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A Comparison of the Transition of Denver Neighborhood Crime from 2000 to 2010

David Muenkel
University of Denver

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Abstract

The purpose of this project was to study crime in the City of Denver, Colorado and show how crime moves between neighborhoods over time. The study involved looking at crimes aggregated at the neighborhood level to determine how crime transitioned within the City of Denver from 2000 to 2010. The crime data was also compared with calls for service to determine how police activity and citizen reporting related to crime in the City of Denver. The results indicated that the City of Denver, while increasing in population from 554,636 in 2000 to 600,156 in 2010 had a reduction in the total number of reported crimes from 41,143 in 2000 to 37,340 in 2010 although there was fluctuation from year to year during this decade. The citizen and police response to crime indicated that at both the city and neighborhood level, increase in crime was typically coincident with an increase in citizen initiated calls for service, which resulted in a subsequent increase in police presence, quantified by police officer initiated calls for service. The resulting increase in police activity produced a reduced the number of crimes for the affected area, which coincided with a reduction in citizen calls. This suggests that calls for service initiated by a community are a leading indicator that crime is on the rise, and the subsequent police response reduces an area's crime. This cause and effect relationship is evident at both the city and neighborhood level.

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First Advisor

Steven Hick

Second Advisor

Andrew Goetz

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A COMPARISON OF THE TRANSITION OF DENVER NEIGHBORHOOD CRIME FROM 2000 to 2010

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by

David Muenkel

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Steven Hick

Capstone Advisor and Academic Director

Upon the Recommendation of the Department

Andrew Goetz, Ph.D.

Department Chair

Table of Contents

List of Figures

List of Tables

Abstract

The purpose of this project was to study crime in the City of Denver, Colorado and show how crime moves between neighborhoods over time. The study involved looking at crimes aggregated at the neighborhood level to determine how crime transitioned within the City of Denver from 2000 to 2010. The crime data was also compared with calls for service to determine how police activity and citizen reporting related to crime in the City of Denver. The results indicated that the City of Denver, while increasing in population from 554,636 in 2000 to 600,156 in 2010 had a reduction in the total number of reported crimes from 41,143 in 2000 to 37,340 in 2010 although there was fluctuation from year to year during this decade. The citizen and police response to crime indicated that at both the city and neighborhood level, increase in crime was typically coincident with an increase in citizen initiated calls for service, which resulted in a subsequent increase in police presence, quantified by police officer initiated calls for service. The resulting increase in police activity produced a reduced the number of crimes for the affected area, which coincided with a reduction in citizen calls. This suggests that calls for service initiated by a community are a leading indicator that crime is on the rise, and the subsequent police response reduces an area's crime. This cause and effect relationship is evident at both the city and neighborhood level.

1.0 Introduction

The research questions will all focus on how crime has changed in Denver neighborhoods between 2000 and 2010, and how calls for service relate with the number of crimes. This is exploratory research in which crime will be looked at to document and quantify any transition that occurred between 2000 and 2010. In addition Calls for Service (CFS) are synchronized with the annual crime to observe how/if CFS is related to crime. In addition some specific neighborhoods that showed a significant change or did not change at all will be looked at in more detail. Throughout the document the term Citizen Calls for Service (CFS Citizen) will be used to address citizen initiated calls to police (911 calls, reactive police engagement). The term Officer Calls for Service (CFS Officer) will be used to identify police action within a neighborhood independent of citizen calls (proactive police engagement).

2.0 Overview

The city of Denver has had approximately 1400 to 1500 sworn officers between 2000 and 2010. These officers have been responsible for dealing with 40,000 to 50,000 crimes per year as well as addressing over 300,000 annual citizen CFS, and initiating 150,000 to 200,000 officer initiated CFS actions. These CFS actions and their relationship to crime are summarized in this report. Figure 1 shows that while the number of crimes has fluctuated between 37,000 and 51,000, the number of officers has remained constant between 1,410 and 1,539. Note that between than between 2000 and 2005 the number of officers dropped from 1,471 to 1,410 while the number of crimes rose from 41,122 to 48,870.

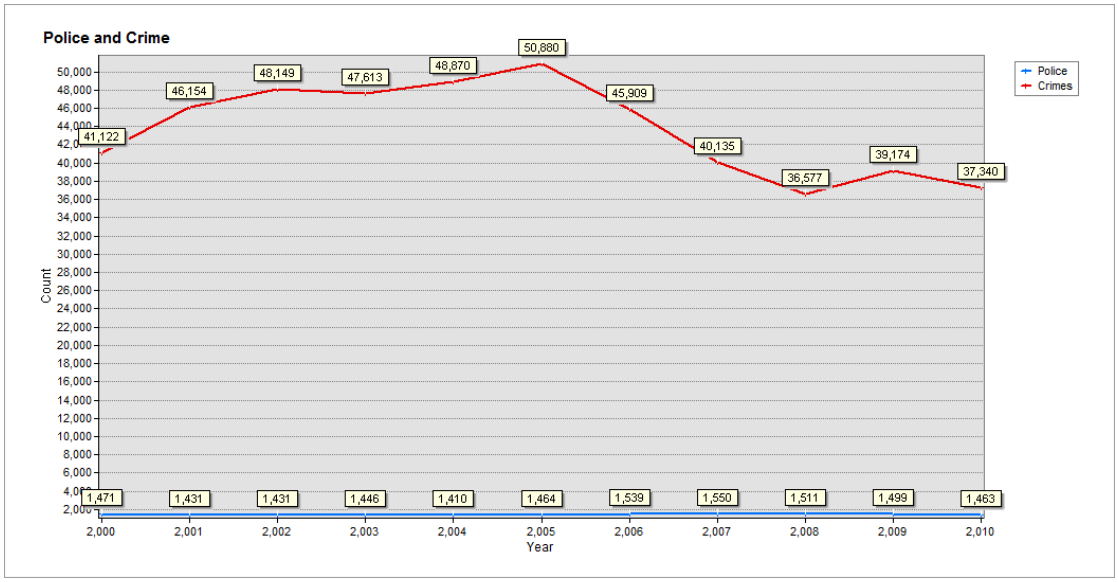


Figure 1 Number of Police officers and volume of Crime

Figure 2 shows that between 2005 and 2007 the number officers increased from 1,464 to 1,550 and the police initiated CFS rose from 114,324 to 166,671. This action coincides with a reduction in the number of crimes from 49,994 to 40,133. When looking at the graph you can see that as police activity increases, citizen CFS decreases, and the number of crimes falls. This indicates that citizen calls for service are a response to increased suspicious activity in an area, and that active police response results in decreased crime.

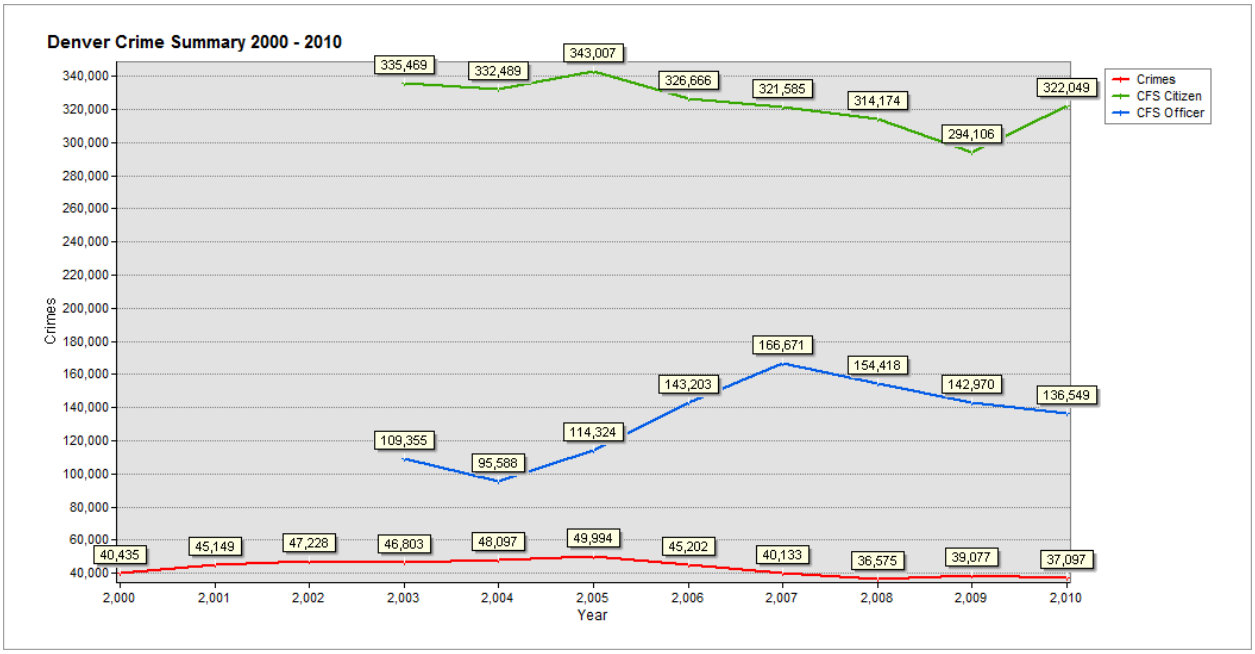


Figure 2 Number of Police officers, Crime and CFS

2.1 Research Questions

1. A change in crime for a particular neighborhood is assumed to be caused by some transition that is occurring, that transition is probably based on some socio-economic factors that are causing the neighborhood to break down and become socially disorganized. This disorganization can make the area susceptible to criminal activity. This project identifies neighborhoods that may be in transition by calculating crime rates over a ten year period for each Denver neighborhood. The fluctuation in crime is used as an indication of some social or economic transition. In analyzing this transition citizen CFS, officer CFS, and crimes will be tracked to identify any relationship to crime. This helps determine how citizens and police respond to crime and what is the resulting effect on crime.

