individual street segments.

To unravel this issue, we began examining more specifically these trends for each of the segments. In terms of the crime type makeup of our segments, a large majority of places in Seattle experienced some crime event over the fourteen year period (see Table 2). Across the fourteen years, the mean number of incident reports per street segment was approximately 3.6

[13] This data was compiled by data provided in Seattle Police Department's Annual Reports available from 1942-2002.

(sd = 11.8). The percentage of the city that experienced violence was much smaller compared to non-violent crimes.

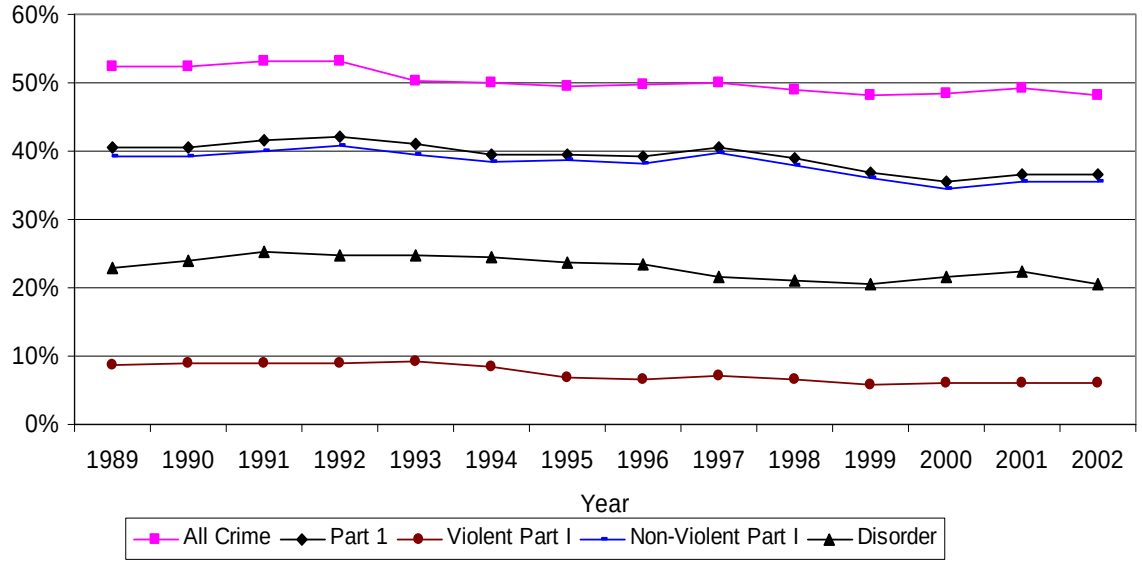
Table 2. Participation: Percentage of the city that had ever experienced specified crime type over the study period

Crime Type	% of total segments that experienced this type of crime
All crime	78%
UCR Part I	71%
UCR Violent Part I	33%
UCR Non-violent Part I	70%
Disorder[14]	61%

As with Table 1 and Figures 1 and 2, however, Table 2, still does not tell us how much of the city is affected each year and whether these distributions change from year to year. So, we sought to look across the fourteen years by determining the percentage of segments with a specified crime category for each year. Figure 3 illustrates that across the fourteen year period, the percentage of segments each year which experience a specified type of crime changes little.

Figure 3. Percentage of Total Segments in Seattle with Specified Crime Type by Year

[14] Disorderly conduct, alcohol related disorders, disturbances, generic fights without any assault reported, gambling, harassment, dumping, littering, menace, nuisance, obscenity, obstruction, vandalism, loitering, suspicious activity, trespassing, mischief, etc.



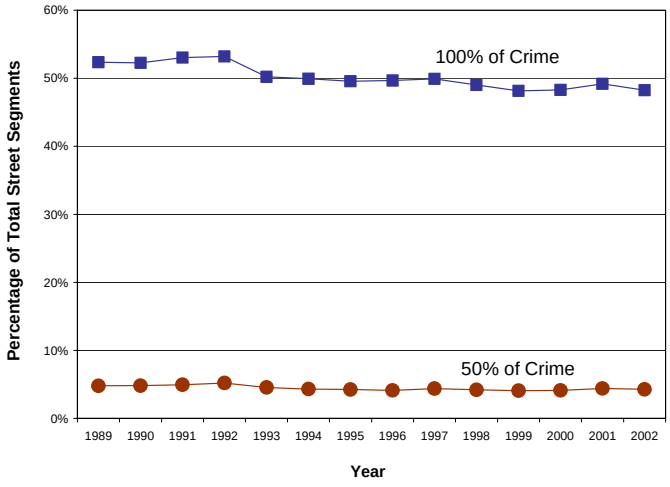
Comparing Table 2 with Figure 3 illustrates an important point. For example, across the entire fourteen year period, 78% of Seattle experienced at least one crime event. However, each year, the percentage of segments which experience an event consistently declines slightly, hovering around 50%. Yet, we still do not know whether for each year, the same segments experienced the crime represented by Figure 3. There may be changes in where crimes occur and ultimately, perhaps variations within segments that are masked by these aggregations. Thus, although Figure 3 provides us with some clues as to the nature of crime over time in street segments generally, it still fails to illustrate whether for each year, the same segments constitute those that experience a particular type of crime or whether the next year's percentage represent a new mix of segments and crime types.

Another approach we took in understanding variations in the frequency of crime events at places over time was to extend Sherman et al.'s (1989) measure of concentration at one year to our fourteen years. Sherman and his colleagues reported that over a period of a year 50.4% of all

calls for service in Minneapolis occurred at 3.3% of all addresses and intersections and that 100% of such calls occurred at 60% of all addresses, a finding confirmed by a number subsequent studies. For example, Weisburd and Green (2000) found that approximately 20% of all disorder crimes and 14% of crimes against persons were concentrated in just 56 drug crime hot spots in Jersey City, New Jersey which comprised only 4.4% of street segments and intersections in the city. Eck et al. (2000) found that the most active 10% of places (in terms of crime) in the Bronx and Baltimore accounted for approximately 32% of a combination of robberies, assaults, burglaries, grand larcenies and auto thefts.

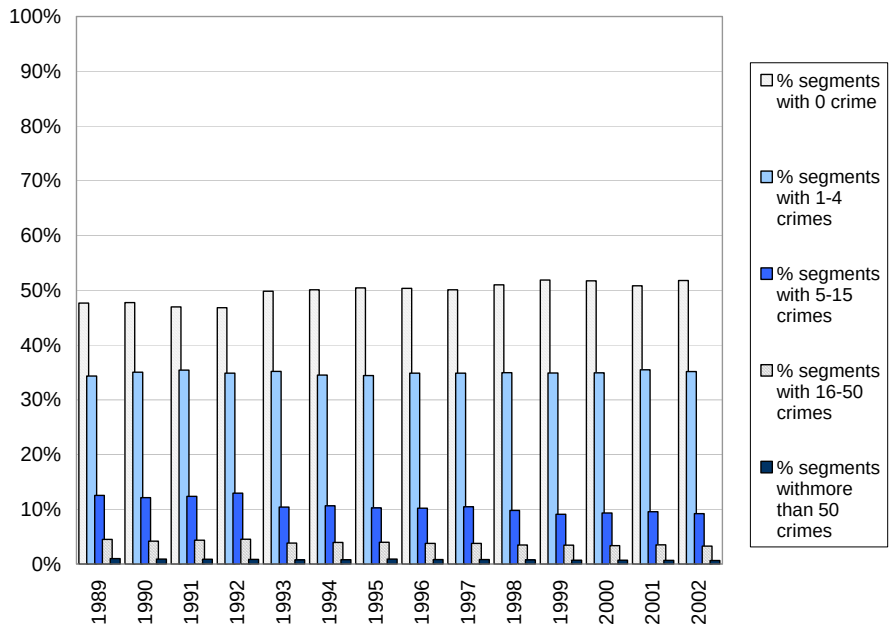
As Figure 4 illustrates, very similar findings for all reported incidents are found for each of the fourteen years observed in Seattle. Between 4 and 5 percent of all street segments account for about fifty percent of incident reports in our data in each of the years examined. 100% of all incident reports are found in between 48 and 53% of all street segments. Figure 4 suggests that a general concentration of crime in hot spots exists, which follows a consistent pattern over time.

Figure 4. Crime Concentration in "Hot Spots"



However, as with previous figures, Figure 4 still does not point to whether individual street segments change over time in terms of the levels of crime that occur within them. A simple review of our data also suggests a significant degree of stability of crime concentrations over time. In Figure 5 we report the percentage of street segments in each year with a specific number of incident reports. Though there is variability, the overall distribution is fairly similar from year to year. For example, the percentage of street segments with no recorded crime varies between 47 percent and 52 percent. Similarly, the proportion of street segments with one to four incidents varies only slightly, between 34 percent and 35 percent. The proportion with more than 50 recorded crime events in a year is approximately 1 percent across all 14 years. Of course, it may be that although the proportions of street segments with specific thresholds of crime activity remain consistent year to year, the actual segments within each of these thresholds change. This change is still not reflected in Figure 5.

Figure 5. Crime Concentration Stability across Seattle Street Segments



These descriptive exercises on the aggregate data continued to leave many of our initial research questions unanswered. Specifically, these approaches provide evidence of general consistency of concentration of crime across the fourteen year period, yet did not provide further answers to the specific behaviors of the individual 29,849 segments. Were there places for which there are different patterns of crime over time; for example, are there places that show consistent increases in the number of events while other places that show consistent decreases in the number of offenses? Did some places accelerate and then decelerate during the study period? Could we differentiate places that were stable compared to those that fluctuated in terms of crime frequencies? As illustrated in these examples, the ability when using traditional approaches to measure frequency of crime events at a place and over time is limited. Because of this, we then turned to examining each of the 29,849 segments and attempted to characterize these segments as to the percent change in frequency of events at each segment from year to year. This was a daunting task, as average percent changes across the years for each segment masked non-linear variations of direct interest to our research questions. Additionally, the complexity in reducing 29,849 segments with year to year differences into categories that could be interpreted was difficult. This exercise led us to explore a recently developed tool in the study of developmental patterns of criminal careers, defined as trajectory analysis (Jones et al., 2001; Nagin, 1999; Nagin and Tremblay, 2001). In the next chapter we detail the application of this approach to criminal careers of places and discuss our general findings.

VI. CRIME TRAJECTORIES OF PLACES[15]

Because of initial limitations of previous approaches as outlined in the preceding chapter, and because we were unaware of any available technique currently in use in the criminology of places that would allow us to answer many of our research concerns, we turned to methods used by developmental criminologists. In particular, we believed that group-based trajectory analysis (Nagin, 1999, in press; Nagin and Land, 1993) might be especially helpful in understanding accelerations, decelerations, onset, desistance or stability of crime event occurrences at these places over time. This technique and related complementary growth curve techniques such as hierarchical linear modeling (Bryk and Raudenbush, 1987, 1992; Goldstein, 1995) and latent curve analysis (McArdle and Epstein, 1987; Meredith and Tisak, 1990; Muthen, 1989; Willet and Sayer, 1994) are designed to allow developmental researchers in the social sciences to measure and explain differences across population members as they follow their developmental path.[16] The need for such techniques arose in the 1980s as psychologists, sociologists and criminologists all began to turn to the study of developmental processes rather than to static events or states (see Bushway et al., 2001; Hagan and Palloni,1988; Laub et al., 1998; Loeber and LeBlanc, 1990; Moffitt, 1993).

The group-based trajectory model, first described by Nagin and Land (1993) and further elaborated in Nagin (1999, in press), is specifically designed to identify clusters of individuals with similar developmental trajectories and it has been utilized extensively to study patterns of change in offending and aggression as people age (see Nagin, 1999; Nagin and Tremblay, 1999).

[15] We are indebted to Shawn Bushway of the University of Maryland for working with us on the development of trajectory models and for his writing of significant portions of this Chapter of our report.
[16] For an overview of these methods, see Raudenbush (2001), Muthen (2001), Nagin (1999) or Nagin (in press).

As such, we believe it is particularly well suited to our goal of exploring the patterns of change in the Seattle data.

