IS THERE A LAW OF CRIME CONCENTRATION FOR MOST CRIME IN A CITY? A MULTI-CITY STUDY

by

Taryn N. Zastrow

A Thesis
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DEDICATION

For my parents, Phil and Leslie Zastrow, for their constant and unwavering support.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

IS THERE A LAW OF CRIME CONCENTRATION FOR MOST CRIME IN A CITY? A MULTI-CITY STUDY

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Research has continually shown that crime is highly concentrated in small geographic places, leading Weisburd (2015) to formally propose a possible law of crime concentration. Scholars have since tested the law using smaller proportions of crime (i.e., 25% and 50%), finding remarkable consistency across place and time. However, the present study aims to address an unanswered question: Can a law of crime concentration exist for most or all crime? Using crime data from five U.S. cities, this study examines the distribution of most and all crime by calculating the proportions of crime occurring on street segments. The analysis finds that the concentration of most and all crime is relatively consistent between cities. Between 44.8% and 55.6% of street segments produced 100% of crime across the five cities, suggesting that roughly half of all street segments do not experience any crime each year. The study also finds high concentration and tight bandwidths for crime thresholds encompassing most crime. The results suggest that variation between cities may occur because of differing street networks and

landscapes. The findings fill in the gaps for literature of crime concentration, specifically the concentration of most and all crime.

INTRODUCTION

Growing evidence that crime concentrates in small geographic places led to the establishment of the "Law of Crime Concentration" by Weisburd (2015), who stated: "for a defined measure of crime at a specific microgeographic unit, the concentration of crime will fall within a narrow bandwidth of percentages for a defined cumulative proportion of crime" (p. 138; see also Weisburd, Groff and Yang, 2012). This finding has enormous implications for how researchers, practitioners, and policymakers approach crime reduction and prevention. Consequently, many studies have tested this phenomenon, examining how crime concentrates across place and time. Most of the analyses in these studies have focused on "smaller" proportions of crime, such as 25% and 50%, which has shown a remarkable consistency of concentration. However, an additional question is whether the law of crime concentration can apply to most or all the crime in a city. A small number of previous studies have suggested that roughly half of all micro-geographic places produce 100% of a city's total crime. Inversely, this suggests that half of micro-geographic places remain crime free. This offers powerful knowledge for police agencies, community organizations, city planners, or other entities looking to address crime in their cities. This thesis tests whether this phenomenon holds for 100% of crime across five United States cities and explores the possibility of a law of crime

concentration for most or all crime by examining larger proportions of crime incidents (i.e., 75% - 100%).

LITERATURE ANALYSIS

The Law of Crime Concentration

The notion that crime concentrates at small geographic places and does so in such a highly stable manner that a law could be established defining the phenomenon was first explored in the 2012 book entitled *The Criminology of Place* (Weisburd, Groff, and Yang, 2012). Here, the relationship between crime and street segments is examined in Seattle, Washington. Like prior studies on the distribution of crime, Weisburd and colleagues found that crime was very concentrated at small number of micro geographic places – 50% of crime occurred within 5-6% of street segments over a 16-year period. Not only was crime highly concentrated at place, but it remained so over time. Subsequently, Weisburd (2015) formally proposes the law of crime concentration. The law states that "for a defined measure of crime at a specific microgeographic unit, the concentration of crime will fall within a narrow bandwidth of percentages for a defined cumulative proportion of crime" (p. 138).

The proposition of such a law was influenced by several studies showing that crime concentrated at just a small percentage of places. In one of the first studies demonstrating the phenomenon, Sherman et al. (1989) found that crime was in fact not randomly distributed in Minneapolis, Minnesota. Instead, just 3.3% of unique addresses accounted for 50.4% of calls to police. Around the same time, Pierce et al., (1988) discovered 2.6% of addresses comprised 50% of calls to police in Boston, Massachusetts. After these initial studies, scholars continued to demonstrate that crime generally

concentrated at places and often did so at a rate consistent with previous studies (see Andresen & Malleson, 2011; Braga, Papachristos, & Hureau, 2014; Brantingham & Brantingham, 1999; Crow & Bull, 1975; Curman, Andresen, & Brantingham, 2015; Roncek, 2000; Weisburd & Amram, 2014; Weisburd & Green, 1994; Weisburd, Lawton, & Ready, 2012; Weisburd et al., 1992; Weisburd, Maher, & Sherman, 1992; Weisburd, Morris, & Groff, 2009).

To further support the argument that a law of crime concentration could exist, Weisburd (2015) examined a sample of eight cities ranging in size and geographic location (Brooklyn Park, MN; Cincinnati, OH; New York, NY; Redlands, CA; Sacramento, CA; Seattle, WA; Tel Aviv-Yafo; Ventura, CA). He defines cities with populations of about 300,000 to over 8,000,000 as large and cities with populations of approximately 70,000 to 108,000 as small. To calculate crime concentration across the cities consistently, he uses a standard measure of crime data (incidents), the same time frame (one year), and the same unit of analysis (street segment). He finds that approximately 50% of crime is concentrated within 4.2% to 6% of street segments in the larger cities and 50% of crime is concentrated within just 2.1% to 3.5% of street segments in smaller cities. 25% of crime was observed within 0.8% to 1.6% of street segments in larger cities, while 25% of crime was found within 0.4% to 3.5% of street segments in smaller cities. In addition to supporting the law of crime concentration, these results suggested crime may concentrate differently between cities of varying sizes.

The establishment of the law of crime concentration by Weisburd (2015) led many scholars to further test the law (see Andresen, Curman, & Linning, 2016;

Andresen, Linning, & Malleson, 2017; Breetzke & Edelstein, 2019; Bernasco & Steenbeek, 2017; Chainey et al., 2019; de Melo, Matias, & Andresen, 2015; Gill, Wooditch, & Weisburd, 2017; Hibdon, Telep, Groff, 2016; Hipp & Kim, 2016; Jaitman & Ajzenman, 2016; Park, 2019; Perry, 2019; Rosser et al., 2016). Virtually all these studies, which vary by location type and time period, have found highly concentrated levels of crime consistent with the bandwidths presented by Weisburd (2015). For example, de Melo and colleagues (2015) found that 3.66% of street segments observed half of all crime during a four-year period in a large Brazilian city. Gill et al. (2017) found that just 2% of street segments produced 50% of crime and 0.4% of street segments produced 25% of crime over a 14-year period in a United States suburb, suggesting that the law of crime concentration is applicable in non-urban contexts.

Some scholars examining larger numbers of cities have challenged the consistency of the law of crime concentration across cities, though their findings tend to confirm an overall average concentration level close to that proposed by Weisburd (2015). Hipp and Kim (2016) for example, found that five percent of street segments produced between 39 and 94 percent of crime in the 42 cities they studied. When taking out an outlier (Yorba Linda), however, which had only 211 crime incidents in a year, the range was between 39 and 61 percent. Moreover, Hipp and Kim do not present the percent of streets that produce 25 and 50 percent of crime, but rather the percent of crime that is found at the top five percent of streets, making comparisons to earlier studies difficult. In turn, many of the cities studied have more streets segments than crime incidents, reflecting both their small size and the limited crime categories that are used in

the study. Lee et al. (2017), who review a large number of prior studies also note greater variability than observed in prior studies, though again, the comparability to Weisburd's law is difficult to develop, both because the definitions of crime in the studies vary, as well as the geographic units that are examined. Important, the average concentration of crime across cities follows closely the estimates originally reported by Weisburd et al. (2012). These studies more generally highlight the importance of continuing to explore the behavior of crime and how it is distributed at the micro geographic level.

Higher Proportions of Crime

Given the steadiness of concentration for smaller proportions of crime across place and time, the question becomes whether such a law could be applied to larger proportions of crime. While the focus of crime concentration studies has primarily been around analyzing smaller proportions of crime (i.e., 25 and 50 percent of crime), a few studies have reported the concentration rates of 100% of crime, as displayed in table 1. In Seattle, 100% of incidents were found on approximately 50% of street segments over a 14-year period (Weisburd et al. 2004). In Minneapolis, 60% of addresses encompassed all calls for police service (Sherman et al. 1989). Examining concentration outside of a United States context, Andresen, Curman, and Linning (2016) found that 100% of crime occurred on 45% of street segments in Vancouver, Canada. Although caution is warranted in drawing any larger conclusions from just three studies that use different data types and units of analysis, these findings may suggest that, in general, roughly half of all microgeographic places experience no crime in a given year.