2. How has crime moved between Denver neighborhoods between 2000 and 2010? What neighborhoods have changed, by how much, and in what direction (increased or decreased crime?

3. What is the neighborhood response to crime? How do citizen initialed calls for service (CFS) relate to neighborhood crime?

4. What is the police response to crime and citizen CFS? How does police initiated CFS relate to citizen CFS and crime? Are responses crime dependent or independent of citizen CFS?

2.2 Methodology

The collected crime and call for service data will be aggregated and joined to allow for the comparison of crimes and calls for service area and time frame. The method consisted of two parts. The first was to aggregate crimes by neighborhood, and census tract. This provided the data necessary to establish crime rank and mobility indexes. The rank and index provided a history of crime trends. Second CFS was aggregated at the neighborhood level. The data was then analyzed, plotted, and graphed for comparison by both year and month.

The Denver Crime and Calls for service data was aggregated at the neighborhood and census tract level, The calls for service data was split into calls for service initiated by citizens (911 calls), and police calls for service which is when police officers call in to report officer initiated response in the field. The calls for service were used to identify areas of changes in criminal activity. The citizen initiated action in which the police take a reactive role and respond to citizen concerns. The police calls for service in which police are taking a proactive role in

controlling crime were compared with the citizen calls to observe police reaction. Overall whether police are being reactive or proactive the result is that there is police presence on the street which both responds to the issue at hand, as well as showing a police presence. This presence should be related to criminal activity by actively arresting offenders as well as providing a deterrent.

2.2.1 Crime Mobility Index

A crime mobility index (CMI) was developed to normalize crime transition between neighborhoods. The Crime Mobility Index used was the formula for a traditional population mobility index. I will change the RMI to CMI (Crime Mobility Index)

CMI = C1 –C2 / C1 + C2

R1 = Crime Rank at Time 1

R2 = Crime Rank at Time 2

An RMI Value is between -1 and 1, a value of 0 means no change

I used an Epoch Analysis Net Crime Migration Formula to illustrate crime moving in and out of a neighborhood. The specific epoch will be from 2000 to 2010.

Crime Migration between Time 1 and Time 2 for a given neighborhood will be:

Crime Migration = CM

Time 1 = T1

Time 2 = T2

Formula: CM (T1,T2) = CT2 – CT1

2.2.2 Rank Index

Rank index for each year was calculated by ranking the neighborhoods for each year and

assigning a rank for that year. To calculate the overall rank index each neighborhood the rank index for each year was added. The lowest score had the highest overall crime rank.
For example if a neighborhood were ranked number 1 from 2000 - 2010 it would have an overall rank of 11.

2.2.3 Hot Spot / Kernel Density

For Hot Spot analysis the crime point data was collected prior to running the Hot Spot analysis tool. The Kernel density was run using the default options.

3.0 Literature Review

Effective crime analysis can provide the information needed to understand crime, and assist in the operational and administrative planning necessary to minimize criminal activity and provide for safer neighborhoods. Understanding crime patterns, in time and in space, can drive better policing decisions.

The causes of crime have been investigated by the social, psychological, and geographic disciplines. Some of the factors that affect crime include:

- Population density
- Stability of the population
- Economic conditions
- Cultural diversity
- Employment
- Strength of law enforcement
- Law enforcement policies

- Community involvement
- Education
- Values
- Religion

All of these factors combine to form a complex inter-relationship that is hard to quantify. Utilizing quantitative analysis to this type of social problem is difficult because predicting human behavior is unlikely to have a discreet answer.

3.1 How Crime Happens

The crime triangle (also known as the problem analysis triangle) comes straight out of one of the main theories of environmental criminology and routine activity theory. This theory formulated by Lawrence Cohen and Marcus Felson states that predatory crime occurs when a likely offender and suitable target come together in time and space, without a capable guardian present (Center for Problem Oriented Policing). Offenders can sometimes be controlled by other people: those people are known as handlers. Targets and victims can sometimes be protected by other people as well: those people are known as guardians, and places are usually controlled by someone: those people are known as managers. Thus, effective problem-solving requires understanding how offenders and their targets/victims come together in places, and understanding how those offenders, targets/victims, and places are or are not effectively controlled. Understanding the weaknesses in the problem analysis triangle (Vellani, 2010), (ICA, 2010) in the context of a particular problem may point the way to new and effective interventions. The following diagram (figure 3) shows the Crime Triangle reorganized to indicate when a crime occurs. It is the intersection of the conditions illustrated by the Crime Triangle that creates the opportunity. The

triangle on the left shows what conditions provide the opportunity for crime, the result of the analysis on the right indicates when a crime is likely to occur. It occurs when a suitable target is in the proximity of a likely offender, and there is no capable guardian to prevent the crime.

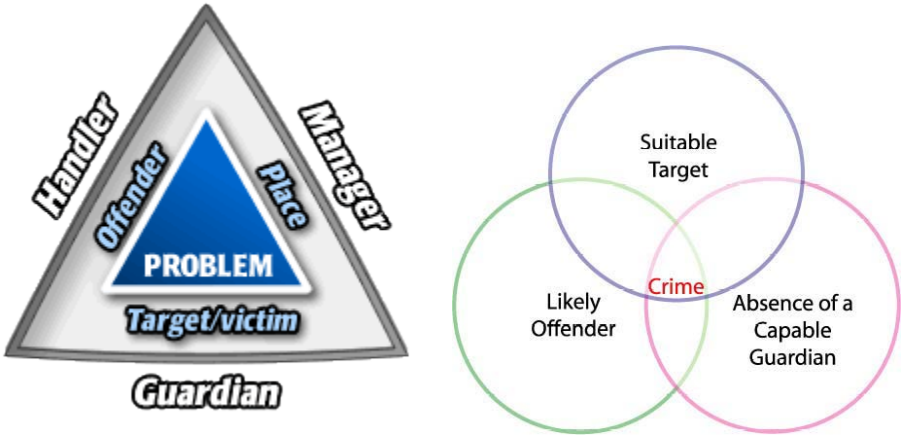


Figure 3 Crime Triangle

For environmental criminologists, 'opportunity makes the thief' is more than just a popular saying; it is the cornerstone of their approach. They believe that if opportunity increases so will crime. More importantly, they also believe that if opportunity is reduced crime will decline, which is why they advocate situational prevention measures.

Crime prevention can involve changing offenders' perceptions of the opportunity for crime. If the perceptions of opportunity decrease in one area they sometimes tend to transition to another area or method. In this paper citizen CFS (citizen involvement), and officer CFS (police presence) are studied for their effect as possible influences on "perceptions of the opportunity for crime".

This leads to a theory of displacement that sees crime as being shifted around in several ways:

1. Crime is moved from one place to another (geographical).

2. Crime is moved from one time to another (temporal).
3. Crime is directed away from one target to another (target).
4. One method of committing crime is replaced by another (tactical).
5. One kind of crime is substituted for another (crime type).

This displacement can be facilitated by the crime and CFS analyzed in this report. For whatever reason crime has always been a part of society and will probably never be eliminated, only controlled to an acceptable level. Which leads to the following section "Why Crime Happens", and what happens to the crime, where does it go?