Formally, the model specifies that the population is comprised of a finite number of groups of individuals who follow distinctive developmental trajectories. Each such group is allowed to have its own offending trajectory (a map of offending rates throughout the time period) described by a distinct set of parameters that are permitted to vary freely across groups. This type of model has three key outputs: the parameters describing the trajectory for each group, the estimated proportion of the population belonging to each group, and the posterior probability of belonging to a given group for each individual in the sample. The posterior probability, which is the probability of group membership after the model is estimated, can be used to assign an individual to a group based on their highest probability.[17]

This approach is less efficient than linear growth models but allows for qualitatively different patterns of behavior over time. There is broad agreement that delinquency and crime is one such case where this group-based trajectory approach might be justified, in large part because not everyone participates in crime, and people appear to start and stop at very different ages (Muthen, 2001; Nagin, 1999, in press; Raudenbush, 2001). Given that we have no strong expectation about the basic pattern of change, the group-based trajectory approach appears to be an excellent choice for identifying major patterns of change in our data set.[18]

There are two software packages available that can estimate group-based trajectories: Mplus, a proprietary software package, and Proc Traj, a special procedure for use in SAS, made

[17] The group-based trajectory is often identified with typological theories of offending such as Moffit (1993) because of its use of groups (see Nagin et al., 1995). But it is important to keep in mind that group assignments are made with error. In all likelihood, the groups only approximate a continuous distribution. The lack of homogeneity in the groups is the explicit trade off for the relaxation of the parametric assumptions about the random effects in the linear models (Bushway et al., 2003). For a different perspective on this issue, see Eggleston et al. (2004).

[18] Those interested in a more detailed description of the group-based trajectory approach should see Nagin (1999) or Nagin (in press).

available at no cost by the National Consortium on Violence Research (for a detailed discussion of Proc Traj, see Jones et al., 2001).[19] In using Proc Traj, we had three choices when estimating trajectories of count data: parametric form (Poisson vs. Normal vs. Logit), functional form of the trajectory over time (linear vs. quadratic vs. cubic), and number of groups.

The Poisson distribution is a standard distribution used to estimate the frequency distribution of offending that we would expect given a certain unobserved offending rate (Lehoczky, 1986; Maltz, 1996; Osgood, 2000).[20] We found that the quadratic was uniformly a better fit than the linear model, and that the cubic model did not improve the fit over the quadratic in the case of a small number of groups. In choosing the number of groups we relied upon the Bayesian Information Criteria because conventional likelihood ratio tests are not appropriate for defining whether the addition of a group improves the explanatory power of the model (D'Unger et al., 1998). These models are highly complex, and researchers run the risk of arriving at a local maximum, or peak in the likelihood function, which represents a sub-optimal solution. The stability of the answer when providing multiple sets of starting values should be considered in any model choice (McLachlan and Peel, 2000). In the final analysis, the utility of the groups is determined by their ability to identify distinct trajectories, the number of units in each group, and their relative homogeneity (Nagin, in press).

[19] The procedure, with documentation, is available at www.ncovr.heinz.cmu.edu.

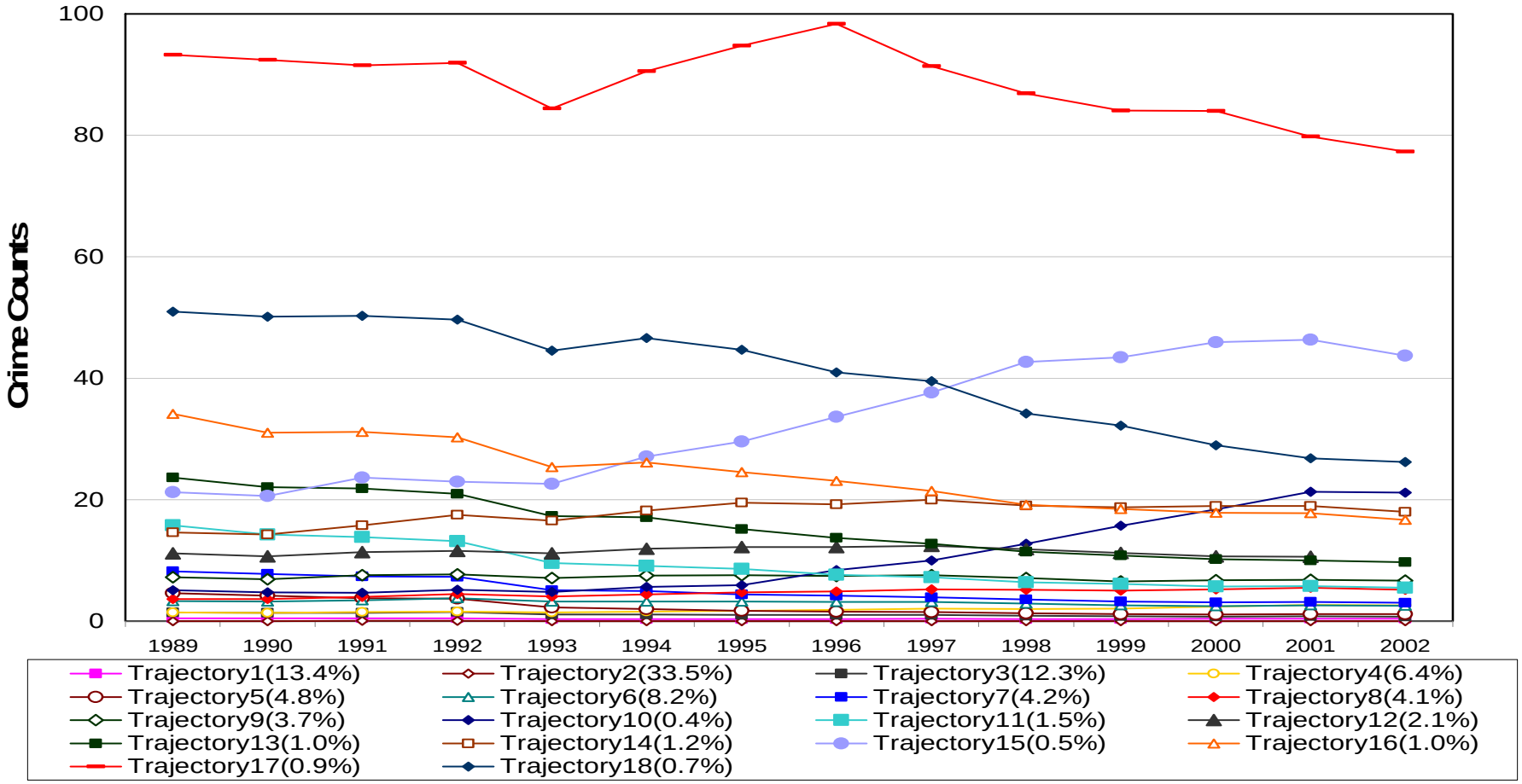
[20] Proc Traj also provides the option of estimating a Zero Inflated Poisson (ZIP) model. The ZIP model builds on a Poisson by accommodating more non-offenders in any given period than predicted by the standard Poisson distribution. The zero-inflation parameter can be allowed to vary over time, but cannot be estimated separately for each group. It is sometimes called an intermittency parameter, since it allows places to have "temporary" spells of no offenses without recording a change in their overall rate of offending. In this context, the ZIP model's differentiation between short-term and long-term change is problematic. The Poisson model, on the other hand, tracks movement in the rate of offending in one parameter, allowing all relatively long-term changes to be reflected in one place. We believe this trait of the Poisson model makes it the better model for modeling trends, especially over relatively short panels, even though the ZIP model provides a better fit according to the BIC criteria used for model selection. For a similar argument see Bushway et al. (2003).

We began our modeling exercise by fitting the data to three trajectories. We then fit the data to four trajectories and compared this fit with the three-group solution. When the four-group model proved better than the three-group, we then estimated the five-group model and compared it to the four-group solution. We continued adding groups, each time finding an improved BIC, until we arrived at nineteen groups. We were unable, despite repeated attempts, to estimate the twenty-group solution and interpret this failure to mean that such a solution is not viable. The nineteen-group solution had a better BIC score than the eighteen-group, but proved very unstable, meaning that it did not converge to the same solution in multiple attempts with similar starting values. In each case, the model simply divided a larger group into two parallel curves. In contrast, the eighteen-group model found the same solution in at least four attempts from different starting values, and created a new group with a different shape than we found in the seventeen-group analysis.[21] We therefore chose the eighteen-group model with a BIC score of -626,182.42.

Figure 6 illustrates the final eighteen trajectories we obtained with the percentage of segments that fall within each trajectory. The figure presents the actual average number of incident reports found in each group over the 14 year time period. The main purpose of trajectory analysis is to identify the underlying heterogeneity in the population. What is most striking, however, is the tremendous stability of crime at places suggested by our analysis. Looking at the trajectories, it is clear that although many have different initial intercepts in terms of the level of criminal activity observed, most evidence relatively stable slopes of change over time.

[21] It is worth noting that this model was extremely complex because of the large number of segments. As a result, the model estimation was time and computer intensive. For example, the eighteen-group model took 8 hours and 15 minutes to converge using an AMD Athlon (TM) 2100 1.73 GHZ machine with 1.00 GB of RAM.

Figure 6. Eighteen Trajectory Solution for Seattle Street Segments



Note: The percentages in parentheses represent the proportion of street segments that each trajectory accounts for in the city of Seattle.

The stability of crime at place over time is reinforced when we look at the number of street segments found within the trajectories. By far the largest trajectory, in terms of number of segments, trajectory 2 (with 33.5% of the street segments) changes little throughout the study period. Similar trends are noted in trajectories 1 and 3 which again include large numbers of street segments and at the same time evidence a very high degree of stability in crime trends over time. As the stability of crime at place is one of the central findings of our study, we wanted to explore this stability and the instability evidenced in our trajectory analysis more carefully to understand more clearly the developmental trends evidenced in our data. We take this approach in the next chapter of our report.

VII. VARIABILITY AND INVARIABILITY OF CRIME AT PLACE

In the previous chapter we used trajectory analysis to provide a general view of the development of crime at place over time. Our main conclusion was that there was a good deal of stability in the frequency of crime at place over time. In this chapter we want to examine this stability more closely, with the intent of both defining its degree across street segments and in examining and exploring contrary developmental trends that suggest invariability of crime at place. This approach allows us to distinguish between general trends of stability in our data, and specific changes that occur across specific trajectories of street segments. It also allows us to shed light on more general trends in crime that have been observed over the last decade. The "crime drop" which we discussed in Chapter 5 is illustrated by our data in Seattle as in data drawn from other American cities. Our trajectory analysis of crime at place suggests a new interpretation of these data that focuses less on trends across cities than on the developmental patterns of specific groups of street segments.

Stable, Decreasing and Increasing Trajectories

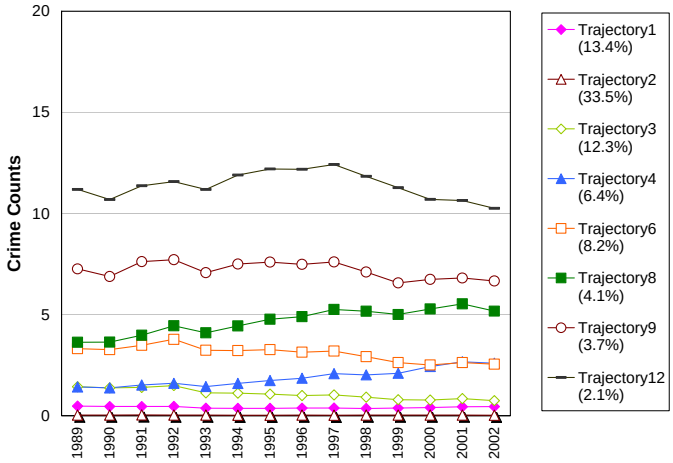
The eighteen trajectories represented in Figure 6 can be interpreted more easily if we classify our trajectories into common patterns. To simplify our description and to focus our discussion more directly on the question of stability of crime at place across time, we divided the trajectories from Figure 6 into three groups: stable, increasing and decreasing trajectories (Figures 7, 8 and 9, respectively). To aid in this classification, which does not depend on the quadratic term in the fitted trajectories, we fit a linear curve to the average number of offenses at each time point for each group. This created eighteen linear trend lines that were either basically

stable, declining or increasing. Under each figure, we provide the fitted linear slope and intercepts for each trajectory.[22]

Figure 7 illustrates clearly the dominance of street segments with stable crime trajectories during the fourteen year study period. As is apparent in Figure 7, the stable trajectories had slopes very close to 0 (ranging from between -.0779 and +.1412). Eight of the eighteen trajectories we identified fit this pattern, and they represent fully 84 percent of all the segments we examined. This reinforces our discussion in the previous chapter and suggests that most places in Seattle evidenced little change in crime during the fourteen year study period and did not follow the general crime declines found in Seattle as a whole. Indeed, there is a decrease of only 1,590 in incident reports between 1989 and 2002 in stable trajectories, a decline of only 4 percent. This may be contrasted with the overall decline of about 30,000 incidents in the city as whole, a 24-percent drop.