Table 1: Distribution of 100% of Crime in Past Studies

City	Years of Study	Type of Data	Unit of Analysis	Total Crime Concentration
Seattle, WA	14 (1989 - 2002)	Crime Incidents	Street segment	100% of crime at **50%** of street segments
Minneapolis, MN	1 (1986)	Calls for Police Service	Street Addresses	100% of crime at **60%** of street addresses
Vancouver, BC	1 (2006)	Calls for Police Service	Street segment	100% of crime at **45%** of street segments

Theoretical Background

The studies described above offer clear evidence that crime is highly concentrated at micro-geographic levels. So, why does crime occur on approximately half of micro-geographic places, and why doesn't crime occur on the other half of places? Scholars have used environmental theories to understand the distribution of crime. Environmental criminology is an umbrella term for a number of theories focusing on the setting of where crime occurs as well as the characteristics of those settings. The concentration of crime in "hot spots", or places with high levels of crime, can be explained by several environmental theories that place an emphasis on the opportunity of crime, including the routine activities theory and the crime pattern theory. Given that these theories support the law of crime concentration for smaller levels of crime, would we expect that most or

all crime is also concentrated? This section explores the theoretical background of crime distribution and possible support for a law of crime concentration for most or all crime.

Routine activities theory and crime pattern theory both focus on specific crime opportunities occurring at specific places and situations. Cohen and Felson introduced the routine activities theory after the scholars sought to explain the increasing crime rate after the Second World War when social factors, such as employment rates, education, and median income (factors thought to affect crime) were generally improving. This paradox led to the idea that because the everyday lives of individuals were shifting (e.g., leaving home more for work or entertainment), so was the opportunity for crime. Thus, Cohen and Felson proposed the routine activities theory, which posits that criminal opportunity arises when three factors converge in both time and space: motivated offenders, suitable targets, and a lack of effective guardianship (Cohen & Felson, 1979). Rather than focusing on potential offenders, this environmental theory focuses on the crime as an event. In other words, the offending itself stems from the opportunities for crime that are generated out of the routine activities of society (Ratcliffe, 2015). Because this theory is dependent on the interactions between space, time, and the three elements described above that create the opportunity for crime, routine activities can explain why some places have more crime than others. At the micro-geographic level, places have varying levels of people, activities, and matter, and these "ingredients" are not randomly distributed across, say, a city.

Looking to build a more integrated theory, Paul and Patricia Brantingham contributed to the area of environmental criminology by developing a theory that looked

to explain not only why crime occurred at certain locations, but also the specific influences that caused crime opportunities (Brantingham & Brantingham, 1991, 1993). Acknowledging that while routine activities explain how a crime occurs, the offenders themselves play an important role through their own routines, awareness and assumptions of a place, and their "readiness potential" – a term the Brantinghams describe as the capacity for a potential offender to be activated into criminal behavior. This became known as the crime pattern theory, which put forth the concept of an activity "backcloth" that provided ideal conditions for crime opportunities at specific places. As individuals go about their daily routines, they have places they frequently visit (knowns as "nodes") as well as routes used to travel there (known as "pathways"). Brantingham and Brantingham (1993) describe these places as crime "generators", which are specific places people gather (e.g., shopping areas, transportation hubs, office complexes). On the other hand, crime "attractors" are places, such as neighborhoods or districts, known to produce high levels of crime (Bernasco & Block, 2011). These elements that create opportunistic places to commit crimes explain why crime is not randomly distributed. The variations in crime highly depend on the individual behavior in conjunction with the environmental backcloth of a place.

Given that these opportunity theories are used to explain the distribution of crime, there then becomes an expectation that if there are hot spots of crime, there should also be hot spots of crime opportunity. This concept was put to the test by Weisburd, Groff, and Yang (2012) in which crime opportunities were operationalized and measured in Seattle, Washington between 1992 and 2005. The authors identified four components to

measure that stemmed from opportunity theories: motivated offenders, suitable targets, accessibility, and guardianship. To capture the distribution of motivated offenders, Weisburd and colleagues used high-risk juveniles as a measurement and mapped their location using data provided by Seattle Public Schools. This analysis found that 50% of high-risk juveniles were located on just 5% of street segments in Seattle, while all high-risk juveniles were located between 18 and 23% of street segments across 13 years. In addition to their high levels of concentration, the authors also found that the juveniles were spread throughout the city, rather than simply being concentrated in one area.

Suitable targets were measured using several factors, including employment, residential population, and business sales. These indicators are used under the assumption that large swaths of people present greater opportunities for victimization. 50% of employment was found on just 0.8% of street segments and 100% of employment could be found between 25 and 28.5% of street segments. Using the population of public-school students and registered voters as a proxy for population by street segments, the study found that 74.8% of streets contained at least one resident in 2004, but 50% of the population lived between 12 and 14% of street segments. Additionally, business sales were measured and 50% of all sales were found on just 0.2% of street segments, while 100% of sales were found on 6.0% of street segments.

The accessibility of offenders and victims to commit or experience crime in specific places is also used to examine crime opportunities. Weisburd and colleagues use bus stops to measure accessibility and urban form throughout the city of Seattle. They found that 50% of bus stops were located on 4% of street segments and all bus stops

could be found between 12 and 13% of streets. Finally, the authors measure guardianship in Seattle. While unable to obtain data on officer presence, which is perhaps the most relevant indicator of guardianship, the analysis includes indicators of police station and fire station presence as well as street lighting to measure guardianship. The authors find that while stations are not necessarily concentrated, they do strongly vary at the microgeographic level. Additionally, 50% of street lighting was found on 11.5 to 13% of street segments, while 100% of street lighting was located between 84 and 87% of street segments.

This analysis by Weisburd and colleagues (2012) establishes that in addition to hot spots of crime, there are also hot spots of crime opportunities. Further, the mapping of these crime opportunities shows that while concentrated, opportunities can occur throughout the entire city. Clearly, these opportunities are highly concentrated, particularly when considering 50% of those opportunities. Moreover, even 100% of individually operationalized crime opportunities concentrate at astonishing levels. If the rate of crime concentration at hot spots coincides with the rate of concentration for crime opportunities, we would expect that 100% of crime concentrates in a similar manner to 100% of crime opportunities. Further, the distribution of crime would occur throughout the entire city, much like the distribution of crime opportunities.

Still, opportunity theories are not the only perspectives that have been used to understand crime patterns. In fact, the study of crime patterns in a geographic context dates back to the early 20th century at the Chicago School where scholars developed the theory of social disorganization, which William Thomas referred to as “a decrease of the

influence of existing social rules of behavior upon individual members of the group" (Thomas, 1966: 3). This came as a result of emerging interest in understanding the relationship between structural socioeconomic conditions and social integration at a localized level. The social disorganization theory posits that low economic status, ethnic heterogeneity, and residential mobility contribute to social disorganization within a community, ultimately leading to increases in crime and delinquency (Shaw & McKay, 1942; Sampson & Groves, 1989).

Building off this theory, Sampson et al. (1997) argue that more informal mechanisms may influence a community's ability to maintain control over their neighborhoods. The scholars developed the concept of collective efficacy and described it as "the willingness of local residents to intervene for the common good" (p. 919). Sampson and colleagues argue that social disorganization occurs when community members fail to gain control over their community mainly because the social network and ties between residents are particularly weak. This perspective emphasizes that poverty combined with residential mobility, neighborhood rates of family disruption, and high population density can mediate the level of collective efficacy in a community.

Unlike opportunity theories, social disorganization theory and collective efficacy have been used to explain community-level variation in crime, disregarding the possibility of street-by-street variability. However, describing street segments as a type of micro-community, Weisburd et al. (2012) test the applicability of social disorganization to micro-geographic places. Like the indicators selected to measure opportunities of crime, the authors examine indicators of social disorganization and collective efficacy to

identify potential hot spots of social disorganization. Their analysis found that indicators of structural social disorganization were highly concentrated at place. 50% of housing assistance vouchers were used at just 0.4% of street segments, while 100% were found between 7.7 and 10.1% of street segments over the study period. Additionally, half of all incidents of physical disorder occurred between 1.5 and 3.0% of street segments, while 100% of these incidents could be found between 6.1 and 10.0% of street segment. Notably, the distribution varies over time. Still, like indicators of crime opportunity, both housing vouchers and physical disorder was found to occur throughout the entire city of Seattle but concentrated more heavily in some areas of the city.