3.2 Why Crime Happens

A popular theory of why crime happens was explored by Shaw and McKay (Vey, 2004) (Thabit, 2010). They were proponents of the Social Disorganization Theory, and the growth of cities. Social Disorganization focuses on the characteristics of neighborhood demographic and environmental factors. Socially disorganized neighborhoods are typically in transition and lack the necessary social controls. This lack of controls (social structure) combined typically with poverty, population heterogeneity, and residential mobility may be predictors of increased crime rates. Shaw and Henry McKay described the social structure in terms of a Concentric Zone Theory developed Robert E. Park and Ernest W. Burgess. In this theory a city grows from the center outward into several zones. These zones are described as follows:

Zone 1 (Inner Circle, Industry) – Industrial / Commercial Area

Zone 2 (Transition Zone) – Encroached by Industrial zone, consists of low income, dense and undesirable housing

Zone 3 (Suburban Housing) – Consists of dense middle class housing)

Zone 4 & 5 (Affluent) – Stable upper class neighborhoods

While the zones may not be literally geometric concentric circles, the Zone descriptions are applicable to many urban areas. They can be conceptually represented within any metropolitan area. They can sometimes be geographically identified through the analysis of demographic and crime data. Within the zone descriptions, Zone 2 is the most interesting from a crime perspective, in that it is probably where increased or decreased crime rates are likely to occur. This would be illustrated by neighborhoods transitioning from unstable to stable (reduced crime), or transitioning from stable to unstable (increased crime).

3.3 Analytical Response to Crime

Police respond to crime at several levels, the data that they use is aggregated to various temporal time frames (day, month, year, decade). For example police must respond to immediate calls for service and react to crime that is in the present. But they also use historical data in an attempt to predict and plan for future response requirements by looking at historical data. There are three typical levels of crime analysis; each level is responsive to a particular level of crime response. The first level is at the "Tactical" level. At this level the focus is on collecting data on the crimes currently being committed (short term), and how to respond within the current operational environment. The second level, "Strategic" crime analysis analyzes long term historical crime patterns and trends. It tends to focus on demographic and geographic factors. This information is then used to identify future resource needs, and operational policies. The third level of analysis is "Administrative", and is primary used to convey crime information to the public and policy makers to justify current and future resources. The analysis in this paper can be used to support

all three levels. At the tactical level CFS can be analyzed to what assets may be needed to support current citizen concerns. At the strategic level the historical crime and CFS pattern can be used to project future resource requirements and allocation based on when the crime currently is, and in what direction it is moving. Finally from an administrative level it can be used to report on crime to the community as well as and justify the resource requirements and allocation planes to policy makers.

These three level of analysis come together to identify crime and optimize police resources to minimize the risk of crime in any given situation. The following diagram (Vellani, 2010) illustrates the concept. The bubbles on the left illustrate the when a crime is likely to be committed, and the bubbles on the right illustrates the corresponding analysis that will assess the risk of a crime actually being committed

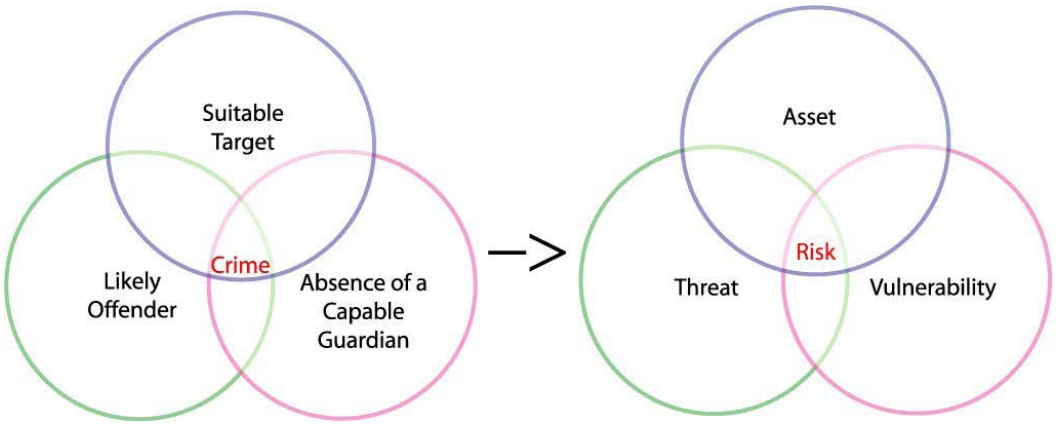
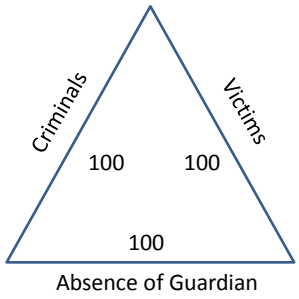


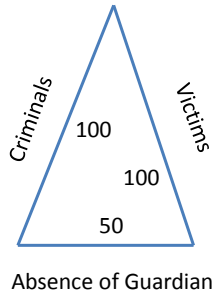
Figure 4 Crime Analysis and Risk

This type of diagram can be used to analyze any type of security issue, whether it is a physical or personal vulnerability. A part of the equation that is missing is that of "Asset Value". If a group of people or neighborhood is not considered valuable it may not be considered in a risk analysis. That could be an issue in any metropolitan area where certain neighborhoods are more valued for

a particular reason, and therefore receive better crime prevention and response. Typically with limited resources you reduce crime in one area by assuming more risk in another.

To look at a conceptual way to operationalize the Crime Triangle you could assume that at any given time that crime in an area is represented by the Crime Triangle with all sides the same length (status quo). The actual crime is represented by the area of the triangle. The area of the triangle is affected by changing the length of one of the sides. For example by reducing the absence of a capable guardian (increase police presence) you shorten the side and decrease the area. This is illustrated in the following diagram. You can also have the same effect by decreasing the criminals (active police sweeps to "round up the usual suspects) or decreasing the victims by increasing community awareness (neighborhood watch). The opposite effect of increasing the area can result from increased criminals on the street, decreased police presence, and lack of community involvement. Proactive crime prevention can attack any side / sides of the triangle to reduce crime.





Using Heron's fromula If the sides of the triangle are a, b, c, and the semiperimeter is s (s = (a+b+c)/2), then the area is: $\sqrt{s(s-a)(s-b)(s-c)}$

For the initial condition s= 100 + 100 + 100 = 300
The area = √ 150 (50) (50) (50) = 4330.127018922193

If the absence of a capable guardian is reduced to 50
(meaning better guardianship / more police)
The area = = √ 125 (75) (25) (25) = 2420.6145913796354

Figure 5 Operational Crime Triangle

4.0 Design and Implementation

4.1 Data Collection

The data for my study currently exists in federal, local government and private foundation databases.

This study will utilize of several different types of data for example:

1. Denver Police Department Crime data from 2000 to 2010

2. Denver Police Calls for Service Citizen Initiated data from 2003- 2010

3. Denver Police Calls for Service Officer Initiated data from 2003 - 2010

3. U.S. Census Data from the 2000

Some of the factors that can influence the quality of the data that may affect the result of the study include accuracy, reliability, and completeness. For the purpose of this study it is assumed that the police crime and call for service data is complete and accurate from the standpoint that it reflects actual documented activity by the Denver Police Department and is used in their own crime analysis. The U.S. Census data is accepted as a reliable standard for demographic data. As in any data collection there are going to be errors and omissions. The 10 year length of this study period should mute any minor data inconsistencies or inaccuracies.

For example data quality is in the eye of the beholder. In order to properly determine true crime rates you must collect crime data that includes all offenses "known to the police", and actual arrests. The first are incidents that that are reported to the police and the second are actual documented crimes. The data for these events are two separate indexes but they contribute to a complementary measure of actual crime. For instance if someone calls the police to report

suspicious / criminal activity and no actual crime is in evidence or no arrest occurs it is typically not reported in crime statistics.

4.2 Analysis

The analysis of the data attempted to look at the crime data from several perspectives. These included looking at a discreet comparison of the data for 2000 and 2010. Then the data was dissected by year to show totals by individual year. The yearly data was used to assign an overall crime rank to each neighborhood and then summarize this data in terms of an overall crime rank for the decade as well as calculate a Crime Mobility Index (CMI) for each neighborhood for the decade. This index described previously was modeled over the concept of Population Rank Mobility Index (RMI) that shows how population shifts over time. The results of this calculation were then used to identify neighborhoods for further analysis. The neighborhoods selected were broken into 3 categories; neighborhoods that stayed consistently high, neighborhoods that, remained consistently low, and those neighborhoods that showed the most dramatic change (increase or decrease in crime). The neighborhoods selected were analyzed individually to examine the crime in relation to calls for service (CFS). The purpose of this is to see if CFS is a leading or lagging indicator in the predicting crime. The CFS shows the relationship between how the neighborhood is involved in crime (CFS Citizen Initiated, 911 calls), and active police involvement (CFS Officer initiated) in the neighborhood.

The analysis consisted of the following steps:

1. Collect City of Denver Crime Data for the years 2000 through 2010.
2. Collect the Census data for the years 2000.

3. Consolidate and Join data by Denver neighborhood and Census Tract

4. Extract and process Denver crime data.

5. Extract and process Denver CFS data.

6. Calculate neighborhood crime rank and CMI map for the years 2000 through 2010. Mobility Index (Greene & Pick, 2006). The rank mobility index (RMI) is a measure of a city's change in population rank among a group of cities. This metric was adapted used to measure the crime rank among Denver neighborhoods as they changed from 2000 - 2010.