[22] We justify our use of a fitted linear trend to curves estimated using a quadratic functional form in the present case because we are primarily interested in differentiating between the simple direction of the trend, and not the shape of the downward or upward trend. Use of the simple linear slope makes this classification easier to present than if we provided the parameters of the quadratic curves. We also use the approach of presenting the actual average curve rather than the smoothed quadratic curve because of the unique nature of geographic, rather than individual data. In this case, we had a number of segments that routinely reported more than fifty crimes. This seems plausible in the case of places, but is unrealistic in the case of individuals, where the most likely explanation for such outliers is over reporting or data entry error. In most analyses of individuals (see Nagin and Land 1993; Jones et al. 2001), the distribution is truncated at approximately fifty to estimate Proc Traj, a practice done without loss of generality. In this case however, presenting the smoothed curves using the data truncated at fifty would in fact be misleading since these types of high crime places are plausible, realistic and an important part of the crime story in Seattle. To get around the shortcomings of the parametric form without harming the descriptive story, we first estimated the groupings based on the truncated distribution, but report the graphs using the untruncated, actual data. This manipulation only affected approximately 1 percent of the segments over the 14 years.

Figure 7. Stable Trajectories



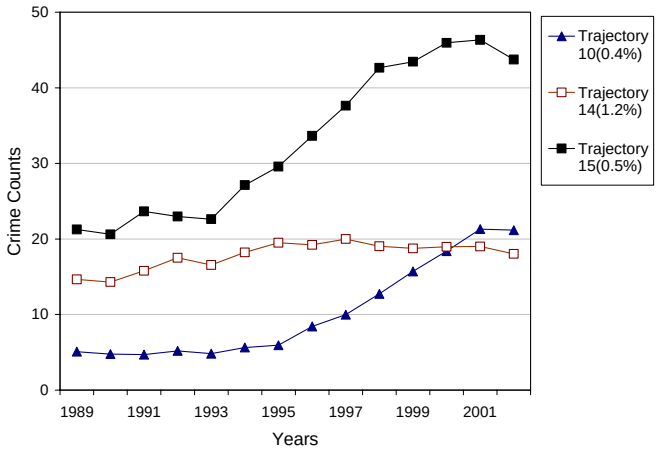
Trajectory	Slope	Intercept
1	-0.0036	0.4382
2	-0.0004	0.0339
3	-0.0583	1.5181
4	0.1005	1.1367
6	-0.0779	3.6649
8	0.1412	3.6051
9	-0.0531	7.5848
12	-0.0353	11.652

It is important to note that these trajectories overall also had relatively low intercepts. For example, trajectories 1 and 2 account for almost half of all the street segments in the city, but may be classified more generally as “no crime” segments, given that their trajectories remain close to zero. In contrast, however, trajectory 12, accounting for about 2 percent of the street segments, shows a stable crime pattern of just over 10 incidents per year and trajectory 9, accounting for almost 4 percent of the segments, has a rate of about 7 incidents per year.

Despite the overall stability in crime at place over the study period, there is evidence of both increasing and decreasing trends. The number of street segments found in trajectories that represented noticeable increasing slopes during the study period is comparatively small. Only about 2% of the street segments (609 segments) in the entire city exhibited trends opposite to the

general trend, which Proc Traj grouped into three trajectories (Figure 8). Nonetheless, despite only two percent of segments showing these developmental trends, the overall crime changes noted here are sometimes large. Trajectory 15, for example, though beginning with a rate of crime of a bit more than 20 incidents per year, increased to more than 40 by the end of the study period. Trajectory 10 began with a relatively low rate of offending of 5 crimes but suddenly increased in the early to mid 1990s, increasing its average crime rate more than four fold during the observation period to an average of more than 20 incident reports per year for each segment.

Figure 8. Increasing Trajectories



Trajectory	Slope	Intercept
10	1.4128	-0.3176
14	0.3306	15.345
15	2.3191	15.555

In criminal career or developmental vocabulary, these places are examples of *acceleration* or *escalation* of crime frequency. Overall these segments accounted for a 6,507 increase in incident reports between the initial and final observation years, representing a 42% increase in reported crime over this period. Not only is the acceleration itself interesting, but

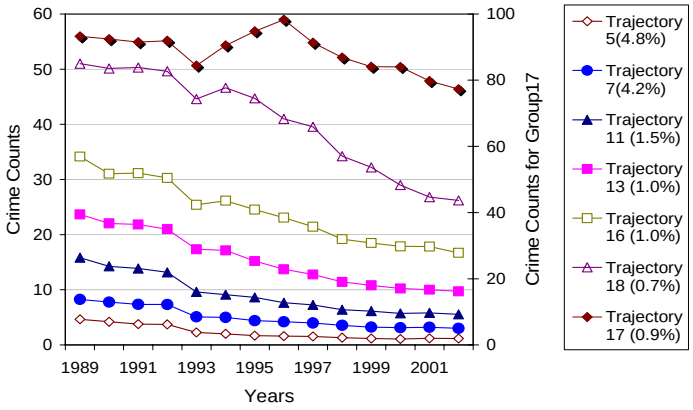
trajectory analysis also revealed variations in the general levels of acceleration. For example, while Trajectory 10 and 15 both represent segments that showed acceleration or escalation in their crime "careers," segments in Trajectory 10 on average had significantly fewer crime per year than segments in Trajectory 15. It is important to note that variations in increasing trajectories shown here may represent places at different levels of development, though the time frame of our data does not allow us to examine this question directly. For example, the low intercept of Trajectory 10 may represent segments closer to the onset of their offending careers, while Trajectory 15 may be a continuation of an early process represented by Trajectory 10. Trajectory 14 may represent a deceleration in the velocity of places with previously increasing frequencies of crime, or a gradual increase of crime frequency from more stable places. Here, different intercepts and slopes may provide further hints as to the development of places across even longer periods than our fourteen years. More generally, though our examination of crime at place looks at a longer period of time than prior studies, these analyses suggest the potential importance of looking at crime trends over much longer periods of time than are available in our data base.

We also found seven *decreasing* trajectories identified in our analysis accounting for about 14% of the street segments in the city (Figure 9).[23] These trajectories represent segments which may have *de-escalated* or moved towards *desistence* in terms of their overall crime frequencies. The extent of the declining slopes varied a good deal across the segments identified here (between -2.1302 to -.2782), as did the intercepts observed. Trajectories 5 and 7 with their relatively lower intercepts and also smaller slopes as compared to the other trajectories in this group appear to represent a "low decreasing" group as compared with the remaining "high decreasing" trajectories.

[23] For visualization purposes, trajectory 17's scale is illustrated on the right side of the graph.

It is significant that, despite the variability of crime across these segments over time, the highest rate trajectories remain relatively high throughout the observation period, and the lower rate trajectories remain lower both in terms of their intercepts and final estimates. For example, the highest rate trajectory begins at a rate of almost 95 incidents and has at the end of our study an average rate of more than 75 incidents. This is still, a higher rate than any other trajectory in our study. Similarly, the largest declining slope (trajectory 18) has an initial estimate of over 50 incidents and falls to about 25. Again, this is still higher than the final estimates for all lower intercept decreasing trajectories we examine.

Figure 9. Decreasing Trajectories (Low and High Rate)

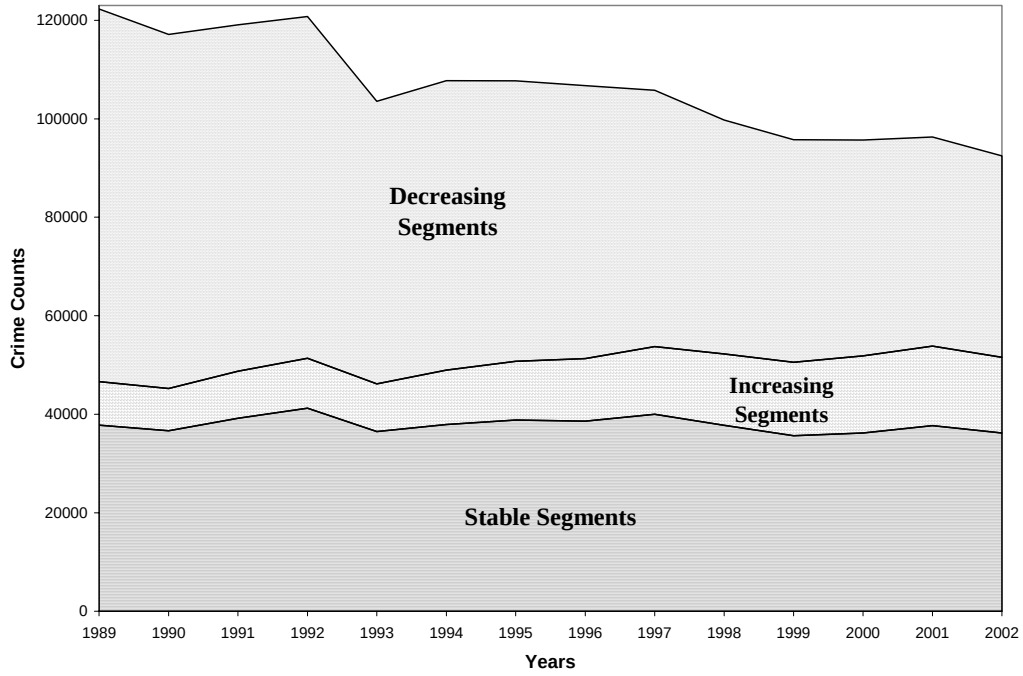


Trajectory	Slope	Intercept
5	-0.2782	4.3213
7	-0.4306	8.1892
11	-0.8166	15.333
13	-1.1729	24.287
16	-1.3664	34.337
17	-0.9911	96.048
18	-2.1302	56.391

Crime Trajectories and General Crime Trends

One interesting observation that can be drawn from our examination of developmental trends of crime at street segments in Seattle is that the overall crime decline in Seattle is not general to the city, but rather concentrated in a small number of street segments that fall into groups that are associated with declining trajectories. This is illustrated in Figure 10, which illustrates the proportion of crime in our database that is accounted for by each of the three trajectory types across the observation period. The area at the bottom of the figure represents crime that occurred in stable trajectories, and shows that their contribution to the overall number of incident reports in the city remains relatively stable throughout the 14 years examined in our study. The increasing trajectories, represented in the next shaded area, provide for a slight increase in crime. When combining both stable and increasing trajectories, representing about 86 percent of the street segments, we identify a small increase in crime between 1989 and 2002. In contrast, we can see that the shaded area associated with decreasing segments provides a fairly consistent degree of decline in the crime rate as measured by incident reports. Indeed, the decreasing trajectories, which show a decline of about 35,000 incidents between the first and last year of observation, can be seen as more than accounting for the overall crime drop in Seattle street segments of about 30,000 events during the study period.

Figure 10. Seattle Crime Drop Analysis



VIII: THE GEOGRAPHY OF CRIME TRAJECTORIES

In addition to identifying these pathways of "offending" of places, we also sought to understand whether these trajectories were geographically related in some way. We think that the use of a micro place level of analysis has allowed us to examine crime trends at places with greater precision. However, it might be argued that this choice has masked more general clustering of crime trends within neighborhoods or communities. For example, it might be the case that decreasing trajectory street segments are clustered within a certain area or district of the city. If this were the case, it would then be important to consider whether the developmental trends we examined were primarily artifacts of developmental trends in larger areas or communities. Similarly, if increasing trajectory street segments were found to be located in only one or two areas of the city and clustered immediately next to each other, we might conclude that the developmental trends at street segments were simply a function of dramatic changes in one or two specific neighborhoods in the city, and of course may be better understood at the neighborhood or area level.