Weisburd and colleagues also examined two indicators of collective efficacy that would measure the distribution of unsupervised teenagers and resident willingness to intervene in public affairs. The former was measured using the location of truant students. 50% of these students lived on between 2.0 and 3.5% of street segments, while all the truant students lived on 8 to 14.5% of street segments over the study period. Willingness to intervene was measured using active registered voters in Seattle. 50% of the active voters were found to live between 12 and 13% of all street segments. 100% of active voters could be found on 68 to 70% of street segments. Again, while concentrated in certain areas of the city, both indicators could be found in all parts of Seattle.

These findings suggest that because indicators of social disorganization and collective efficacy concentrate at a micro-geographic level, the theories of social disorganization and crime opportunities do not operate independently of one another on differing spatial scales. Rather, both social disorganization and crime opportunities may

be used to explain variation in crime at the micro-geographic level. Together they suggest that there will be significant concentration of most or all crime in a city because opportunities for crime and social disorganization are also concentrated. However, they do not provide insight into the precise level of concentration that would be observed for most or all crime.

Present Study

Using place-based opportunity theories as well as the theory of social disorganization as a framework, the current study will explore the distribution of large proportions of crime to test for a law of crime concentration for most and all crime. Given that prior literature has shown both opportunities of crime and social disorganization concentrate to a limited number of places while simultaneously being concentrated throughout many areas of a city, we would expect to find a similar pattern of crime distribution for most and all crime. This study will examine the distribution of most and all crime in multiple United States cities using similar proportion analyses implemented in prior studies. While much progress has been made in the area of crime and place and many studies have tested the salience of Weisburd's law of crime concentration, there remains a gap in the literature concerning the distribution of all crime. The purpose of this study is to explore whether a law of crime concentration can be developed for larger proportions of crime.

This study will begin by following the same measures used in Weisburd (2015). That is, the proportion of street segments that contain 25% and 50% of crime are calculated. This examination will answer a key preliminary question: Do the cities in the

current sample follow the traditional law of crime concentration? Then, this study will examine the number of street segments containing larger proportions of crime (i.e., 75-100% of crime) to answer the primary question of interest: Can a law of crime concentration be established for most or all crime?

METHODS

Study Locations

This study includes a sample of five United States cities sourced from a larger project on police legitimacy and procedural justice in crime hot spots: Cambridge, MA, Houston, TX, Indianapolis, IN, Seattle, WA, and Tucson, AZ. Most of the cities included in this sample have relatively large populations, but there is a wide range of number of residents – Cambridge has the smallest population with just under 115,000 residents, while Houston has the largest population with approximately 2.3 million residents. These jurisdictions vary in region, geographic size, demographics, and socioeconomic characteristics. The heterogeneity of these cities can be seen in table 2. Relative to the other cities, Houston and Tucson can be classified as being more suburban. While these cities certainly have urban features, both are less densely populated and on average contain longer street segments (540 ft. and 496 ft., respectively). In comparison, Seattle and Tucson are more urban. These cities are much more densely populated and have shorter street segments (406 ft. and 314 ft., respectively). Indianapolis is unique in that the city contains strong urban, suburban, and even rural features. Being one of the most populated cities in the Midwest, Indianapolis has many dense areas, particularly downtown. However, the city becomes much more expansive towards the outer edges of the city limits. In fact, Indianapolis contains nearly 200 farms within its municipal boundaries (U.S. Department of Agriculture, 2017).

In addition to their physical geography, these jurisdictions also differ in their social characteristics. Some cities have relatively low crime rates (3 violent crimes per 1,000 in Cambridge, MA) while others are high (12.7 violent crimes per 1,000 in Indianapolis, IN). Percentage of non-white citizens range in this sample from 35.5% to 75.4%, while poverty rates fall between 11.8% and 23.4%. The number of sworn police officers also varies between just 277 and 5229 officers. While selected out of convenience, the varying features of the cities and their geographical distribution across the country offer an opportunity to examine the concentration of crime among jurisdictions that look differently from one another – thus, if consistent rates of concentration are observed across the sample, this will reinforce the notion that the law of crime concentration for all crime holds steady despite a city's individual characteristics.

Table 2. Characteristics of Cities Included in the Analysis

City Characteristics	Cambridge, MA	Houston, TX	Indianapolis, IN	Seattle, WA	Tucson, AZ
Population	114,881	2,344,966	877,584	742,759	537,392
Population density (mi^2)	16470.2	3501.5	2270	7250.9	2294.2
Area (mi^2)	6.4	599.6	361.4	83.9	226.7
Number of street segments	2,618	66,693	50,456	24,480	23,713
Average length of street segment	313.5 ft	574.6 ft	534.0 ft	406.4 ft	495.9 ft
Number of violent crimes per 1,000	3	10.3	12.7	6.8	7.4
Percentage non-white	39.2%	75.4%	44.8%	35.5%	55.5%
Percentage below poverty level	13.2%	20.6%	19.1%	11.8%	23.4%
Number of officers	277	5,229	2,616	1,420	807

Data

The data used in this study come directly from the police departments of the aforementioned cities. The advantage of using incident data provided by the police departments is having more inclusive and detailed records compared to open-source arrest, complaint, or call data that generalizes the location and nature of the incident. Each department provided address-level crime data. This overcomes the obstacle faced by researchers using public open-source data to study crime concentration, which frequently limits the location information to a generalized or approximate area, rather than the specific crime location. The analysis will focus on one year of crime data from each city. Data used in four of the cities come from 2017, while the fifth city, Seattle, comes from 2016. Given that each police department records, organizes, and classifies their crime data differently, a number of steps were taken to ensure the data were consistent between cities when possible. For example, incidents reported as occurring at police stations were identified and removed from all datasets.

The crime incidents are geocoded using the GIS software package ArcMap 10.7. Street centerlines were downloaded through each city's open-source website and cleaned to ensure roads where crime is typically not recorded by police and that improperly break up street segments (i.e., alleys, ramps, access roads) are removed from the file as to not inflate the street segment count. The geocoded crimes are then joined to the closest street segment and a total crime count is calculated for each segment. All five cities produced geocoding "hit" rates of 95% or higher – well above the 'acceptable' minimum

geocoding hit rate of at least 85% (Andresen & Malleson, 2011; Ratcliffe, 2004; Ratcliffe, 2010).

There has been some debate on how to handle crimes that occur at intersections, as these incidents cannot be assigned to just one street segment. In general, two different methods have been established for analyzing crime concentration when crimes occurring at intersections are present. Hipp & Kim (2016) took the approach of evenly distributing a crime across all the street segments associated with that crime. For example, if a crime occurred at an intersection where two roads crossed, each street segment would receive .25 of the crime. Other scholars have opted to exclude crimes occurring at intersections from their analysis completely. Much precedence has been established for the latter method. In Weisburd's 2015 multi-site analysis, intersections were excluded from the 8 cities in the sample, which had proportions of crime at intersections ranging from 0% to 33%. This wide range can be observed in a number of other studies that also excluded intersections from the analysis. In Vancouver, BC, Curman et al. (2015) reported that 25% of calls for police service occurred at intersections between 1991 and 2006. In their analysis of Brooklyn Park, MN, Gill et al. (2017) reported that 6.5% of crime incidents occurred at intersections (see also Dario et al. 2015; Telep et al. 2014; Weisburd et al. 2006, 2012).

The present study will follow these scholars in excluding incidents reported at intersections. Like previously studied cities, the proportions of crime occurring at intersections vary between cities in the current sample. Of the incidents geocoded, between 0% (Houston, TX) and 17.4% (Cambridge, MA) of crimes occurred at

intersections, leaving between 6,960 and 197,410 incidents to be included in the analysis (table 4). A further look at the crimes occurring at intersections show that the majority of these incidents (62% - 72%) are “other” crimes. Throughout all the jurisdictions, “other” crime are classified as miscellaneous crimes and traffic crimes (such as driving while suspended, operating a vehicle while intoxicated, or leaving the scene of an accident). These crimes encompass a significant amount of incidents recorded at intersections, which is not the case for incidents recorded on street segments. The differences in crime types between these two units is the basis for excluding incidents occurring at intersections.