7. Select Neighborhoods for further analysis based on overall crime rank, and rate of transition between 2000 and 2010.

8. Execute Hot Spot and Density Analysis.

9. Prepare comparison tables and maps.

The data was aggregated at the neighborhood and census tract level. The analysis consisted of creating plots to provide a visual representation of the spatial and temporal migration of crime, and comparing it with CFS. In addition use the Census 2000 population data to calculate a baseline crime rate for 2000 to show that crime rate is a different metric from number of crimes at the neighborhood level. Analysis will determine if police activity in any given area, as indicated by calls for service has any relationship with crime, and if so is it a leading or lagging indicator. For example is police presence in any given area a response to crime or an indication that the crime rate will likely increase in the area, and is police presence related to growth or contraction of crime.

4.2.1 Denver Study Area

The following graphic (figure 6) identifies the study area. It shows the location of Denver

neighborhoods and identifies them by name. This graphic is provided to be used as a reference when viewing some of the other Denver graphics since labeling the neighborhoods tends to obscure the analysis data being presented on the map.

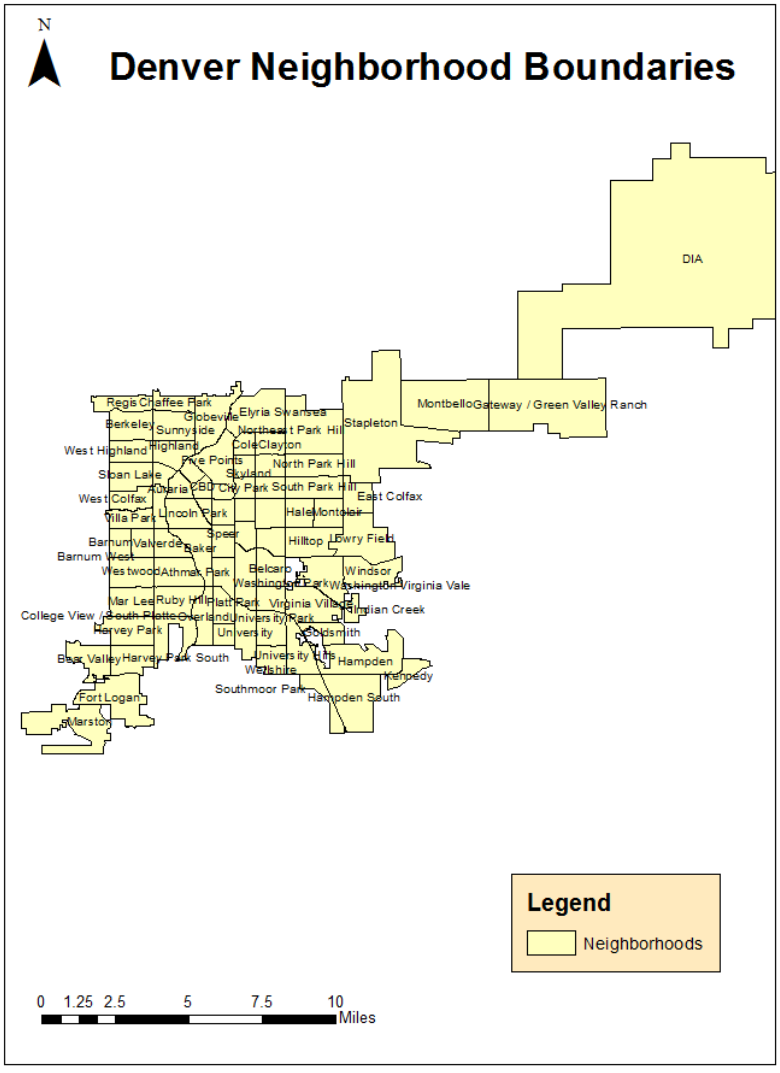


Figure 6 Denver Neighborhood Study Area Overview

4.2.2 Denver Crime Comparison 2000 and 2010

The first part of the analysis compares the crimes in 2000 with the crimes in 2010 and assess if there are any changes that would indicate a significant shift in the magnitude and distribution of crime within the city. Figure 7 below uses a Kernel Density Plot to show how Denver Crime has changed from 2000 to 2010. From the plot it can be seen that from a high level the distribution of crime in the City of Denver has not significantly changed during the 10 year period. The heaviest concentration of crime remains around the Central Business District, and the Five Points Neighborhood area which is in the near the center of the city. The crime tends to be decreasing from the center of the city which is in line with the Park and Burgess Theory of crime moving out from the center as discussed in the Literature review. While overall crime was down in 2010 its distribution is comparable with that of 2000.

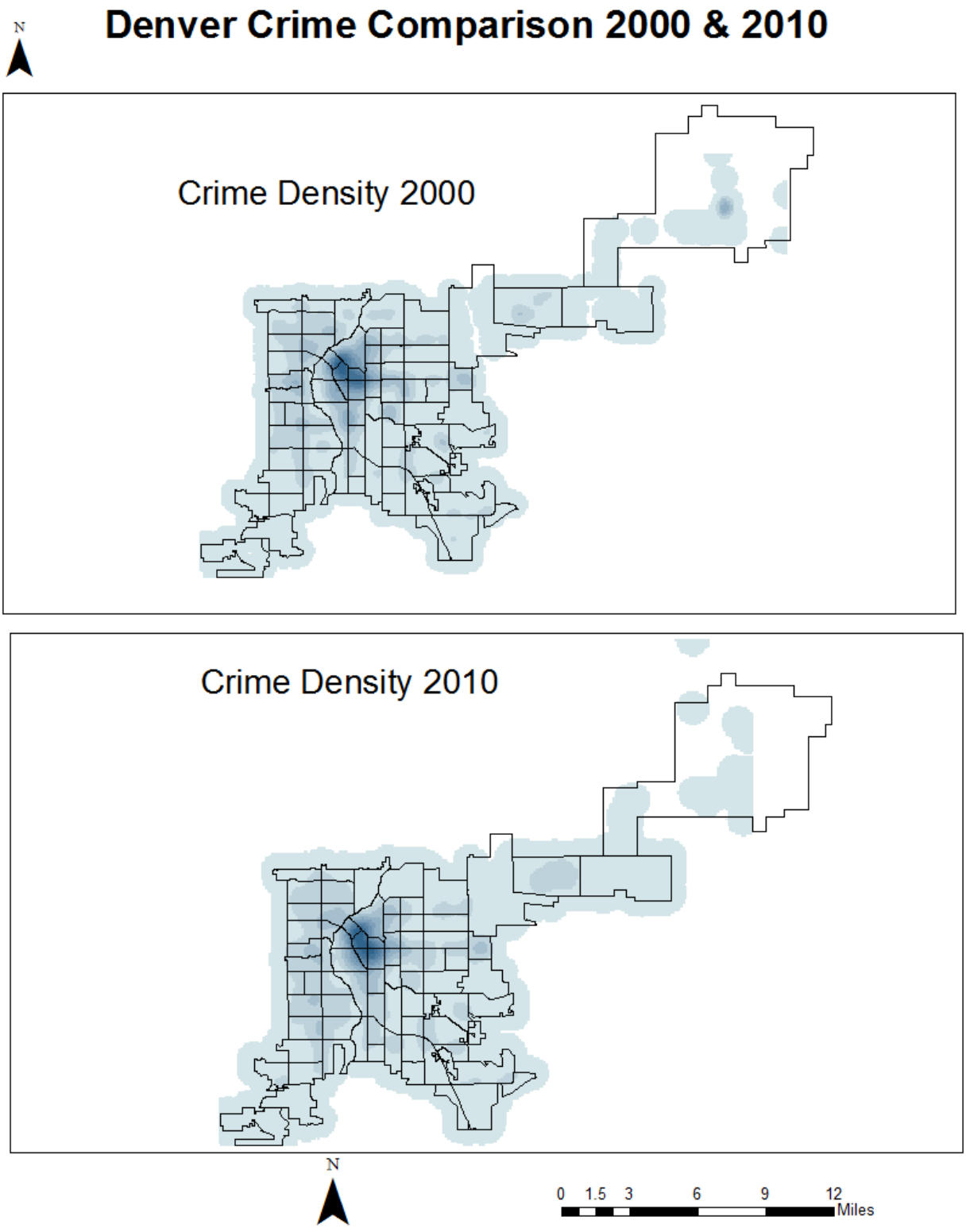


Figure 7 Kernel Density Denver Crime Comparison 2000 and 2010

In order to expand upon the information provided by the Kernel Density Plot, a Hot spot analysis was run on the crimes for an additional comparison. Figures 8 - 11 show the results, and while they are consistent with the density plots they show some hot spots that are not centered around the downtown area. These Hot Spots may represent pockets of crime not readily apparent on the density plot. While these areas may be overall low in crime the Hot Spot suggests that the crime is probably concentrated in a small area. In figure 8 and 9 the comparison between 2000 and 2010 shows the same pattern of a city center hot spot, but the 2010 shows the hot spot expanding and consuming a larger area. This is interesting in that it is in conjunction with an overall crime reduction from 2000 to 2010. The Hot Spot Analysis also confirms that CFS calls and crimes tend to be coincident (figure 10, 11).