To examine these questions we decided to look preliminarily at the geography of the trajectory groupings in the city of Seattle. We developed kernel density maps for each of the three types of trajectories identified in Chapter VII (see Figure 11). Kernel density maps provide a visual interpretation of the number of events across a geographic area, estimated at every point in that area. Kernel density estimates intensity by creating a moving circular window around the region that measures the number of event locations from the center of the window outward at a specified distance, known as a "bandwidth".[24] The intensity is measured at every point to create

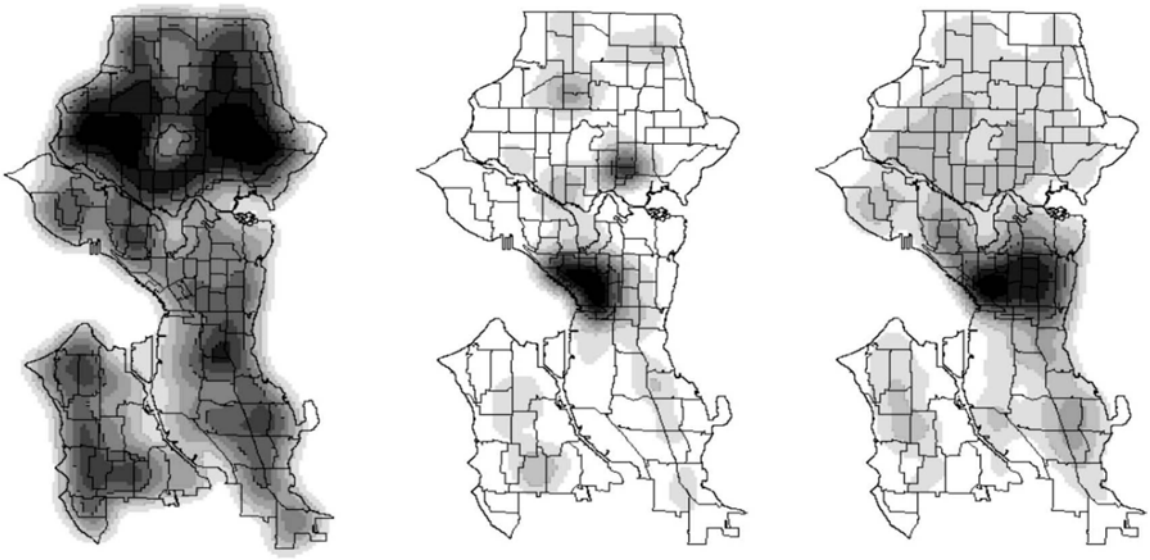
[24] Formally, the kernel density estimation function is represented by the following equation:

$$\hat{\lambda}_{\tau}(s) = \frac{1}{\delta_t(s)} \sum_{i=1}^{n} \frac{1}{\tau^2} k\left(\frac{s - s_i}{\tau}\right)$$

a "smooth" estimate of the terrain of event locations. To estimate kernel densities of segments classified within stable, increasing or decreasing trajectories, equal bandwidths for each estimation were set at 5000 map units with equal output cell sizes of 500 map units. Equalizing bandwidths and output cell sizes allows for comparison among maps.

Figure 11. Kernel Density Estimations

a. Stable Trajectory Group b. Increasing Trajectory Group c. Decreasing Trajectory Group



We recognize that this is only a general estimate of the concentration of segments within each grouping and that further geographic examination using spatial analysis is needed.[25] Overall, though, Figure 11 suggests that street segments of each of the three defined types are spread throughout the city. At the same time there are places of concentration. Segments

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Here, the mean estimated intensity of a particular location is denoted by $\lambda_\tau(s)$. $k()$ is the probability density function, which is the function of intensity around a particular point, the radius of the kernel being the *bandwidth*, or τ and the center of the kernel, s. See Bailey and Gatrell (1995) for a full explanation of kernel density estimation.

[25] We are looking more carefully at the geography of crime trajectories in another paper (see Lum et al., in progress).

classified into stable trajectories, for example (see figure 11a), appear to have considerable diffusion across the entire city, but are especially prominent in more affluent and less densely populated areas in the north of the city. Similarly, though a relatively small proportion of the street segments are increasing trajectories (Figure 11b), we find concentrations in most areas of the city. There is even greater spread of decreasing segments (Figure 11c), though this may be due in part to the larger number of segments in this grouping. At the same time, we do find that there are concentrations of increasing and decreasing trajectories in the urban center of the city. This is particularly interesting in part because it suggests that there may be similar causal processes underlying both types of trajectories.

Kernel density analysis is only the beginning of a wide-scale spatial analysis of the geographic distribution of these trajectories currently being undertaken. Specifically, nearest neighbor spatial dependence analysis of specific areas may provide further substance to this analysis that segments of similar trajectories may cluster. As the analysis reported here already reflects major research efforts, this more in-depth analysis will be reported through future research. Yet, these findings still suggest the salience of analysis at the street segment level. But they also raise the question of whether more general social or demographic trends may be influencing the developmental processes underlying crime at street segments. In the next chapter we examine this question in the context of available information on the social characteristics of street segments.

IX: EXPLAINING SOCIAL, ECONOMIC AND DEMOGRAPHIC DIFFERENCES IN PLACE-BASED TRAJECTORIES

Our finding of distinct trajectories that represent stable as well as variant crime trends at places raises the question of whether such places evidence distinct social or demographic characteristics and changes. Is it the case that increasing trajectories show different characteristics than decreasing or stable trajectories? How is change over time in the social and demographic characteristics of places related to the nature of developmental trends in crime at such places? While our data are limited in this case to census information available at the block group level for two census waves (1990 and 2000), we thought it important to take a preliminary look at such information on the social and demographic characteristics of crime places to see what they could tell us about the relationship between the characteristics of crime place trajectories and crime trends.

We use the census block group for identifying characteristics of street segments because it is the smallest geographic unit for which detailed information is collected by the Census Bureau. A block group consists of a number of blocks and contains all social, demographic, and economic variables collected on the U.S. Census "Long Form" which is given to a sample of all households. Accordingly, if there are strong differences between the demographic characteristics of street segments within a block group this will be masked in our analyses. Nonetheless, the only smaller unit available for analysis, the census block (which includes the four faces of a city block) only includes minimal information regarding the age and race of individuals within the block (collected on the Census "Short Form"). Moreover, the Census Bureau develops block groups with an eye toward keeping within the boundaries of the block

groups some homogeneity of social and economic characteristics (U.S. Department of Commerce, 1994).

To assign each of the 29,849 segments a block group (to then subsequently characterize each segment with 1990 and 2000 census information), ARCGIS was used to spatially join a census block group shape file (obtained from the U.S. Census) to our data. Spatial joining is a method conducted within a GIS to assign geographic indicators of map 1 to that of map 2 by ascertaining where shapes in map 1 fall into map 2. This join resulted in a loss of 223 segments (0.7%) of our initial data because of the minor geographic inconsistency between the 1990 and 2000 census map boundaries provided by the U.S. Census. After this join was accomplished, Foxpro was used to transfer block group level data from the 1990 and 2000 census to each of the 29,626 street segments. A number of social, economic and demographic variables were chosen from the census based on work of other scholars who have been concerned with social ecology (Gottfredson et al., 1991; Gottfredson and Taylor, 1986; Shaw and McKay, 1942; Wooldredge, 2002). The variables used in both waves of census data are listed in Table 3 with their means and standard deviations across all segments.

Table 3. Descriptive Statistics of the 1990 and 2000 Census Variables Chosen

	1990		2000	
	Mean	Standard Deviation	Mean	Standard Deviation
Population	921.82	456.096	1031.88	423.138
Median Income[26]	45260.2	19778.9	53870.6	21970.6
Female Headed	0.0483	0.05756	0.04693	0.05082

[26] The values for median income in the 1990 U.S. Census (which measured income in 1989) were converted to its value in 1999 dollars (which is reported in the 2000 U.S. Census) using the Consumer Price Index Conversion Factor Scores provided by the U.S. Bureau of Labor Statistics.

Household				
% Under Poverty	0.10814	0.1172	0.1056	0.10015
% with College Degree	0.36518	0.19519	0.46869	0.19434
Population Density	7316.34	4997.42	8157.97	6555.46
% African Americans	0.09624	0.15779	0.0779	0.11266
Heterogeneity (% non-white / % white)	0.77461	1.67289	1.0673	2.65133
Unemployment Rate	0.0496	0.04898	0.05228	0.06599

Overall, the census data suggest a growth in overall wealth and educational levels between 1990 and 2000 in Seattle. Median income increased by $8,610 during this period, while the general increase across the U.S. was only $1,612.[27] The proportion of those with college degrees also increased much beyond the national average, with almost half of the population having a college degree in the most recent census year. At the same time the percent under poverty did not decline significantly in the ten year period and unemployment was found to increase. Perhaps most significantly, population heterogeneity, as measured by the percent of non-white over the percent white inhabitants, increased more than three fold between 1990 and 2000.

One commonly observed relationship in studies of the trajectories of individual offenders is that there is a direct negative relationship between measures of wealth and social stability and the initial intercepts, or initial crime frequencies, found for offender groupings (see Nagin et al., 1995). This finding is confirmed when we examine trajectories of crime places. Table 4 lists the 18 crime trajectories we observed in order of the intercepts (or average initial crime rates) defined by our analyses. As expected, trajectories with low intercepts and thus low initial rates

[27] The 2000 U.S. Census listed the median income for the United States as $41,994 (as measured in 1999). The median income of the U.S. in 1989 (as reported in the 1990 census and converted to 1999 dollars) was $40,382.

of crime tend to score much higher on measures of wealth and educational standing, and much lower on those of poverty or minority concentration.

Table 4. Mean Values of Census Variables for Each of the 18 Trajectories

Intercept	Trajectory # (1-18)	Population	Median Income	Female Headed Household	% Under Poverty	College Degree	Population Density	%Blacks	Hetero-geneity (% non-white / %white)	Unemploy-ment Rate
-0.3176	10 (N=122)	946.67	34085.939	0.060	0.196	0.292	8243.994	0.149	1.169	0.065
0.0339	2 (N=9964)	943.970	47560.813	0.045	0.088	0.368	6464.230	0.073	0.587	0.045
0.4382	1 (N=3982)	909.49	47632.489	0.046	0.098	0.374	6680.208	0.088	0.750	0.048
1.1367	4 (N=1904)	915.19	43577.094	0.052	0.111	0.347	7120.275	0.102	0.907	0.049
1.5181	3 (N=3667)	904.480	49092.111	0.043	0.089	0.396	7191.222	0.084	0.667	0.046
3.6051	8 (N=1210)	967.88	40291.246	0.055	0.125	0.331	8239.935	0.108	0.971	0.053
3.6649	6 (N=2415)	910.88	44216.490	0.050	0.105	0.368	7698.670	0.102	0.823	0.049
4.3213	5 (N=1414)	836.08	53397.648	0.044	0.085	0.431	6975.849	0.103	0.682	0.047
7.5848	9 (N=1101)	974.12	36649.616	0.058	0.153	0.314	8925.555	0.129	1.168	0.058
8.1892	7 (N=1253)	842.08	44740.921	0.051	0.118	0.386	7995.464	0.131	0.891	0.054
11.652	12 (N=616)	946.53	33363.453	0.060	0.174	0.313	9893.098	0.150	1.173	0.065
15.333	11 (N=448)	855.95	36351.894	0.074	0.180	0.325	9149.248	0.204	1.479	0.066
15.345	14 (N=339)	959.46	30136.940	0.045	0.203	0.314	10195.782	0.118	0.929	0.067
15.555	15 (N=140)	1035.54	28280.756	0.044	0.214	0.291	10692.063	0.094	0.699	0.062
24.287	13 (N=305)	863.57	30125.159	0.075	0.211	0.288	10100.587	0.196	1.649	0.082
34.337	16 (N=293)	953.19	29547.899	0.075	0.231	0.276	11475.084	0.215	1.668	0.081
56.391	18 (N=195)	966.54	29723.767	0.059	0.236	0.290	11698.567	0.153	1.297	0.080
96.048	17 (N=250)	1003.15	31314.810	0.043	0.245	0.307	10332.222	0.120	0.868	0.074

These findings suggest that the negative relationship between the intercept, or initial rate of offending for offender trajectories, is also found in trajectories of crime places. But a more

intriguing question is whether specific changes in demographic characteristics over time can be associated with specific types of crime-place trajectories. While the census data do not coincide directly with the years observed in our study, we can gain an overall portrait of the relationship between memberships in the different groups of trajectories that we described above and demographic trends by comparing the 1990 and 2000 census information across groups of trajectories (see Table 5).