Table 3: Crime Incidents at Intersections

	Cambridge, MA	**Houston, TX**	**Indianapolis, IN**	**Seattle, WA**	**Tucson, AZ**
Yearly crime incidents on street segments	6,960	197,410	105,620	88,621	101,471
Percentage of crime at intersections	17.4%	0.0%	9.3%	17.1%	8.9%
Crime type at intersections	**Cambridge, MA**	**Houston, TX**	**Indianapolis, IN**	**Seattle, WA**	**Tucson, AZ**
Disorder	1.84%	-	5.29%	5.49%	10.84%
Domestic	3.69%	-	1.01%	1.39%	0.31%
Drug	2.87%	-	8.95%	2.10%	12.55%
Other	72.20%	-	66.21%	63.60%	62.12%
Property	10.72%	-	9.71%	19.38%	5.08%
Violent	8.67%	-	8.82%	8.04%	9.10%

Analytical Strategy

The current study's analysis is very straightforward. Once the crime incident counts are summed for each street segment in each city, the percentage of crimes occurring at certain numerical thresholds can be calculated. The present study will begin by examining the percentage of street segments encompassing the "smaller" proportions of crime – 25% and 50% of crime – that have traditionally been examined in the context of the law of crime concentration. In addition to adding data points to the law of crime concentration literature, taking a look at these specific proportions of crime will establish whether or not the cities in the sample follow the traditional law of crime concentration to begin with.

The analysis will then turn to the main focus of the study, which is to examine the distribution of most and all crime. This will include calculating the proportion of street segments encompassing 75% to 100% of crime in 5-point increments (75%, 80%, 85%, 90%, 95%, 100%). Examining the distribution in this way presents the opportunity to observe trends that may occur between all crime and most crime, given the potential randomness that might occur as the proportion of crime increases. Similarly, this analysis will look at several "minimum number of crime incident" thresholds (e.g., 2+ incidents on a street segment). Identifying the proportion of segments with at least 2 to 5 crime incidents may offer more nuance to a potential law of crime concentration for most or all crime. Not only will this analysis add more data points to the limited literature on the distribution of 100% or most crime, but it will also offer insight as to what a law of crime concentration for majority of crime's bandwidth would look like.

RESULTS

The Law of Crime Concentration: "Smaller" Proportions

Figure 1 displays the distribution of street segments containing 25 and 50 percent of all crime incidents. Overall, these results show that crime is highly concentrated across all five US cities. 50% of crime was found between 2.23% and 5.13% of street segments. 25% of crime was found between just 0.50% and 1.21% of street segments. These rates of concentration are consistent with the ranges in Weisburd's eight-city analysis (2015). Further, the present study yields bandwidths of 2.9% for half of all crime incidents and 0.71% for 25% of all crime incidents. Not only do these findings confirm the presence of the law of crime concentration, they show even tighter bandwidths than presented in previous studies. Recall in Weisburd (2015) that 50% of crime incidents occurred within about a 4% bandwidth, while 25% of crime incidents occurred within a 1.5% bandwidth.

While these results support the original law of crime concentration, there are some noteworthy variations. Weisburd (2015) suggests (cautiously) that the concentration of crime may operate differently between "smaller" and "larger" cities. In his analysis, the three smaller, more suburban cities yield higher levels of concentration. 50% of crime occur on an average of 2.6% of street segments and 25% of crime occur on an average of 0.5% of street segments. Conversely, the five larger cities produce slightly less concentrated results: 50% of crime occur on an average of 5.3% of segments and 25% of crime occur on an average of 1.2% of street segments. In the current study, such a difference is not observed between cities of differing sizes. The least populated city –

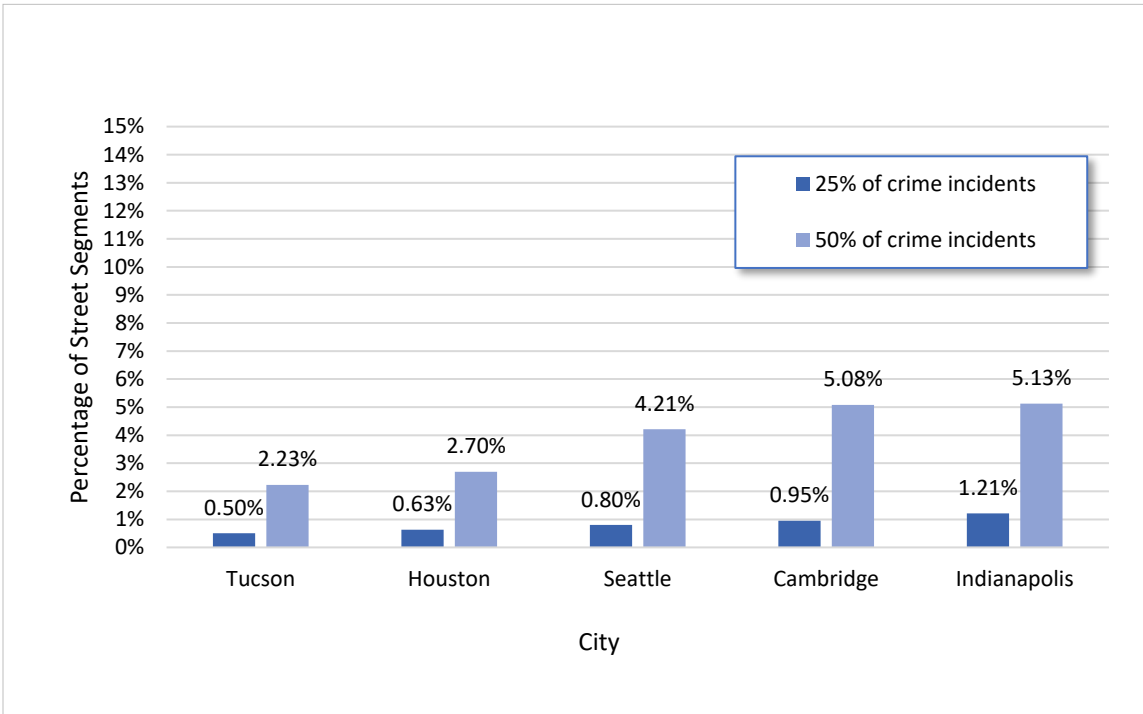


Figure 1. Distribution of Smaller Proportions of Crime

Cambridge, MA – observed concentration rates more consistent with the "larger" cities analyzed in Weisburd (2015) with 50% of crime found at 5.08% of segments and 25% of crime found at 0.95% of segments. What's more, Houston, TX, which is the largest city in the current sample, yields concentration rates more consistent with the "smaller" cities analyzed in Weisburd (2015) with 50% of crime found at 2.70% of street segments and 25% of crime found at 0.63% of segments. These data suggest that the population of a city may not be the key determinant in variability of crime concentrations, but rather the degree to which a city is urban or suburban in layout. Cambridge, a smaller city in terms of population in this study was more similar to the larger cities in Weisburd's analysis, while Houston, a larger city in terms of population was similar to the smaller cities in

Weisburd's study. Recall that Houston is a geographically spread out suburban city, while Cambridge has a very urban layout.

The Law of Crime Concentration: "Larger" Proportions

Table 5 shows the percentage of street segments containing most and all crime in each of the five cities, which is broken down into 5-point increments between 75% of crime and 100% of crime. Though there is a great deal of similarity between the cities, the variability between jurisdictions becomes greater as the percentage of crime examined increases. 75% of crime is found within 9.21% (Tucson) and 15.66% (Cambridge) of street segments, yielding a bandwidth of 6.45%. Conversely, 100% of crime is found between 44.82% (Indianapolis) and 55.95% (Seattle) of street segments, which yields a bandwidth of 11.13%. In general, the bandwidths steadily increase as the amount of crime examined also increases. Further, the change between ascending increments remain within less than half a percentage of each other. The exception here begins at 95% of crime, where interestingly the bandwidth slightly drops (although still within .5% of the bandwidth for 90% of crime) before a much larger increase in bandwidth range is observed for 100% of crime. Here, the bandwidth goes from 7.28% to 11.13% – a 3.85-point jump. The percentage of street segments producing 100% of crime is notability smaller in Indianapolis in comparison to the rest of the cities.

Without Indianapolis, the bandwidth for 100% of crime would be reduced to 6.49% - suggesting considerable consistency of concentration between cities. Again, recall that Indianapolis is a large Midwestern city with a unique combination of urban, suburban, and even rural features, which may explain why the city yields slightly less

concentration for smaller proportions of crime and a relatively higher concentration for 100% crime. This may offer additional support for the idea that variability in crime concentration across cities might be due to differences in city layout and street networks, rather than size alone. This is also evident when considering the concentration of crime in Cambridge, which has one of the larger percentages of street segments producing 100% of crime in the sample. While the smallest city in the sample – both in physical size and population – Cambridge is very urban and dense. The tightly connected street network in Cambridge may contribute to its distribution in crime.