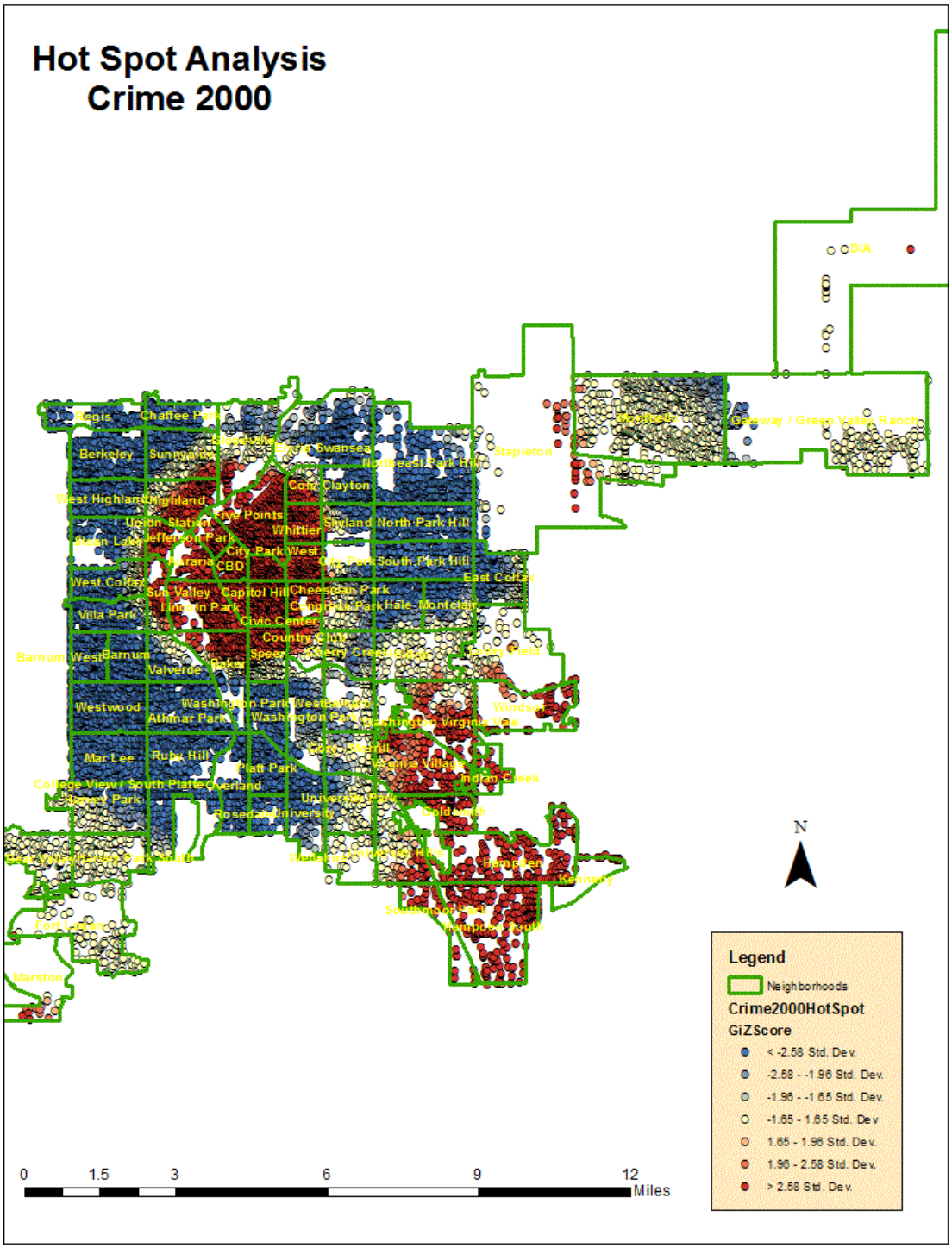


Figure 8 Hot Spot Analysis Crime 2000

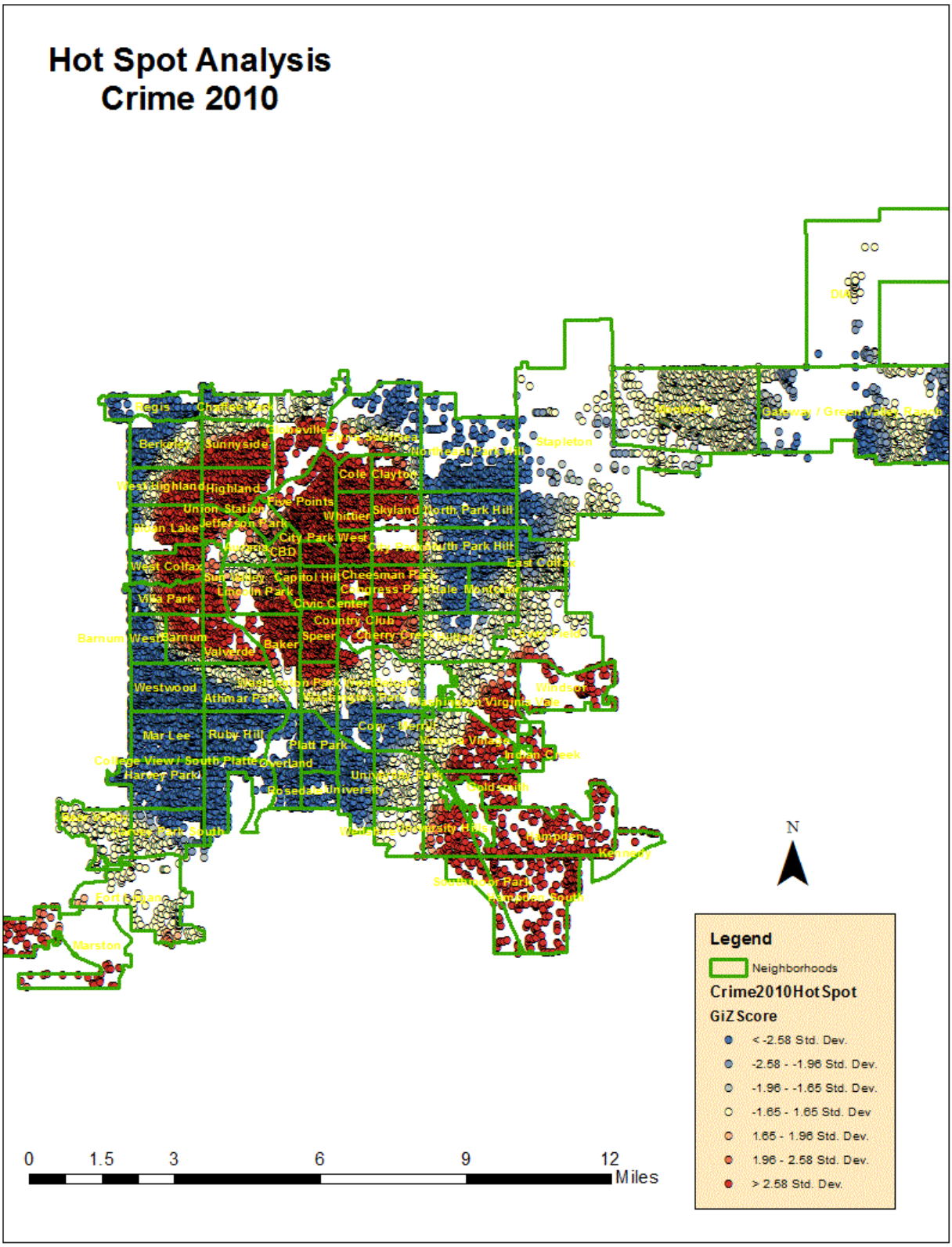


Figure 9 Hot Spot Analysis Crime 2010

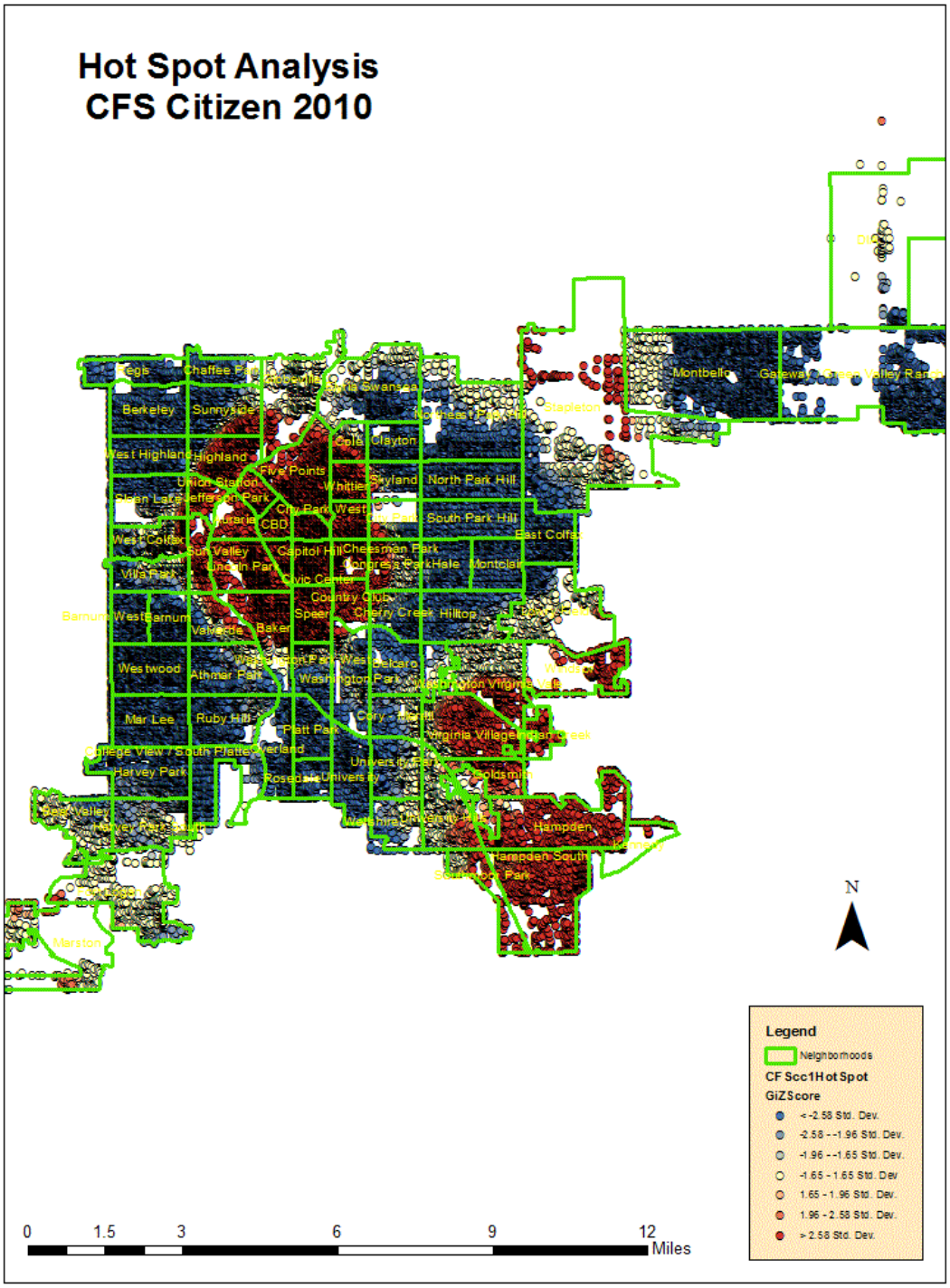


Figure 10 Hot Spot Analysis CFS Citizen 2010

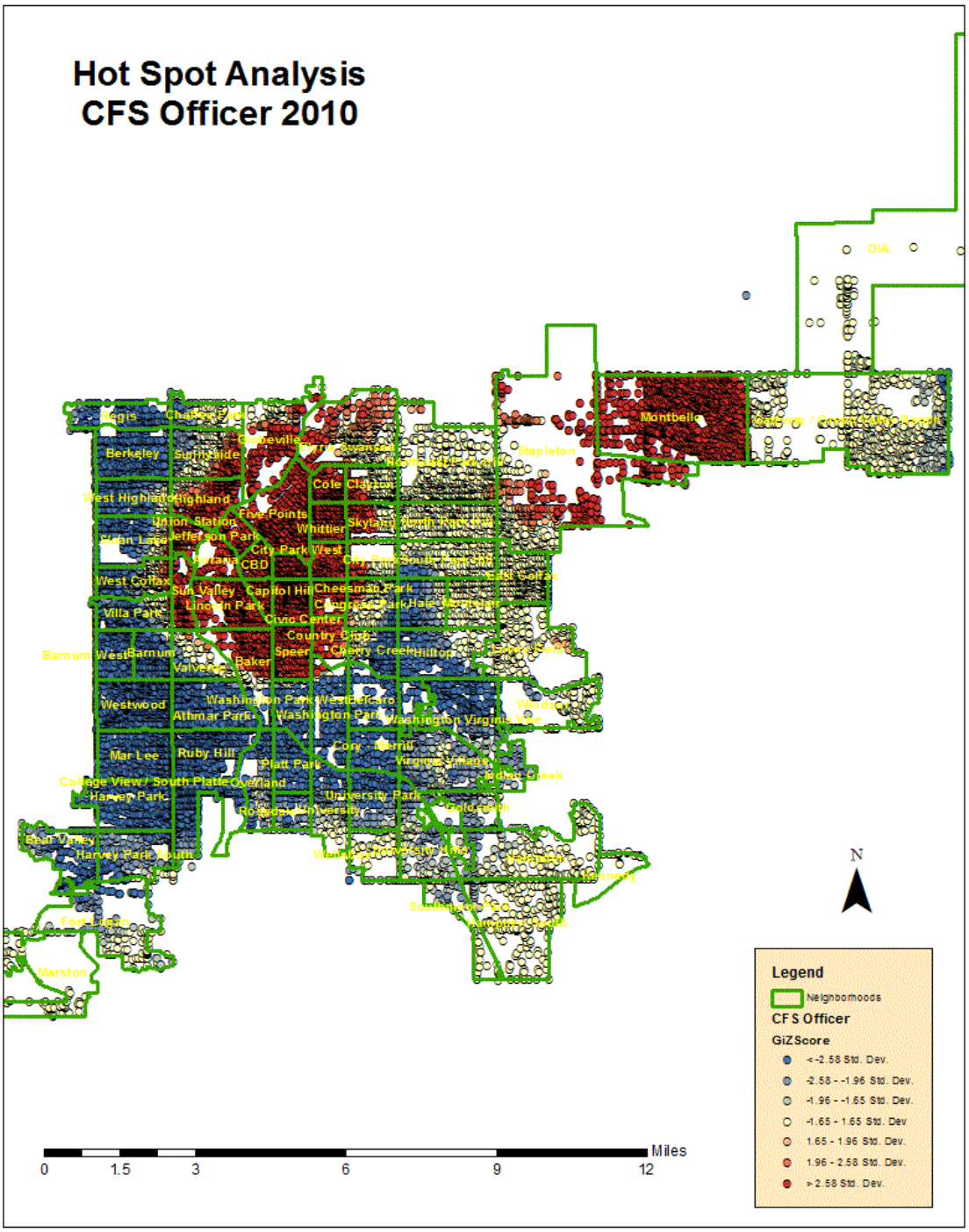


Figure 11 Hot Spot Analysis CFS Officer 2010

The following graphic shows Hot Spot analysis run against the number of crimes in the

individual Census Tracts instead of the Collected Crime Points in Figure 8. It confirms the overall Hot Spot activity, and again shows the concentration in the Downtown area previously shown in with the Density Plots and Hot Spot analysis.