Table 5. Average Percent Changes of Demographic Variables between the Three Trajectory Groupings [(2000-1990)/1990]

	Stable Trajectories	Decreasing Trajectories	Increasing Trajectories
Population	0.11	0.18	0.23
Median Income	0.19	0.21	0.24
Female Headed Households	-0.01	-0.10	-0.01
% Under Poverty	-0.01	-0.07	-0.06
College Degree	0.28	0.27	0.33
Square Miles	N/A	N/A	N/A
Population Density	0.10	0.14	0.29
% African American	-0.18	-0.25	-0.12
Heterogeneity	0.40	0.24	0.61
Unemployment	0.05	0.04	0.24

Interesting, we do not find clear and consistent patterns in expected directions. Those trajectories which evidenced an increasing frequency of crime also experienced, compared to

stable or decreasing crime segments, the highest increases in population, population density and racial heterogeneity. However, these segments also evidenced the greatest increases in median income and the percentage of individuals with college degrees. Decreasing trajectories on the other hand, compared only with stable crime segments also had, in the ten year period measured, increases in population, median income, population density and the percentage of individuals *not* under the poverty line. Segments with decreasing crime frequencies during the fourteen years also had the greatest decline of African Americans or single females with children living within those segments.

Perhaps the most significant pattern observed in the data is that rapid social change appears to be associated with changes in crime frequencies. Overall, with the exception of the percent of African American residents and general racial homogeneity, decreasing and increasing trajectory street segments commonly evidence more social change than street segments in the stable trajectory grouping. This finding is consistent with research regarding crime changes over time in communities carried out by Bursik and Webb (Bursik, 1986; Bursik and Webb, 1982). They found that after 1950, there was evidence of racial and ethnic population changes and corresponding increases or decreases in delinquency rates. Bursik and Webb (1982) argued that at these macro-level areas there may be instability in delinquency over time and that the time it takes for a community to stabilize itself from a dramatic change in its population may be related to increases in delinquency rates while as communities established themselves, crime rates declined.

Our analysis here is of course exploratory, and we think it is important to be careful in drawing any causal inferences. Theoretically, concerns of ecological fallacy may arise when attempting to make inferences about individual-level data (in this case, crimes that occur on a

street segment) based on aggregate level phenomenon (block-group census information). Methodologically, conducting regression analysis on units in which multi-level data have been assigned can be problematic (see Byrk and Raudenbush, 1992; Raudenbush and Byrk, 2002). Moreover, we recognize that the relationship we have examined may not be indicative of a causal sequence but might for example reflect more general factors that influence both crime and social characteristics of places. These concerns and a further exploration into the importance of social, demographic and economic variables are currently being addressed in a related research endeavor.[28] Nonetheless, our data do provide the first opportunity we are aware of to see whether changes in social characteristics of micro places are related to their criminal careers.

[28] See Lum et al., in progress.

X. CONCLUSIONS

Our data both reaffirm and challenge common assumptions about the distribution of crime at places over time. On the one hand our data confirm prior studies that suggest that there is a very high concentration of crime at specific places in a city. We find moreover, such concentration of crime in crime hot spots across the 14 years of our study. On the other hand, we do not find one simple answer regarding the developmental patterns of crime places over time. Indeed, our use of a dynamic modeling approach allowed us to identify different trajectories of offending at places. While the vast majority of street segments in Seattle showed a stable pattern of offending during the study period, a significant minority evidenced either strong decreasing or increasing crime trends. This in some sense confirms the importance of the criminal career approach not only in regard to communities (Schuerman and Kobrin, 1986) but also to places (Sherman, 1995; Weisburd, 1997). But it also suggests greater complexity in describing and understanding crime patterns at micro places than has been suggested in prior studies.

Variability and Invariability of Crime at Place Across Time: Implications for Theory and Practice

In our introduction we argued that prior studies of concentration of crime at place do not provide a solid empirical basis for focusing either theory or practice on micro places. Even if there is tremendous concentration of crime at crime hot spots, as has been documented (see Brantingham and Brantingham, 1999; Crow and Bull, 1975; Pierce et al., 1986; Roncek, 2000; Sherman et al., 1989; Weisburd and Green, 1994; Weisburd et al., 1992), if there is little stability in such concentration across time, the underlying assumptions of this new area of research interest and practical crime prevention would be challenged. Our study enabled us to go beyond

prior description of crime at micro places in two ways. First, we were able to examine assumptions about the stability of crime at place looking at a longer time series than has been available in prior research. Second, we were able to investigate whether different developmental trends are found across groups of places. Taking this approach we find strong support for the position of stability of crime at micro places across time.

Eighty-four percent of the street segments we examined could be grouped into what we defined as stable trajectories. That is, the vast majority of street segments in Seattle showed a remarkably stable pattern of crime over a 14-year period. Moreover, even in the case of the increasing and decreasing trajectories, changes in the rates of incident reports over time suggest a kind of stability of scale. For example, the two decreasing trajectories with the highest initial rates of more than fifty incident reports do not decline to fewer than twenty-five at the end of the study period—still placing these trajectories among the most active in our study. And the highest frequency increasing trajectory, which ended in an average count of more than forty incidents, still began with a rate of more than twenty.

The finding of stability of crime at micro places over time is mirrored in early research on the nature of longitudinal patterns of crime within communities. For example, Shaw and McKay (1942) found that patterns of delinquency in the city of Chicago remained relatively stable over time despite continuous population changes. They argued that the process of invasion and succession of individuals moving into and out of communities contributed to social disorganization, and that subcultures of delinquency were passed on from those leaving to those coming in through institutionalized mechanisms. In particular, the zones of transition were characterized not only by consistently high levels of delinquency but also by many other social

ills, such as high infant morbidity, vacant housing and increased opportunities for illegitimate activities.

Calvin Schmid (1960) also identified evidence of stability of crime in communities over time when analyzing geographic patterns in Seattle using a panel approach. Using census tract boundaries and comparing relatively short time frames (from 1939 to 1941 and from 1949 to 1951) Schmid found that when comparing the frequency of homicide, rape, robbery and burglary in these two sets of years, zones that were high in crime remained high and zones that were lower in frequency also remained low. Crime concentrations in Schmid's research were most likely located at the center of the city within the "business district." Schmid also studied the city of Minneapolis from 1933 to 1936 and found similar evidence that areas of the city that had higher concentrations of crime in 1933 also evidenced high concentrations of crime across the four year period.

Accordingly, one can find strong parallels for the stability of crime at places in the stability that has often been observed in crime in larger geographic units such as neighborhoods. This in turn would seem to support more generally recent theory and practice concerning crime hot spots (e.g., see Braga, 2001; Eck and Weisburd, 1995; Sherman, 1995; Sherman et al., 1989; Taylor, 1997; Weisburd, 2002). At the heart of the hot spots approach is the assumption that crime is concentrated at a discrete group of places, that specific attributes of such places can explain the very high levels of crime that are found there, and that such attributes are fairly stable over time. In turn, this stability provides opportunity for practical crime prevention to interrupt otherwise stable developmental patterns.

It might be argued that the fact that trajectories that show the largest increases or decreases in the number of incident reports are also those with the highest crime frequencies to

begin with, suggesting that random factors unlikely to be under the control of the police or the community might play an important part in the crime patterns found in our data. For example, "regression to the mean" could be one explanation for highly variable crime patterns. Very high levels of crime at a particular time might decline simply as part of a more general set of chance processes. While this explanation could apply to the trajectories with the very highest initial incident report rates, it does not explain why we do not find dramatic increases in incident reports over time at the very lowest rate places, which would be the other side of the regression to the mean phenomenon.

While we do not discount the workings of random fluctuations in our data (Spelman, 1995), we think the overall stability that we observe suggests that such fluctuations are much less important than systematic factors. Our data do not allow us to define directly these underlying causes of crime at place. Nonetheless, before concluding we would like to speculate on the potential mechanisms leading to the distributions we observe and discuss the types of studies that would help us to more fully understand crime trajectories at places.

Many studies of crime hot spots have relied on routine activities theory (see Cohen and Felson, 1979) as an explanation for why crime trends vary at places and as a basis for constructing practical crime prevention approaches (see Eck, 1995; Sherman et al., 1989). The main assumptions of this perspective are that specific characteristics of places such as the nature of guardianship, the presence of motivated offenders, and the availability of suitable targets will strongly influence the likelihood of criminal events (see also Felson, 1994). Studies examining the factors that predict crime at micro places generally confirm this relationship (see Roncek and Bell, 1981; Roncek and Maier, 1991; Smith et al., 2000).

Routine activities theory does not necessarily predict stability of crime at place over time. Indeed, the theory was originally developed to explain changes in crime rates that were observed over long periods and that were related to changes in routine activities (Cohen and Felson, 1979). But most scholars advocating hot spots approaches have argued that the routine activities of places are likely to be fairly stable over relatively shorter periods of time such as the 14 years in this study (see Sherman, 1995; Weisburd, 2002). The availability of suitable targets, of capable guardians, and the presence of motivated offenders in this context are not expected to change rapidly under natural conditions in the urban landscape, though they are likely to change over longer periods as routine activities of offenders, victims and guardians change as well. Accordingly, the overall stability of crime at place we observe in our data is consistent with routine activities theory.

Although we can only speculate on changes in routine activities over time, a theory of routine activities at crime hot spots (see Sherman et al., 1989) might also explain the variability in the increasing and decreasing trajectories. Those advocating hot spots approaches have assumed that the routine activities of places can be altered in the short term by interventions such as greater police presence (see Sherman and Weisburd, 1995; Weisburd and Green, 1995). Indeed, the short-term stability of crime at place predicted by routine activities theory and the assumed amenability of routine activities to change through police or community intervention is seen to provide a strong basis for crime prevention at hot spots (see Braga, 2001; Eck and Weisburd, 1995; Sherman, 1995; Sherman et al., 1989; Taylor, 1997; Weisburd, 2002). It may be that declining trajectories in our study are places where aspects of routine activities that prevent crime have been encouraged, perhaps because the police have focused more attention on them. Increasing crime trajectories could represent places where crime opportunities have

increased, perhaps as a result of the introduction of new targets through urban renewal, or motivated offenders through the introduction of easy transportation access or perhaps the displacement of offenders from other crime hot spots that have been the focus of police or other crime prevention measures.

While routine activities theory has been a central feature of recent interest in crime hot spots, it is important to note that other theoretical approaches might also be consistent with our findings. Ecological theories of social disorganization used to explain the stability of crime patterns in communities (see Schmid, 1960; Shaw and McKay, 1942), for example, might also be applied to micro crime places (see Smith et al., 2000). In this case one might expect a stability of crime patterns because there is an underlying social and demographic stability at places (see Bursik, 1986). Conversely, relatively stable high crime rates at places may be explained by continuous social change that prevents the establishment of strong social bonds and community controls at the micro place level (e.g. see Shaw and McKay, 1942). Relatively high numbers of increasing and decreasing trajectories (representing on average higher overall rates of crime) in the urban center of Seattle are consistent with this perspective, as are the low rate stable trajectories showing higher concentrations in the less densely populated and more affluent northern parts of the city.