Table 4. Crime Concentration at Street Segments for Most and All Crime

Crime Amounts	Percentage of Street Segments					
	Indianapolis	Tucson	Houston	Cambridge	Seattle	Bandwidth Range
75% of Crime	13.84%	9.21%	10.58%	15.66%	14.41%	6.45%
80% of Crime	16.75%	12.25%	13.85%	19.10%	18.20%	6.85%
85% of Crime	20.47%	16.24%	18.22%	23.53%	22.96%	7.29%
90% of Crime	25.32%	21.90%	24.16%	29.41%	29.05%	7.51%
95% of Crime	32.02%	30.40%	32.40%	37.55%	37.68%	7.28%
100% of Crime	44.82%	49.46%	50.42%	52.14%	55.95%	11.13%

Examining the percentage of crime is a sensible way to compare concentration rates across multiple jurisdictions. However, doing so may overlook the nuance of each city. The cumulative percentages of crime in each city (i.e., 75%, 85%, 95% ...)

encompass varying numbers of incidents. For example, 75% of crime in Tucson includes street segments with approximately 8 or more crime incidents, whereas 75% of crime incidents in Cambridge and Indianapolis only include street segments with about 4 or more crime incidents. While these are relatively low counts, there is a 50% decline in crime between the respective cities. It's reasonable to assume residents of the street segment, street officers, and the surrounding community may notice such a difference. This may also have implications for how crime is distributed and compared across cities. Figure 2 shows the distribution of crime by number of incidents in each of the cities, starting with street segments with 5 or more incidents and gradually decreasing to street segments with 1 or more incidents. Note that streets with 1 or more incidents represent 100% of crime as previously displayed in table 5 and are included here again for reference. Street segments with 5 or more crime incidents make up between 13.47% and 16.52% of all street segments between the five cities. Those with 4 or more incidents encompass between 17.11 % and 21.19% of all street segments, while 3 or more incidents encompass between 22.39% and 28.01% of all street segments, and 2 or more incidents encompass 30.25% and 38.37% of all street segments. As expected, the bandwidth ranges follow the same pattern as the ranges for large percentages of crime. That is, as the numbers of incidents examined get smaller (i.e., the proportion of cumulative crime examined increases), the bandwidth between cities gets larger, suggesting greater variability between cities. Street segments with 5 or more incidents yield a bandwidth of 3.05% across the cities. Street segments with 4 or more incidents yield a bandwidth of 4.08%; street segments with 3 or more incidents yield a bandwidth

of 5.62%; street segments with 2 or more incidents yield a bandwidth of 8.12%; and as previously discussed, street segments with 1 or more incidents (100% of crime) yield a bandwidth of 11.13%. Also evident in figure 2 is the proportion of street segments containing just one crime incident within the given year. The percentage of street segments experiencing one crime ranges between 14.59% (Tucson) and 18.12% (Houston).

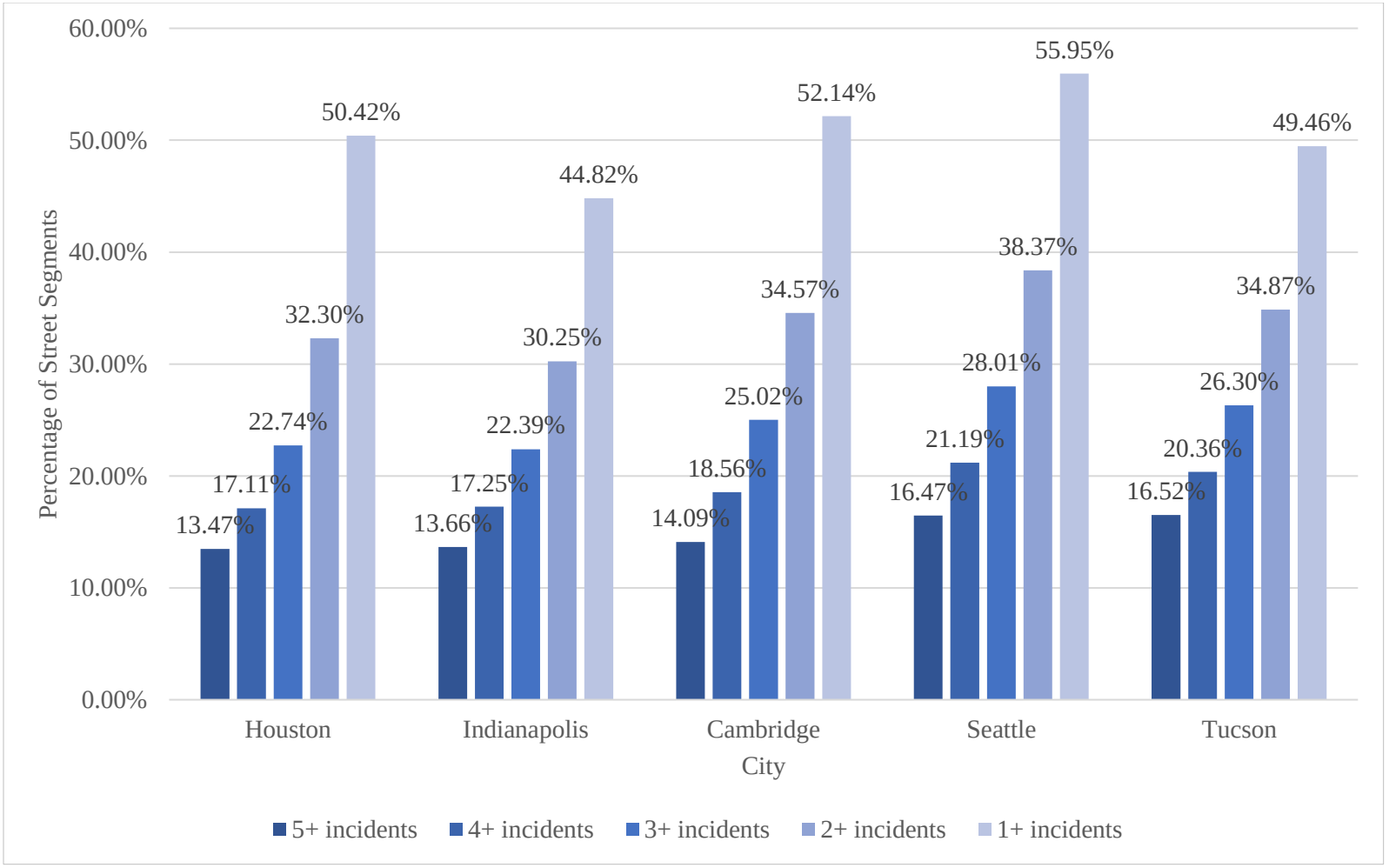


Figure 2. Distribution of Crime Incidents by Incident Count

As an inverse comparison to the concentration of 100% of crime, table 6 shows the percentage of street segments experiencing no crime within the year in each city. Again, the range between these cities when examining either 100% of crime incidents or, inversely, no crime incidents, falls at approximately 11%. While this is certainly a larger bandwidth, roughly half of the street segments in the cities never experience crime. Exploring this phenomenon further, a map of street segments experiencing at least one crime were developed for each city (see Appendix A). These maps show that crime incidents, while often concentrated in specific pockets of the city, are spread throughout the jurisdiction.

Looking at population density as a possible indicator for the variation in the proportion of crime free street segments, there does not immediately appear to be a relationship between the two. However, considering Seattle and Cambridge are relatively more urban to the more suburban cities Tucson and Indianapolis, the percent of street segments with no crime might be explained by the nuances of city layout.

Table 5. Percentage of Street Segments with No Crime

City	Percent of Street Segments with No Crime	Population Density (per sq. mile)
Seattle	44.05%	7,250.9
Cambridge	47.86%	16,470.2
Houston	49.58%	3,501.5
Tucson	50.54%	2,294.2
Indianapolis	55.18%	2,270.0

DISCUSSION

This paper assesses whether a law of crime concentration may be applicable to most or all crime. The vast majority of studies examining crime concentration have focused on smaller proportions of crime (i.e., 25% & 50% of crime) and have generally supported the existence of the law of crime concentration proposed by Weisburd (2015), in which a defined proportion of crime falls into a narrow bandwidth of microgeographic places. The current study adds more evidence for this phenomenon, showing that in the five cities examined, 25% of crime incidents occurred between 0.50% and 1.21% of street segments and 50% of crime incidents occurred between 2.23% and 5.13% of street segments, producing narrow bandwidths of 0.71% and 2.90% respectively. While these results add more data points to the growing literature on the law of crime concentration, the main objective of this paper was to examine the concentration levels for most and all crime. Still, confirming the presence of the law of crime concentration for smaller proportions of crime offers the ability to subsequently examine whether such a law might exist for higher proportions of crime.