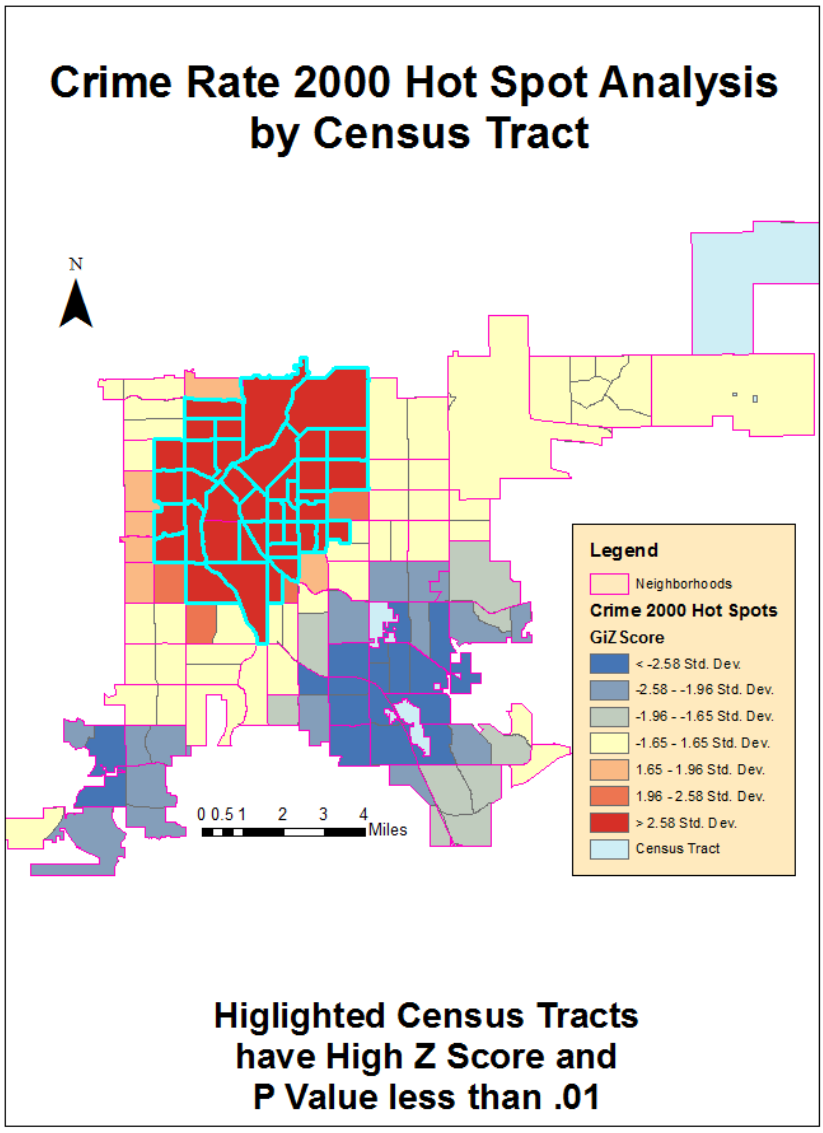


Figure 12 Census Tract Crime Rate Hot Spot Analysis

The following graph compares Offenses for 2000 and 2010. Note that the magnitude of each category of offense has remained consistent during the 10 year period. While overall crime was slightly down from 2000 to 2010 there appears to be a consistent relationship within each offense category.

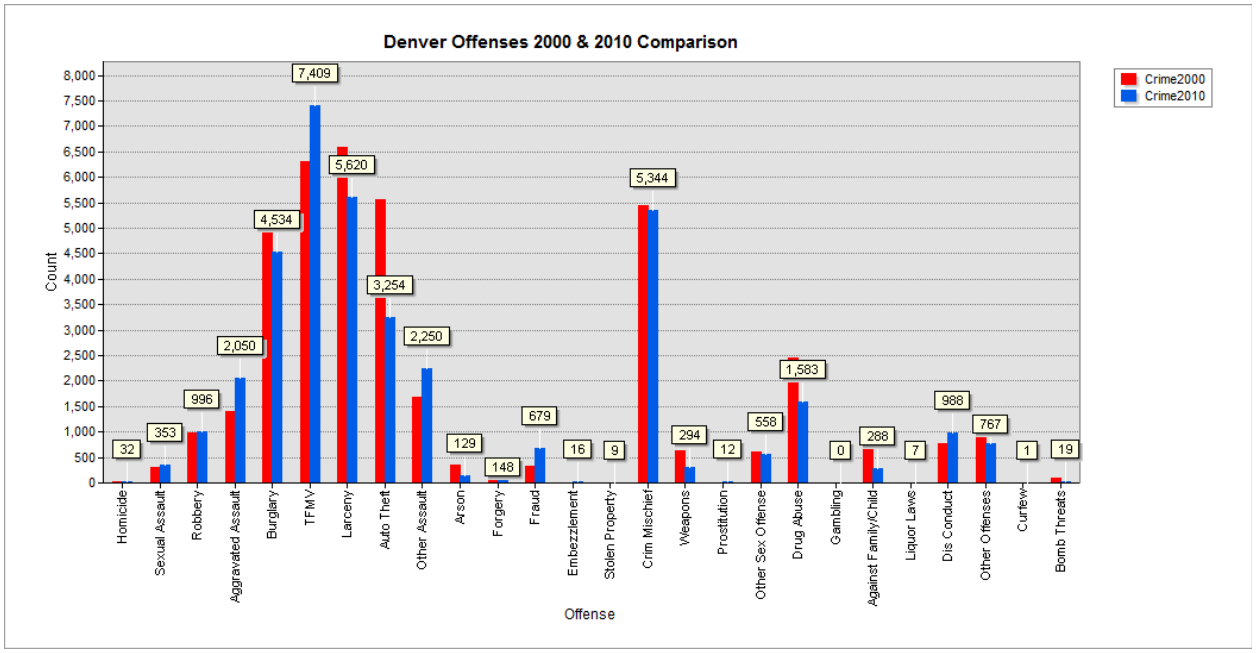


Figure 13 Denver Offense Comparison by Category for 2000 and 2010

The overall crimes per Neighborhood can be seen in the following graphics (figure 14 – 17). While Neighborhoods are how we typically look at a specific city. Crime knows no boundaries. One part of a neighborhood may be considered low crime another section may be high. This is due to the fact that neighborhood boundaries are not typically defined for statistical consistency with other neighborhoods. This is an example of the Modifiable Area Unit Problem (MAUP) in which how you divide your study area may affect your results. To illustrate this point the neighborhood data was compared to census tract data. Since the census data is at a finer

resolution you can look at each neighborhood and see that the seams of crime are not confined to neighborhood boundaries. The Census Tract shows a finer resolution within the neighborhood. A specific "Crime Area" can be within a particular neighborhood or cross the boundaries of adjacent neighborhoods. This phenomenon is illustrated in the following graphic where crimes per neighborhood are compared with crimes per census tract. In essence "Crime knows no Boundary" further analysis could show crime disparities within a census tract (Street level), or even within a given street. Figure 15 and 17 tend to show that crime is fairly consistent within a particular neighborhood, but in some cases there are areas that have distinct areas with distinct differences (figure 14 and 16 at the Census Tract level). A specific example can be found in the Montbello neighborhood in which the neighborhood view shows a moderate level of crime, but the Census tract level shows 3 distinct areas ranging from low to moderate. Figures 15 and 17 show the entire City, while Figure 18, zooms into the Montbello area.