But if social disorganization variables explain the crime patterns we observe, formal social controls, such as hot spots policing, may have less potential for affecting the trajectories of crime at places. While the police may affect social disorganization at crime places by reinforcing forces of social organization and social control, the social disorganization perspective suggests emphasis on a much broader set of policies than increased police attention. If the primary causal mechanism underlying crime trajectories can be found in factors such as single

family households, racial heterogeneity and economic deprivation, all linked to the social disorganization perspective, then a much wider set of social interventions would be required to change the form of trajectories at crime hot spots. Of course, it may be that a combination of routine activities and social disorganization variables influence crime patterns at micro places (see Smith et al., 2000), and thus a complex combination of interventions might be required to have a meaningful and long term impact on crime at hot spots.

Accordingly, while we think that our finding regarding the stability of crime at place across time is a robust one and is consistent with the theoretical arguments underlying crime prevention practice at hot spots, our study suggests that more analysis of crime trajectories at places drawing from a much more comprehensive set of data is needed. Future studies should examine changes in the social and demographic characteristics of places over time, and in the characteristics of their routine activities and guardianship, including the role of police activities in altering crime trajectories. Such data would be needed to tease out the characteristics of places that encourage stability and those which lead to change in crime rates, and would provide a basis for testing directly the relevance of routine activities theory and theories of social organization for understanding trajectories of crime at micro places over time.

Because different causal mechanisms may underlie different types of crime (Clarke, 1983) examination of crime trajectories of specific types of crime might also lead to new insights. It may be for example, that homicide or robbery trajectories at places differ markedly from those we observed here, though of course such studies might encounter new problems in defining trajectories when the occurrence of such crime events is relatively rare at micro units of analysis. In turn, while focusing on general trends, such as those represented by stable, increasing and decreasing trajectories, has allowed us to examine assumptions underlying hot

spots approaches, more specific analyses of specific trajectories would likely increase our understanding of the dynamics of crime at place.

Finally, while our study has examined a longer time series than has been available to other scholars, it is still relatively short when one considers the overall developmental patterns of crime at places. Theories of routine activities and social disorganization are often concerned with changes that occur over decades or even longer time periods (e.g. see Bursik, 1986; Bursik and Webb, 1982; Cohen and Felson, 1979). Our analysis accordingly, may have underestimated dynamic elements of change over the long run and thus provides only a part of the story of crime trajectories at places. Although such long-term longitudinal data may prove extremely difficult to identify, they would provide key insights into the nature of trajectories of crime at places and the underlying theoretical mechanisms that explain such change.

Crime Place Trajectories and the Crime Drop

Whatever the specific strategies that may influence crime at hot spots, the overall trends we observe in our data reinforce the basic premise of recent interest in micro crime places. Indeed, our observations regarding the crime drop in Seattle have important implications for understanding crime trends more generally. Our data show that the crime drop in Seattle is not a phenomenon that occurs broadly across the city landscape. Most of Seattle's street segments experienced little change in crime during the period of study. The crime drop in Seattle is found in a relatively small group of segments that are associated with decreasing trajectories. This suggests that large impacts on the crime rate can be gained by focusing on very specific types of places.

Our finding that specific trajectories account for the crime drop in Seattle moreover is consistent with broader trends in crime and violence across American cities.[29] Comparing changes in crime rates as measured by the Uniform Crime Reports between 1995 and 2002 it is clear that trends of crime were different in major cities in the United States despite the overall crime drop (Federal Bureau Investigation, 1995, 2002). Some cities experienced substantial decreases (e.g., New York, New Orleans and Baltimore), some experienced little change (e.g., Phoenix and Denver), and some even experienced large increases (e.g., Indianapolis and San Antonio) in violent crime at least for substantial periods in the 1990s (see also Blumstein, 2000; Travis and Waul, 2002). While the national trends illustrate an overall decrease during the 1990s, there was thus a good deal of variability across cities. When looking at specific crimes there has also been acknowledgement of important differences across populations. For example, Cook and Laub (1998, 2002) observe that the youth violence epidemic was concentrated among minority males who resided in poor neighborhoods, used guns and engaged in high risk behaviors such as gang participation (see also Braga, 2003).

Conclusions

Our analysis of crime at street segments in Seattle over a 14-year period and our use of the trajectory approach allowed us to fill an important gap in our understanding of crime at micro places. Our study confirms prior research showing that crime is tightly clustered in specific places in urban areas, and that most places evidence little or no crime. But we also are able to show that there is a high degree of stability of crime at micro places over time. This stability is evident in the vast majority of street segments in our study of 14 years of official data.

[29] We are indebted to Anthony Braga for bringing this insight to our attention.

Moreover, for those trajectories that evidenced decreasing or increasing trends, we still found a stability of scale with the highest rate segments generally remaining so throughout the observation period.

Our data however, also suggest that crime trends at specific segments are central to understanding overall changes in crime. The crime drop in Seattle was confined to very specific groups of street segments with decreasing crime trajectories over time. If the trends in Seattle are common to other cities, the crime drop should be seen not as a general phenomenon common to places across a city but rather as focused at specific places.[30] Such places in our study are also street segments where crime rates are relatively high. This reinforces a public policy approach that would focus crime prevention resources on hot spots of crime (Braga, 2001; Sherman and Weisburd, 1995; Skogan and Frydl, 2003; Weisburd and Braga, 2003; Weisburd and Eck, 2004).

These observations are of course preliminary given the nature of our data. Our more general findings must be subjected to examination in other contexts and across other micro place units. To understand the etiology of crime trajectories at micro places we also need more insight into the nature of such places and their experiences across the periods of study. Nonetheless, our examination of trajectories of crime at micro places over time suggests the importance of a developmental, criminal career perspective in the study of micro crime places (Sherman, 1995; Weisburd, 1997).

[30] One reviewer, Anthony Braga, has suggested that our finding that specific trajectories account for the overall crime drop in Seattle is consistent with broader trends in crime and violence across American cities. While the national trends illustrate an overall decrease in crime during the 1990s, there was a good deal of variability across cities (Blumstein, 2000; Travis and Waul, 2002). When looking at specific crimes there has also been acknowledgement of important differences across populations. For example, Cook and Laub (1998, 2002) observe that the youth violence epidemic was concentrated among minority males who resided in poor neighborhoods, used guns and engaged in high risk behaviors such as gang participation (see also Braga, 2003).

XI. REFERENCES

Abeyie, Daniel and Keith D. Harries (eds.)
1980 Crime: A Spatial Perspective. New York, NY: Columbia University Press.

Agnew, Robert
1992 Foundation for a General Strain Theory of Crime and Delinquency. Criminology 30(1):47-84.
1999 A General Strain Theory of Community Differences in Crime Rates. Journal of Research in Crime and Delinquency 36(2):123-155.

Akers, Ronald
1973 Deviant Behavior: A Social Learning Approach. Belmont, CA: Wadsworth Publishing.

Andrews, Donald A., Ivan Zinger, Robert Hoge, James Bonta, Paul Gendreau, and Francis Cullen
1990 Does Correctional Treatment Work? A Clinically Relevant and Psychologically Informed Meta-analysis. Criminology 28(3):369-404.

Appleyard, Donald
1981 Livable Streets. Berkeley, CA: University of California Press.

Bailey, Trevor and Anthony Gatrell
1995 Interactive Spatial Data Analysis. Harlow, England: Pearson Education Ltd.

Barr, R and K. Pease
1990 Crime Placement, Displacement and Deflection. In M. Tonry and N. Morris (eds.), Crime and Justice: A Review of Research 12. Chicago, IL: The University of Chicago Press.

Baumer, Eric, Janet Lauritsen, Richard Rosenfeld, and Richard Wright
1998 The Influence of Crack Cocaine on Robbery, Burglary, and Homicide Rates: A Cross-City, Longitudinal Analysis. Journal of Research in Crime and Delinquency 35(3):316-340.

Block, Carolyn and Richard Block
1980 Patterns of Change in Chicago Homicide: The twenties, the sixties and the seventies, 2nd ed. Statistical Analysis Center, Illinois Law Enforcement Commission.
1985 Lethal violence in Chicago over Seventeen Years: Homicides Known to the Police, 1965-1981. Chicago, IL: Criminal Justice Information Authority.

Block, Carolyn, Margaret Dabdoub, and Suzanne Fregly (eds.)
1995 Crime Analysis Through Computer Mapping, Washington, DC: Police Executive Research Forum.

Blumstein, Alfred

2000 Disaggregating the Violence Trends. In Alfred Blumstein and Joel Wallman (eds.), The Crime Drop in America. Cambridge, UK: Cambridge University Press.

Blumstein, Alfred, Jacqueline Cohen, J.A. Roth and C.B. Visher (eds.)

1986 Criminal Careers and "Career Criminals". Washington DC: National Academy Press.

Blumstein, Alfred and Joel Wallman (eds.)

2000 The Crime Drop in America. Cambridge, UK: Cambridge University Press.

Braga, Anthony A.

2001 The Effects of Hot Spots Policing on Crime. The Annals of American Political and Social Science 578:104-125.

2003 Serious Youth Gun Offenders and the Epidemic of Youth Violence in Boston. Journal of Quantitative Criminology 19(1): 33-54.

Brantingham, Patricia L. and Paul J. Brantingham

1975 Residential Burglary and Urban Form. Urban Studies 12(3):273-284.

1981 Notes on the Geometry of Crime. In Paul J. Brantingham and Patricia L. Brantingham (eds.), Environmental Criminology. Beverly Hills, CA: Sage.

1999 Theoretical Model of Crime Hot Spot Generation. Studies on Crime and Crime Prevention Volume 8(1):7-26.

Bryk, Anthony S. and Stephen W. Raudenbush.

1987 Application of Hierarchical Linear Models to Assessing Change. Psychology Bulletin 101:147-158.

1992 Hierarchical Linear Models for Social and Behavioral Research: Application and Data Analysis Methods. Newbury Park, CA: Sage.

Bureau of Justice Statistics

1987 Law Enforcement Management and Administration Statistics. Washington D.C.: Department of Justice.

1997 Law Enforcement Management and Administration Statistics. Washington DC: Department of Justice.

Bursik, Robert J., Jr.

1986 Ecological Stability and the Dynamics of Delinquency. In Albert Reiss, Jr. and Michael Tonry (eds.), Communities and Crime. Crime and Justice: A Review of Research 8. Chicago, IL: The University of Chicago Press.

Bursik, Robert J., Jr. and Harold G. Grasmick

1993 Neighborhoods and Crime. San Francisco: Lexington.

Bursik, Robert J., Jr. and Jim Webb
1982 Community Change and Patterns of Delinquency. American Journal of Sociology 88(1):24-42.

Bushway, Shawn D., Alex Piquero, Lisa Broidy, Elizabeth Cauffman and Paul Mazerolle
2001 An Empirical Framework for Studying Desistance as a Process. Criminology 39(2):491-515.

Bushway, Shawn D., Thornberry, Terence P., and Marvin D. Krohn
2003 Desistance as a Developmental Process: A Comparison of Static and Dynamic Approaches. Journal of Quantitative Criminology 19(2):129-153.

Chaiken, J.M., M.W. Lawless and K.A Stevenson
1974 The Impact of Police Activity on Crime: Robberies on the New York City Subway System. Report no. R-1424-NYC. Santa Monica, Calif.: RAND.

Clarke, Ronald V.
1983 Situational Crime Prevention: Its Theoretical Basis and Practical Scope. In Michael Tonry and Norval Morris (eds.), Crime and Justice: An Annual Review of Research 14. Chicago, IL: The University of Chicago Press.
1992 Situational Crime Prevention: Successful Case Studies. Albany NY: Harrow and Heston.
1995 Situational Crime Prevention: Achievements and Challenges. In Michael Tonry and David Farrington (eds.), Building a Safer Society: Strategic Approaches to Crime Prevention, Crime and Justice: A Review of Research 19. Chicago, IL: The University of Chicago Press.
1996 Situational Crime Prevention: Successful Case Studies. Guilderland, New York: Harrow and Heston.

Clarke, Ronald V. and Derek B. Cornish
1983 Crime Control in Britain: A Review of Policy Research. Albany, NY: State University of Albany Press.

Clarke, Ronald V., S. Field and G. McGrath
1991 Target Hardening of Banks in Australia and Displacement of Robberies. Security Journal 2: 84-90.