The current study began an analysis on the concentration of most and all crime incidents by continuing the use of a straightforward strategy examining the percentage of street segments encompassing defined proportions of crime. The results showed what environmental criminology theories and prior crime concentration studies would suggest, which is that most and all crime remains concentrated to a limited number of microgeographic places, but those places are spread throughout the cities. Given the

amount of crime included, the majority of crime, or 75% to 95%, held relatively tight bandwidths across the sample, ranging from 6.45% - 7.51%**.** We see a similar pattern even when looking at the number of crime incidents occurring on street segments, rather than percentages of crime. Here, the bandwidth of street segments between cities steadily increase as more crime is considered. Segments with 5 or more incidents range from 13.47% to 16.52% of all streets – a 3.05% bandwidth – while segments with just 2 or more incidents range from 30.25% to 38.37% - an 8.12% bandwidth.

However, 100% of crime's less narrow bandwidth of 11.13% suggests all crime might not concentrate at similar rates across various cities. Segments with one or even two crime incidents may be occurring more randomly across cities, making it difficult to suggest a standard range of street segments containing all crime. One reason for the increase in bandwidth may be the stochastic nature of a segment experiencing one crime in a year. Still, generally half of all street segments across the five cities experience no crime in a given year. When considering the results of this study in conjunction with the results of past studies, we can be more confident in assuming most cities (at least in the United States and similar countries) follow this rule of being roughly 50% crime free at a micro-geographic level.

The "type" of city being analyzed should also be considered, especially when comparing crime distribution trends across multiple jurisdictions. Past scholarship has considered the size of city when trying to explain variations in crime. However, more recent literature combined with the results of the current study suggest that variations in crime concentration may have less to do with the size of a city, and more to do with the

nature of a city and its urban network. In the current sample, cities with stronger rates of concentration were found in cities that are relatively less urbanized and more spread out, such as Houston and Tucson. On the other hand, more dense and urbanized cities like Seattle and Cambridge observed slightly weaker rates of concentration. These findings support Gill et al.'s (2017) study on crime concentration in Brooklyn Park. Recall that this suburban city observed higher rates of concentration than found in urban cities.

The theoretical framework behind this study largely focuses on environmental criminology. Routine activities and crime patterns have primarily been used to explain crime concentration in past studies, and the results here continue to support the notion that crime is not randomly distributed geographically. Additionally, past research has confirmed the existence of both hot spots of crime opportunities as well as hot spots of social disorganization. The distribution of crime observed in the current study follows these patterns. Like crime opportunities and social disorganization, as the percentage of crime examined increases, so does the bandwidth of street segments containing those crimes between cities. However, the frequency of street segments experiencing just one crime in a given year cannot be ignored. This poses an interesting theoretical question, as environmental theories can explain why some micro-geographic places experience high levels of crime, but less so when crime in extremely infrequent at a place. While criminal opportunities can certainly arise almost anywhere if the conditions are right, street segments experiencing very few crimes may just be victims of random crime opportunities rather than experiencing place-specific issues that generate and attract crime. Thus, when we talk about crime concentration, it is important to consider the

points in which crime is predictable and consistent and in which crime begins to become more random in space.

This study is not without its limitations, some of which have already been raised by other analyses of the law of crime concentration. First, the cities used in this analysis were selected out of convenience. This is a common issue when examining crime data at the micro-geographic level, as detailed crime data can be difficult to obtain from police departments. As previously mentioned, data for the five cities in the present sample were obtained as a result of a larger project identifying crime hot spots. Still, the cities range in urban landscape, regional location, and demographic characteristics, and make for an interesting comparison to other cities examined in previous studies. Second, the present study only analyzes one year of data in each site. Prior studies have found that while the rate of concentration for smaller proportions of crime tend to stay stable over time, where crime concentrates may change throughout the years (Levin, 2015; Johnson et al., 2008). Given the potential randomness of many street segments experiencing just one crime incident per year, this may have implications for the proportion of street segments containing any crime (i.e. – the number of street segments encompassing 100% of crime may fluctuate more between years). Third, this analysis was dependent on official department data, and while raw police data offers more information about individual crimes that open source data, we are still limited to what the department provides, which may vary in crime reporting practices and crime categorization across different police departments. Lastly, this study focuses on general crime concentration patterns in each city, and does not differentiate by crime type. The literature on crime concentration has

noted that different crime types concentrate differently within a city (see Amemiya & Ohyama, 2019; Andresen & Linning, 2012; Andresen, Curman, & Linning, 2017; Hipp & Kim, 2016; de Melo, Fonseca, & Andresen, 2015). Future studies may need to analyze how 75 to 100% of crime of different types impacts a potential law of crime concentration for most or all crime.

Despite these limitations, the results of this study add to our still somewhat limited understanding of how crime is distributed. While the utilization of crime mapping and identifying places where crime occurs regularly has become a key component of policing and crime prevention, new techniques used in crime analysis and hot spots policing have not had the time to be tested rigorously across places and time periods. The current study hopes to initiate more conversation in how crime is distributed and the potential for a law of crime concentration for all crime. Certainly, more work is needed in this area, and this study simply serves as a step in that direction. Still, the results here offer some key policy implications that highlight the importance of studying the distribution of most and all crime at the micro-geographic level. First, these findings highlight that about 50% of all street segments do not experience any reported crime, meaning police do not need to utilize resources in half of their jurisdiction or attempt to address crime in those places. This information may be a key point of discussion between scholars and practitioners when developing crime intervention programs. Second, given that street segments experiencing just one crime a year are seemingly random events that may not be related to place-specific issues, focusing police and other community resources may not be feasible or effective in those places. Therefore, moving the focus to

most of the crime, rather than all, may be more realistic. The findings of this study suggest that 95% of all crime are produced by roughly one-third of all street segments, further reducing the amount of places police or other community organizations would need to focus on in order to address an astonishing amount of crime. Given that most hot spot policing efforts focus on 50% or less of all crime, leaving the other 50% of crime ignored, some cities may look at these results and be able to expand their interventions to address the vast majority of crime depending on the city's size, their resources, and their need to address more crime.