Clarke, Ronald V. and David Weisburd
1994 Diffusion of Crime Control Benefits: Observations on the Reverse of Displacement. Crime Prevention Studies 2:165-84. Monsey, NY: Willow Tree Press.

Cloward, Richard and Lloyd Ohlin
1960 Delinquency and Opportunity. Glencoe, IL: Free Press.

Cohen, Lawrence E. and Marcus Felson
1979 Social Change and Crime Rate Trends: A Routine Activity Approach. American Sociological Review 44:588-605.

Cook, Philip J. and John H. Laub
1998 The Unprecedented Epidemic of Youth Violence. In Michael Tonry and Mark H. Moore (eds.), Youth Violence, Crime and Justice: A Review of Research 24:27-64. Chicago, IL: The University of Chicago Press.
2002 After the Epidemic: Recent Trends in Youth Violence in the United States. In Michael Tonry (ed.), Crime and Justice: A Review of Research 29:1-17. Chicago, IL: The University of Chicago Press.

Crow, W. and J. Bull
1975 Robbery Deterrence: An Applied Behavioral Science Demonstration - Final Report. La Jolla, CA: Western Behavioral Science Institute.

D'Unger, Amy, Kenneth Land, Patricia McCall and Daniel Nagin
1998 How Many Latent Classes of Delinquent/Criminal Careers? Results from Mixed Poisson Regression Analysis. American Journal of Sociology 103:1593-1630.

Duffala, Dennis C.
1976 Convenience Stores, Armed Robbery, and Physical Environmental Features. American Behavioral Scientist 20(2):227-246.

Eck, John
1993 The Threat of Crime Displacement. Criminal Justice Abstracts 25: 527-546.
1995 Examining Routine Activity Theory: A Review of Two Books. Justice Quarterly 12(4): 783-797.

Eck, John E and David Weisburd (eds.)
1995 Crime and Place: Crime Prevention Studies 4. Monsey, NY: Willow Tree Press.

Eck, John, Jeffrey Gersh, and Charlene Taylor
2000 Finding Crime Hot Spots Through Repeat Address Mapping. In Victor Goldsmith, Philip McGuire, John Mollenkopf and Timothy Ross (eds.), Analyzing Crime Patterns: Frontiers of Practice. Thousand Oaks, CA: Sage.

Eggleston, Elaine P., John H. Laub, and Robert Sampson
2004 Methodological Sensitivities to Latent Class Analysis of Long-Term Criminal Trajectories. Journal of Quantitative Criminology 20(1):1-26.

Elder, Glen Jr.
1986 Military Times and Turning Points in Men's Lives. Developmental Psychology 22: 233-245.

Farrington, D.P., S. Bowen, A. Buckle, T. Burns-Howell, J. Burrows and M. Speed
1993 An Experiment on the Prevention of Shoplifting. In Ronald V. Clarke (ed.), Crime Prevention Studies 1. Monsey, NY: Willow Tree Press.

Federal Bureau of Investigation
1995 Crime in the United States, Uniform Crime Reports--1995. Washington, DC: U.S. Department of Justice.
2002 Crime in the United States, Uniform Crime Reports--2002. Washington, DC: U.S. Department of Justice.

Felson, Marcus
1994 Crime and Everyday Life: Insights and Implications for Society. Newbury Park, California: Pine Forge Press.
1998 Crime and Everyday Life. Thousand Oaks, CA: Pine Forge Press.

Gabor, Thomas
1990 Crime Displacement and Situational Prevention: Toward the Development of Some Principles. Canadian Journal of Criminology 32: 41-74

Goldstein, Harvey
1995 Multilevel Statistical Models. (2nd ed.). London: Arnold.

Gottfredson, Michael and Travis Hirschi
1990 A General Theory of Crime. Stanford, CA: Stanford University Press.

Gottfredson, Denise C., Richard J. McNeil III and Gary D. Gottfredson
1991 Social Area Influences on Delinquency: A Multilevel Analysis. Journal of Research in Crime and Delinquency 28(2): 197-226.

Gottfredson, Stephen D. and Ralph B. Taylor
1986 Person-Environment Interactions in the Prediction of Recidivism. In Byrne, James and Robert J. Sampson (eds.) The Social Ecology of Crime. New York: Springer-Verlag.

Green (Mazerolle), Lorraine
1996 Policing Places with Drug Problems. Thousand Oaks, CA: Sage.

Guerry, Andre-Michel
1833 Essai sur la Statisticque morale de la France. Paris: Crochard.

Hagan, John and Alberto Palloni
1988 Crimes as Social Events in the Life Course: Reconceiving a Criminological Controversy. Criminology 26(1):87-100.

Hesseling, Rene
1994 Displacement: A Review of the Empirical Literature. In Ronald V. Clarke (ed.),

Crime Prevention Studies 3. Monsey, NY: Willow Tree Press.

Hirschi, Travis
1969 Causes of Delinquency. Berkeley, CA: University of California Press.

Hunter, Ronald D.
1988 Environmental Characteristics of Convenience Store Robberies in the State of Florida. Paper presented at the annual meeting of the American Society of Criminology. Chicago, IL.

Hunter, Albert and Terry L. Baumer
1982 Street Traffic, Social Integration and Fear of Crime. Sociological Inquiry 52: 122-131.

Jacobs, Jane
1961 The Death and Life of Great American City. New York: Vintage Books.

Jeffrey, Clarence R.
1971 Crime Prevention Through Environmental Design. Beverly Hills, CA: Sage.

Jones, Bobby, Daniel S. Nagin, and Kathryn Roeder
2001 A SAS Procedure Based on Mixture Models for Estimating Developmental Trajectories. Sociological Methods and Research 29(3):374-393.

Klinger, David and G. Bridges
1997 Measurement Error in Calls-For Service as an Indicator of Crime. Criminology 35(4):705-726.

Lateef, B.A.
1974 Helicopter Patrol in Law Enforcement: An Evaluation. Journal of Police Science and Administration 2: 62-65.

Laub, John and Robert J. Sampson
2003 Shared Beginnings, Divergent Lives: Delinquent Boys to Age 70. Cambridge, MA: Harvard University Press.

Laub, John, Daniel S. Nagin, and Robert J. Sampson
1998 Trajectories of Change in Criminal Offending: Good Marriages and the Desistance Process. American Sociological Review 63(2):225-238.

Laycock, Gloria and Nicholas Tilley
1995 Implementing Crime Prevention. In M. Tonry and D. Farrington (eds.), Building a Safer Society: Strategic Approaches to Crime Prevention, Crime and Justice: A Review of Research 19. Chicago: Chicago University Press.

LeBeau, James
1987 The Methods and Measures of Centrography and the Spatial Dynamics of Rape. Journal of Quantitative Criminology 3:125-141.

Lehoczky, John
1986 Random Parameter Stochastic Process Models of Criminal Careers. In Alfred Blumstein, Jacqueline Cohen, Jeffrey A. Roth, and Christy A. Visher (eds.), Criminal Careers and Career Criminals. Washington, DC: National Academy of Sciences Press.

Loeber, Rolf and Marc Le Blanc
1990 Toward a Developmental Criminology. In Michael Tonry and Norval Morris (eds.), Crime and Justice: A Review of the Research 12:375-473. Chicago, IL: The University of Chicago Press.

Loftin, Colin and Robert H. Hill
1974 Regional Subculture and Homicide: An Examination of the Gastil-Hackney Thesis. American Sociological Review 39(5):714-724.

Lum, Cynthia
2003 The Spatial Relationship between Street-Level Drug Activity and Violence. Ph.D. Dissertation. College Park, MD: University of Maryland.

Lum, Cynthia, David Weisburd, and Sue-Ming Yang
Social, Economic, Demographic and Geographic Characteristics of the Trajectories of Crime Places. (In Progress)

Maltz, Michael
1996 From Poisson to the Present: Applying Operations Research to Problems of Crime and Justice. Journal of Quantitative Criminology 12(1):3-61.

Mayhew, Patricia, Ronald V. Clarke, A. Sturman, and Mike Hough
1976 Crime as Opportunity. Home Office Research Study 34. London: H.M. Stationery Office.

McArdle, J. and D. Epstein
1987 Latent Gross Curves within Developmental Structural Equation Models. Child Development 58:110-133.

McLachlan, Geoffrey and David Peel
2000 Finite Mixture Models. New York: Wiley.

Meredith, W. and J. Tisak
1990 Latent Curve Analysis. Psychometrika 55:107-122.

Merton, Robert K.
1968 Social Structure and Anomie. American Sociological Review 3:672-682.

Moffitt, Terrie E.
1993 Adolescence-Limited and Life-Course Persistent Antisocial Behavior: A Developmental Taxonomy. Psychological Review 100:674-701.

Muthen, Bengt
1989 Latent Variable Modeling in Heterogeneous Populations. Psychometrika 54:557-585.
2001 Second-generation Structural Equation Modeling With a Combination of Categorical and Continuous Latent Variables: New Opportunities for Latent Class-Latent Growth Modeling. In Linda M. Collins and Aline G. Sayers (eds.), New Methods for the Analysis of Change. Washington, DC: American Psychological Association.

Nagin, Daniel S.
1998 Criminal Deterrence: Research at the outset of the Twenty-First Century. In Michael Tonry (ed.), Crime and Justice: A Review of Research 23. Chicago, IL: The University of Chicago Press.
1999 Analyzing Developmental Trajectories: A Semiparametric, Group-Based Approach. Psychological Methods 4:139-157.
In Press Group-based Modeling of Development Over the Life Course, Cambridge, MA: Harvard University Press.

Nagin, Daniel and Kenneth C. Land
1993 Age, Criminal Careers, and Population Heterogeneity: Specification and Estimation of a Nonparametric, Mixed Poisson Model. Criminology 31(3):327-362.

Nagin, Daniel and Richard Tremblay
1999 Trajectories of Boys' Physical Aggression, Opposition, and Hyperactivity on the Path to Physically Violent and Nonviolent Juvenile Delinquency. Child Development 70:1181-1196.
2001 Analyzing Developmental Trajectories of Distinct but Related Behaviors: A Group-Based Method. Psychological Methods 6:18-34.

Nagin, Daniel S., Farrington, David P., and Terrie E. Moffitt
1995 Life-Course Trajectories of Different Types of Offenders. Criminology 33(1):111-139.

Nettler, Gwynn
1978 Explaining Crime (2nd ed.). New York, NY: McGraw Hill.

Newman, Oscar
1972 Defensible Space: Crime Prevention Through Environmental Design. New York: Macmillan.

Osgood, D. Wayne
2000 Poisson-Based Regression Analysis of Aggregate Crime Rates. Journal of Quantitative Criminology 16(1):21-43.

Patterson, G.R., B.D. DeBaryshe, and E. Ramsey
1989 A Developmental Perspective on Antisocial Behavior. American Psychologist: 329-335.

Pierce, Glenn, S. Spaar, and L.R. Briggs
1986 The Character of Police Work: Strategic and Tactical Implications. Boston, M.A: Center for Applied Social Research, Northeastern University.

Press, S.J.
1971 Some Effects of an Increase in Police Manpower in the 20th Precinct of New York City. New York: Rand Institute.

Quetelet, Adolphe J.
1842 A Treatise of Man. Gainesville, FL: Scholar's Facsimiles and Reprints (1969 ed.)

Raine, Adrian
1993 The Psychopathy of Crime. New York: Academic Press.

Raudenbush, Stephen
2001 Toward a Coherent Framework for Comparing Trajectories of Individual Change. In Linda M. Collins and Aline G. Sayers (eds.), New Methods for the Analysis of Change: 35-63. Washington, DC: American Psychological Association.

Raudenbush, Steven and Anthony Byrk
2002 Hierarchical Linear Models: Applications and Data Analysis Methods, 2nd Edition. Newbury Park, CA: Sage Publications.

Rengert, George
1980 Theory and Practice in Urban Police Response. In: Daniel Georges-Abeyie and Keith Harries (eds.), Crime: A Spatial Perspective. New York, NY: Columbia University Press.
1981 Burglary in Philadelphia: A Critique of an Opportunity Structural Model. In Paul J. Brantingham and Patricia L. Brantingham (eds.), Environmental Criminology. Beverly Hills: Sage.