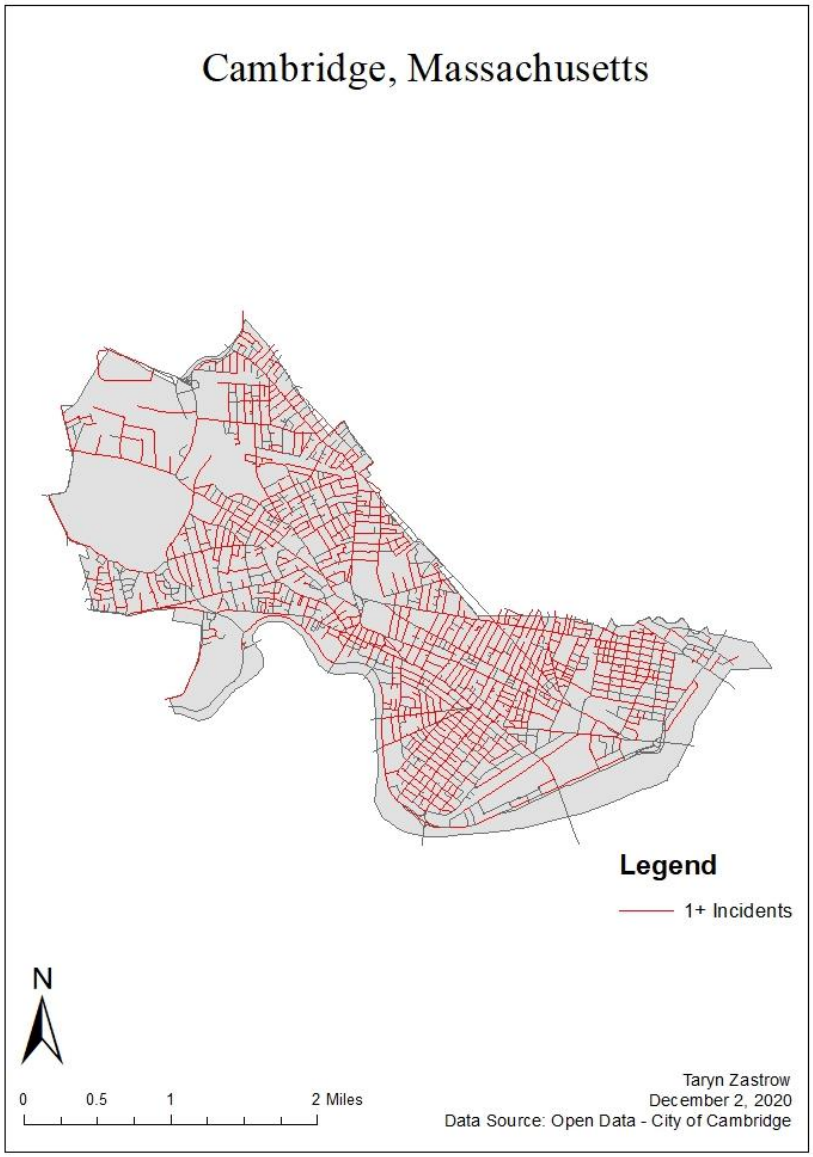
CONCLUSION AND FUTURE RESEARCH

Since the development of the law of crime concentration, scholars have answered the call to further study the phenomenon by examining concentration rates across different geographical contexts and time periods, using a number of methods to measure the distribution of crime. However, the vast majority of these studies have focused on examining just half of all crime or less. While these studies have generally confirmed the law of crime concentration, how the other 50% of crime distributes on a micro-geographic level has remained unanswered. The current study, while exploratory, is the first to assess the distribution of most and all crime across multiple US cities. Aiming to identify potential for a law of crime concentration for all crime, the results of this analysis show that while most crime continues to concentrate at similar rates across multiple cities, the size of the bandwidths increase as larger numbers of crimes are examined. This may occur because of the randomness of one crime occurring on specific streets segments in a given year.

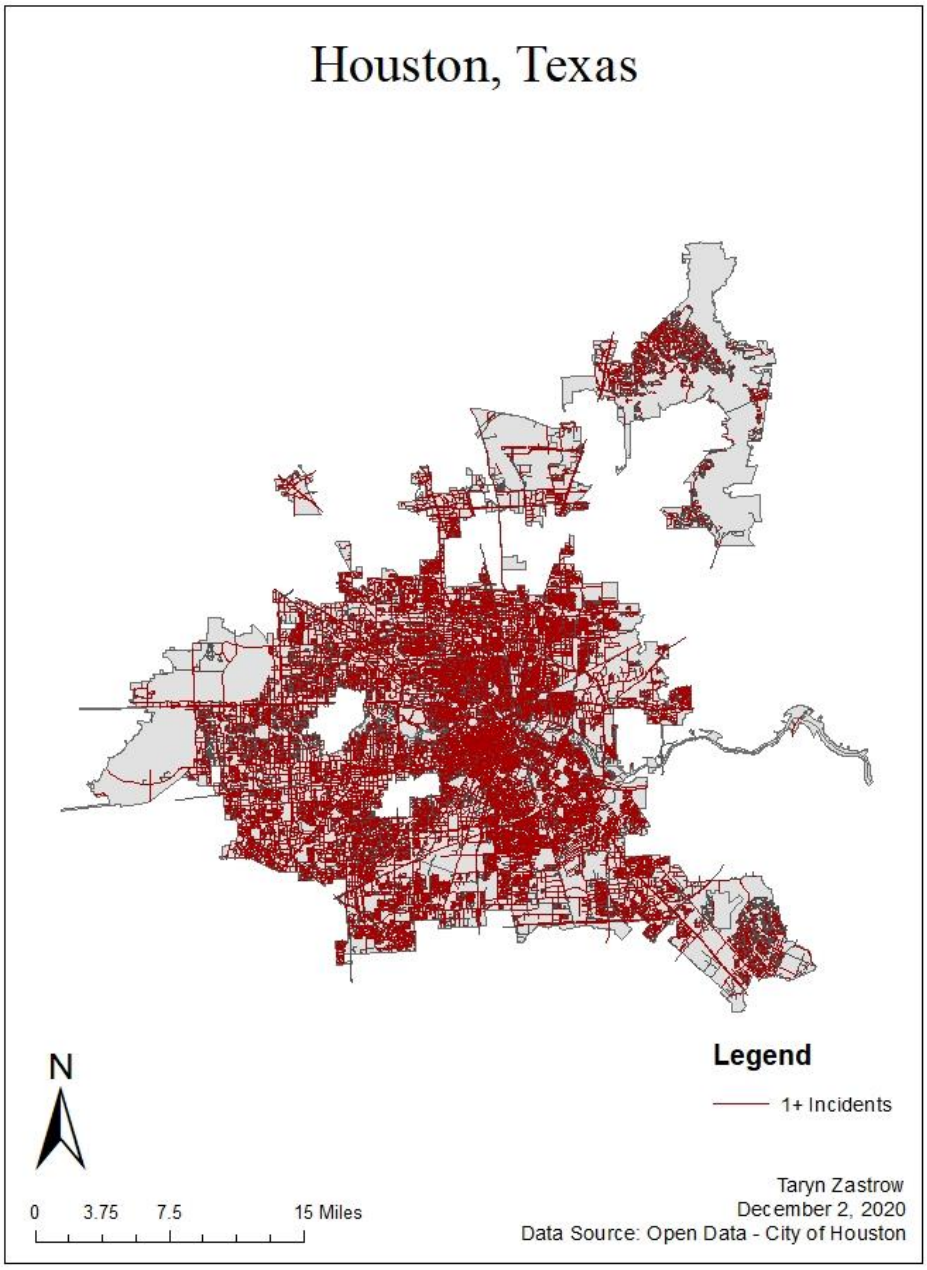
More evidence is needed to identify a standard law of crime concentration for all crime. Future research should carry out longitudinal examinations of 100% and most crime and continue to include cities of varying sizes, regions, and countries. Studies should also examine the types of crime that occur in the bottom 50% of crime. Findings from these studies will provide meaningful information for researchers, policymakers, and practitioners that can ultimately enhance crime prevention efforts.

APPENDIX A

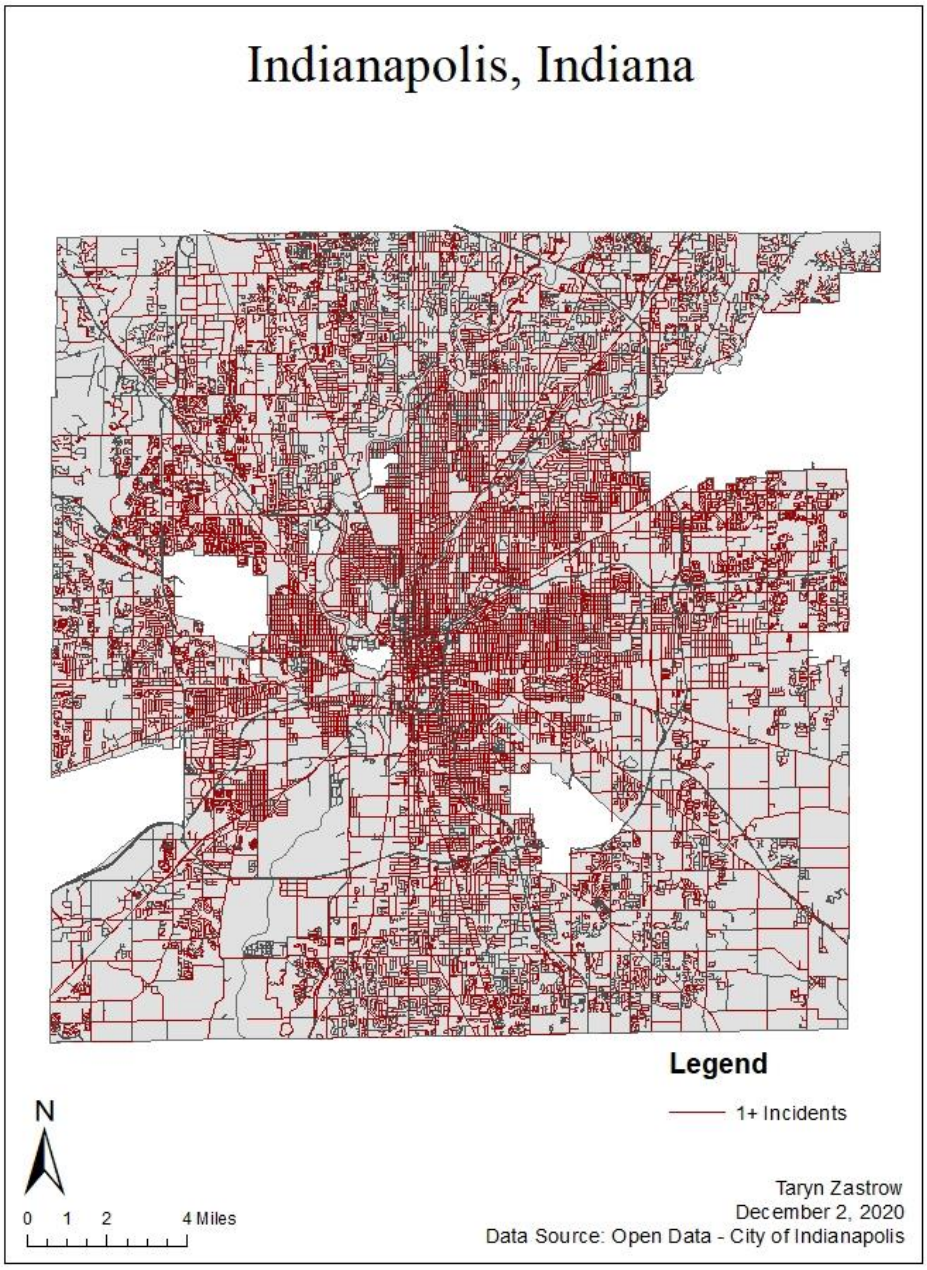
Cambridge, MA Crime Distribution Map



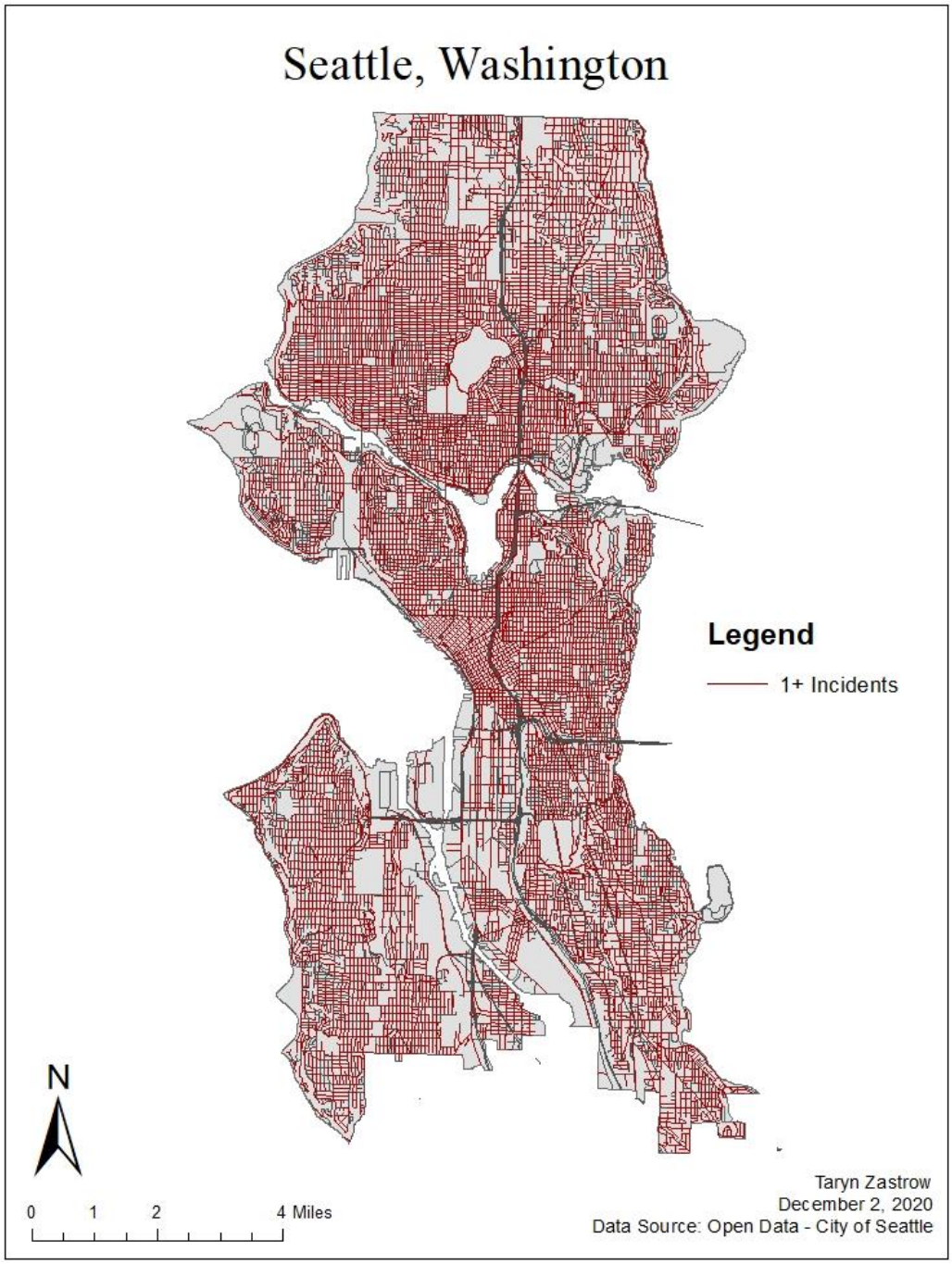
Houston, TX Crime Distribution Map



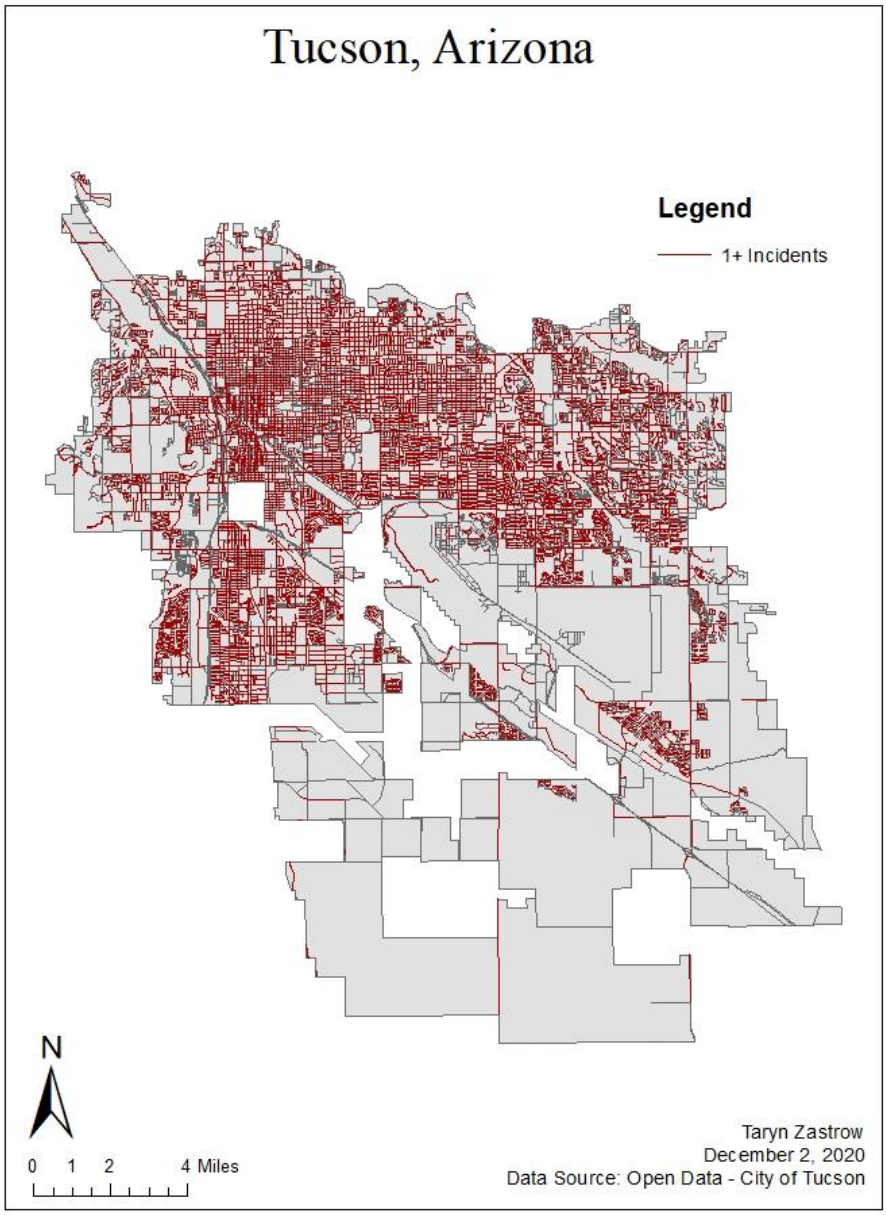
Indianapolis, IN Crime Distribution Map



Seattle, WA Crime Distribution Map



Tucson, AZ Crime Distribution Map



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