Repetto, T.A.
1976 Crime Prevention and the Displacement Phenomenon. Crime and Delinquency 22: 166-177.

Robins, Lee
1978 Sturdy Childhood Predictors of Adult Antisocial Behavior: Replications from Longitudinal Studies. Psychological Medicine 8:611-622.

Robinson, Jennifer B., Brian A. Lawton, Ralph B. Taylor, and Douglas D. Perkins.
2003 Multilevel Longitudinal Impacts of Incivilities: Fear of Crime, Expected Safety, and Block Satisfaction. Journal of Quantitative Criminology 19(3):237-274.

Roncek, Dennis
2000 Schools and Crime. In Victor Goldsmith, Philip McGuire, John Mollenkopf, and Timothy Ross (eds.), Analyzing Crime Patterns Frontiers of Practice. Thousand Oaks, CA: Sage.

Roncek, Dennis and Ralph Bell
1981 Bars, Blocks, and Crimes. Journal of Environmental Systems 11(1):35-47.

Roncek, Dennis and Pamela Maier
1991 Bars, Blocks and Crimes Revisited: Linking the Theory of Routine Activities to the Empiricism of "Hot Spots". Criminology 29(4):725-754.

Sampson, Robert
1985 Neighborhood and Crime: The Structural Determinants of Personal Victimization. Journal of Research in Crime and Delinquency 22(1):7-40.

Sampson, Robert and W. Byron Groves
1989 Community Structure and Crime: Testing Social Disorganization Theory. American Journal of Sociology 94:774-802.

Sampson, Robert and John Laub
1993 Crime in the Making: Pathways and Turning Points through Life. Cambridge, MA: Harvard University Press.

Schmid, Calvin
1960 Urban Crime Areas: Part II. American Sociological Review 25(5):655-678.

Schuerman, Leo and Solomon Kobrin
1986 Community Careers in Crime. In Albert Reiss, Jr. and Michael Tonry (eds.), Communities and Crime. Crime and Justice: A Review of Research 8. Chicago, IL: The University of Chicago Press.

Shaw, Clifford, Frederick Zorbaugh, Henry McKay, and Leonard Cottrell
1929 Delinquency Areas. Chicago, IL: The University of Chicago Press.

Shaw, Clifford and Henry McKay
1942 Juvenile Delinquency and Urban Areas: A Study of Rates of Delinquents in Relation to Differential Characteristics of Local Communities in American Cities. Chicago, IL: The University of Chicago Press.

Sherman, Lawrence
1995 Hot Spots of Crime and Criminal Careers of Places. In John Eck and David Weisburd (eds.), Crime and Place: Crime Prevention Studies 4. Monsey, NY: Willow Tree Press.

Sherman, Lawrence, Denise Gottfredson, Doris MacKenzie, John Eck, Peter Reuter and Shawn Bushway

1997 Preventing Crime: What Works, What Doesn't, What's Promising. Washington, DC: U.S. Department of Justice, Office of Justice Programs.

Sherman, Lawrence and David Weisburd

1995 General Deterrent Effects of Police Patrol in Crime "Hot-Spots": A Randomized Controlled Trial. Justice Quarterly 12:626-648.

Sherman, Lawrence, Patrick R. Gartin, and Michael E. Buerger

1989 Hot Spots of Predatory Crime: Routine Activities and the Criminology of Place. Criminology 27(1):27-56.

Skogan, Wesley

1990 Disorder and Decline. New York: Free Press.

1996 Community Policing in Chicago, Year Three. Chicago, IL: Illinois Criminal Justice Information Authority.

Skogan, Wesley and Sampson Annan

1994 Drugs and Public Housing: Toward and Effective Police Response. In Doris Mackenzie and Craig Uchida (eds.), Drugs and Crime: Evaluating Public Policy Initiatives. Thousand Oaks, CA: Sage.

Skogan, Wesley and Kathleen Frydl

2003 Effectiveness of Police Activity in Reducing Crime, Disorder and Fear. In Wesley Skogan and Kathleen Frydl (eds.), Fairness and Effectiveness in Policing: The Evidence: 217-251. National Research Council.

Smith, William, Sharon Frazee, and Elizabeth Davidson

2000 Furthering the Integration of Routine Activity and Social Disorganization Theories: Small Units of Analysis and the Study of Street Robbery as a Diffusion Process. Criminology 38(2):489-524.

Spelman, William

1995 Criminal Careers of Public Places. In John E. Eck and David Weisburd (eds.), Crime and Place: Crime Prevention Studies 4. Monsey, NY: Willow Tree Press.

Sutherland, Edwin H.

1947 Principles of Criminology: A Sociological Theory of Criminal Behavior. New York: J.B. Lippincott, Company.

Taylor, Ralph

1997 Social Order and Disorder of Street Blocks and Neighborhoods: Ecology, Microecology, and the Systemic Model of Social Disorganization. Journal of Research in Crime and Delinquency 34 (1):113-155.

1999 Crime, Grime, Fear, and Decline: A Longitudinal Look. Research in Brief. Washington, DC: National Institute of Justice.

2001 Breaking Away From Broken Windows: Baltimore Neighborhoods and the Nationwide Fight Against Crime, Grime, Fear, and Decline Boulder, CO: Westview Press.

Taylor, Ralph, Steven Gottfredson, and Sidney Brower
1984 Block Crime and Fear: Defensible Space, Local Social Ties and Territorial Functioning. Journal of Research in Crime and Delinquency 21(4):303-331.

Tierney, J. P., and J. B. Grossman, with N. Resch
1995 Making a Difference: An Impact Study of Big Brothers/Big Sisters. Philadelphia, PA: Public/Private Ventures.

Travis, Jeremy and Michelle Waul
2002 Reflections on the Crime Decline: Lessons for the Future? Proceedings from the Urban Institute Crime Decline Forum. Washington, DC: The Urban Institute.

Tyrpak, S.
1975 Newark High-Impact Anti-Crime Program: Street Lighting Project Interim Evaluation Report. Newark, NJ: Office of Criminal Justice Planning.

United States Bureau of the Census
1990 Website: www.census.gov
2000 Website: www.census.gov

United States Department of Commerce
1994 Geographic Areas Reference Manual. http://www.census.gov/geo/www/GARM/GARMcont.pdf. Retrieved January 11, 2004.

Weisburd, David
1997 Reorienting Crime Prevention Research and Policy: From the Causes of Crime to the Context of Crime. National Institute of Justice Research Report. Washington, DC: U.S. Government Printing Office.
2002 From Criminals to Criminal Contexts: Reorienting Criminal Justice Research and Policy. Advances in Criminological Theory 10:197-216.

Weisburd, David and Anthony Braga
2003 Hot Spots Policing. In H. Kury and J. Obergfell-Fuchs (eds.), Crime Prevention: New Approaches. Manz: Weisser Ring.

Weisburd, David and John E. Eck
2004 What Can Police Do to Reduce Crime, Disorder and Fear? Annals of American Political and Social Science 593:42-65.

Weisburd, David and Lorraine Green (Mazerolle)
1994 Defining the Drug Market: The Case of the Jersey City DMA System. In Doris

Layton MacKenzie and Craig D. Uchida (eds.), Drugs and Crime: Evaluating Public Policy Initiatives. Newbury Park, CA: Sage.

1995 Policing Drug Hot-Spots: The Jersey City Drug Market Analysis Experiment. Justice Quarterly 12:711-735.

2000 Crime and Disorder in Drug Hot Spots: Implications for Theory and Practice in Policing. Police Quarterly 3(2):152-170.

Weisburd, David, Lisa Maher, and Lawrence Sherman

1992 Contrasting Crime General and Crime Specific Theory: The Case of Hot-Spots of Crime. Advances in Criminological Theory 4:45-70.

Weisburd, David, and Thomas McEwen

1997 Crime Mapping and Crime Prevention. Crime Prevention Studies 8. Monsey, NY: Criminal Justice Press.

Willett, John, & Sayer, Aline G.

1994 Using Covariance Structure Analysis to Detect Correlates and Predictors of Change. Psychological Bulletin (116): 363-381.

Wolfgang, Marvin E. and Franco Ferracuti

1967 The Subculture of Violence, Toward and Integrated Theory in Criminology. New York: Tavistock.

Wolfgang, Marvin E., Robert Figlio, and Thorsten Sellin

1972 Delinquency in a Birth Cohort. Chicago, IL: The University of Chicago Press.

Wooldredge, John

2002 Examining the (IR) Relevance of Aggregating Bias for Multilevel Studies of Neighborhood and Crime with an Example Comparing Census Tracts to Official Neighborhoods in Cincinnati. Criminology 40(3); 681-709.

Worden, Robert, Timothy Bynum, and James Frank

1994 Police Crackdowns on Drug Abuse and Trafficking. In Doris Layton Mackenzie and Craig Uchida (eds.), Drugs and Crime: Evaluating Public Policy Initiatives. Thousand Oaks, CA: Sage.

XII. APPENDICES

APPENDIX A

DATA SURVEY USED FOR SITE SELECTION

Questions about the initial system

1. What year did your department first start computerizing crime incident reports?

2. Where were those reports entered? (i.e. mainframe, computer database)

3. What parts of those reports were entered ? (specifically, what fields were captured? We are interested in an address field, type of crime, case number, and date/time of the incident)

4. What is the integrity of that data?

    a. specifically, were all reports entered? Which were and weren't?

    b. were those records archived/preserved?

5. Can that data be accessed or downloaded? In what form (tape, microfilm, database or table, text file, etc)

Questions about current system

6. Is the system you are using now to computerize crime incident data the same one you started with?

7. What is the new system you use and when did you start using it?

8. What parts of those reports were entered? specifically, were the following fields captured: address, date and time, case number, type of crime

9. What is the integrity of that data?

    a. Are all reports entered? Which one's were and weren't?
    b. Where are those records kept/preserved/archived?

10. Can that data be retrieved or downloaded?

11. Has anyone ever conducted a large scale research project about older crime data in your department? Contact info?

Questions about the hardcopies of reports

12. How far back are the hardcopies (or whether paper or microfilm) kept for retrieval?

13. How does one retrieve a specific report? In other words, how are they indexed?

Questions about Calls for Service

14. How far back are computerized data for calls for service kept?

15. In what form are those calls for service? (mainframe, database)

16. What system are the calls for service kept on?

17. What fields are available in the calls for service database?

Questions about Crime Analysis

17. When did you first start geocoding data?

18. What types of data were geocoded?

19. Did you keep the geocoding of this data or was it deleted?

20. What other kinds of crime analysis do you collect?

21. What program do you use to geocode data?

22. What programs do you use for crime analysis?

23. Do you have zip drives or cd burners that you use?

24. Do you have programs already written to clean addresses for mapping?

25. Do you have someone there that knows how to manipulate data using DBF applications (i.e. FOXPRO, ACCESS, ETC)

Questions about Arrest Data

26. Are data kept on arrestees in your department?

27.How far back does this data go?

28. What is included in this data?

APPENDIX B

LETTER OF COOPERATION FROM SEATTLE POLICE DEPARTMENT

City of Seattle

Paul Schell, Mayor

Seattle Police Department
Gil Kerlikowske, Chief of Police

January 8, 2001

Dr. David Weisburd
University of Maryland
Department of Criminology and Criminal Justice
2220 Le Frak Hall
College Park, MD 20742

Dear Dr. Weisburd:

The purpose of this letter is to strongly support the proposal by the University of Maryland and yourself to study "micro" locations of crime. This is an area of particular interest to the Seattle Police Department. The ability to link location with career offenders would be, in my opinion, very helpful to law enforcement.

On behalf of the Seattle Police Department, we are most appreciative of the opportunity to participate in this research. Please feel free to contact me should you have any questions.

Sincerely,

R. Gil Kerlikowske
Chief of Police

RGK:kan

Seattle Police Department, 610 Third Avenue, Seattle, WA 98104-1886
An equal employment opportunity, affirmative action employer. Accommodations for people with disabilities provided upon request.
Call (206) 233-7203 at least two weeks in advance.