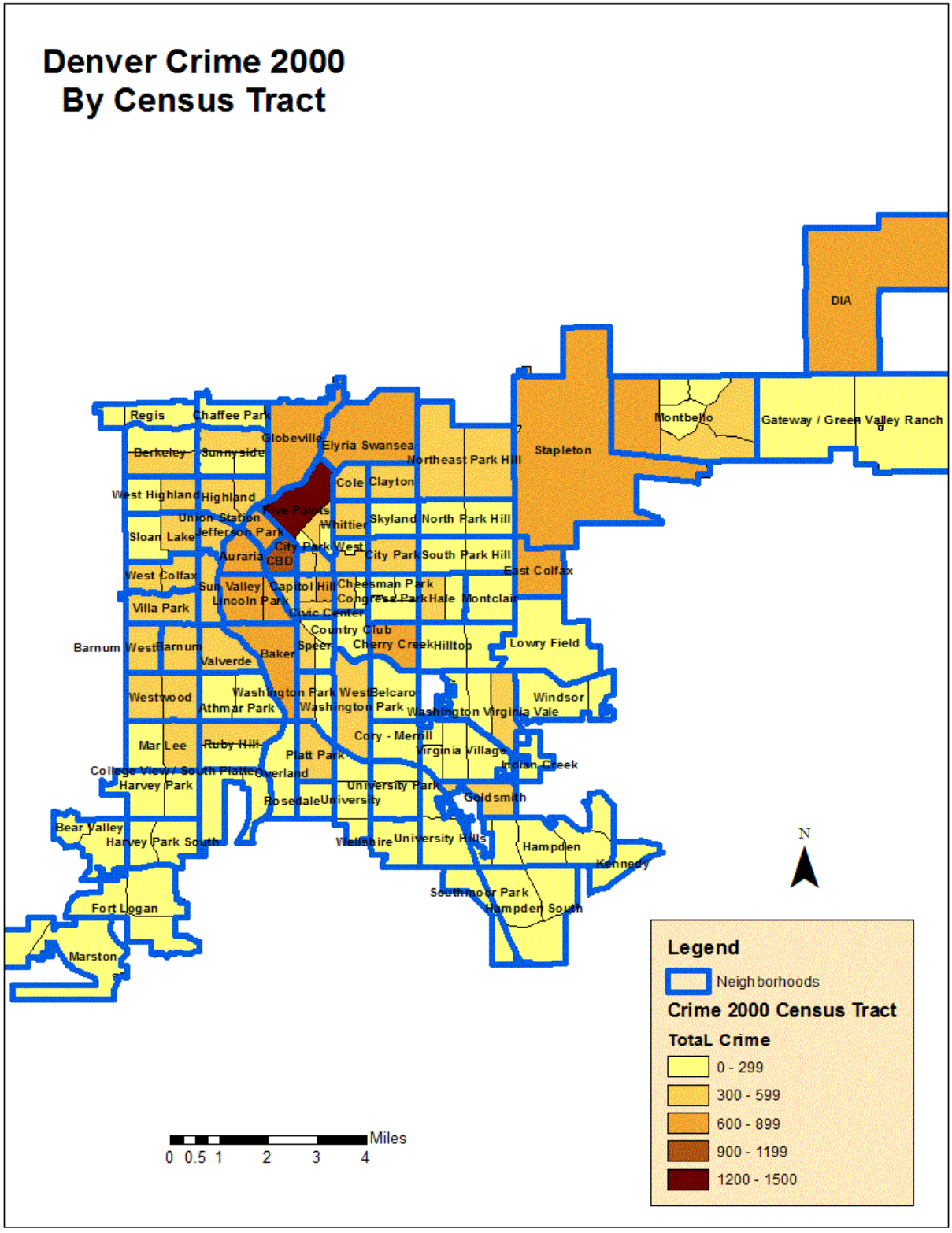


Figure 14 Denver Crime 2000 by Census Tract

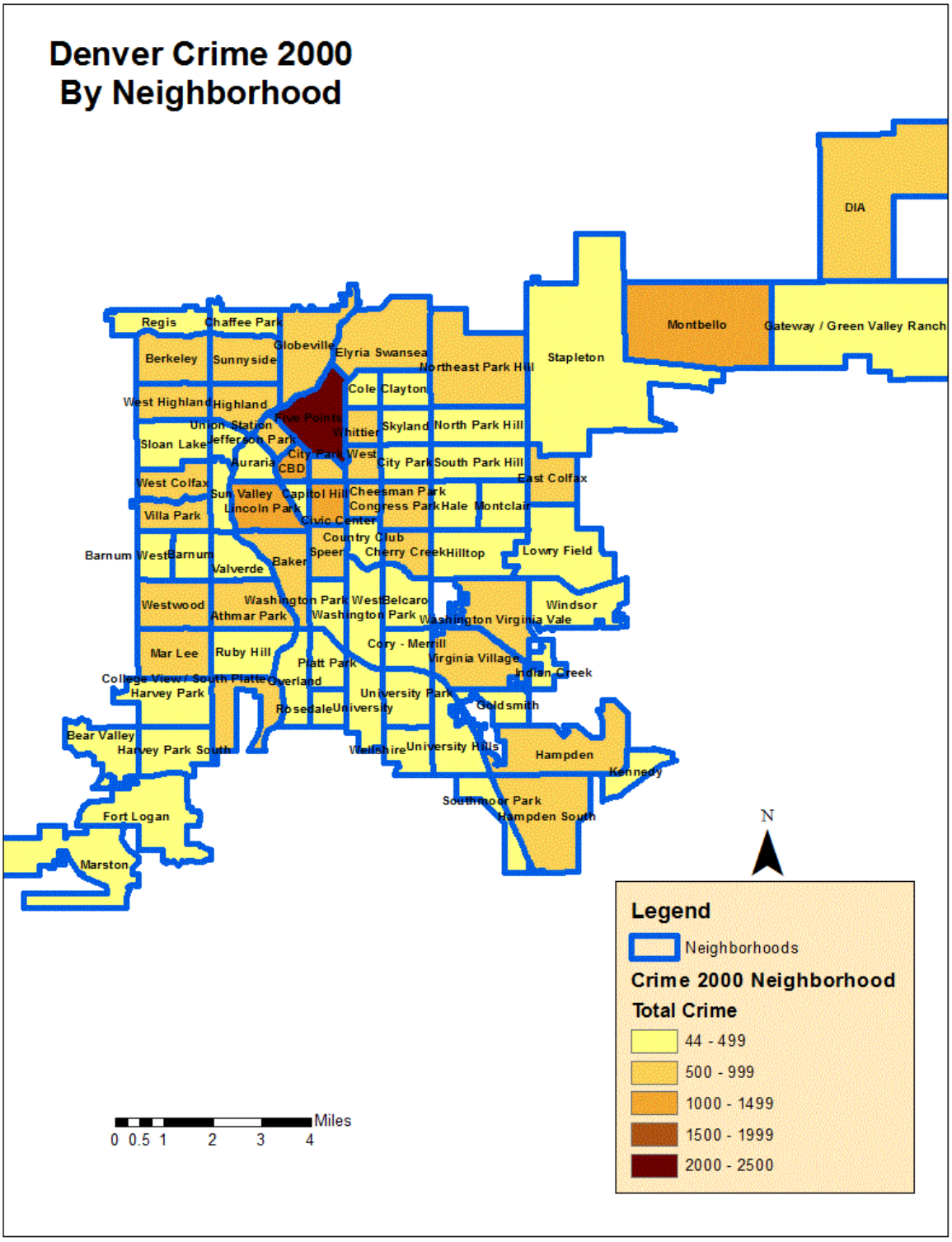


Figure 15 Denver Crime 2000 by Neighborhood

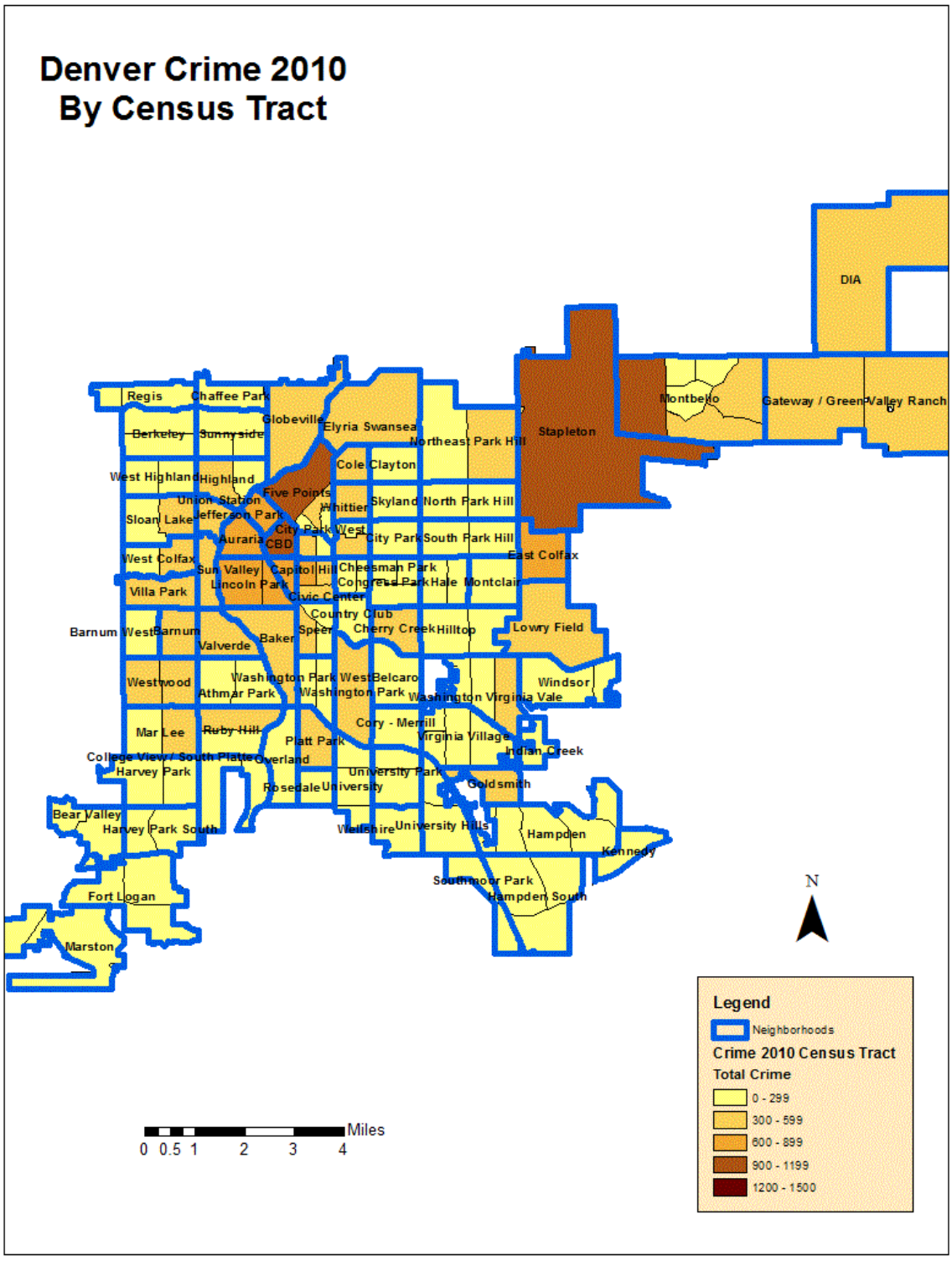


Figure 16 Denver Crime 2010 by Census Tract

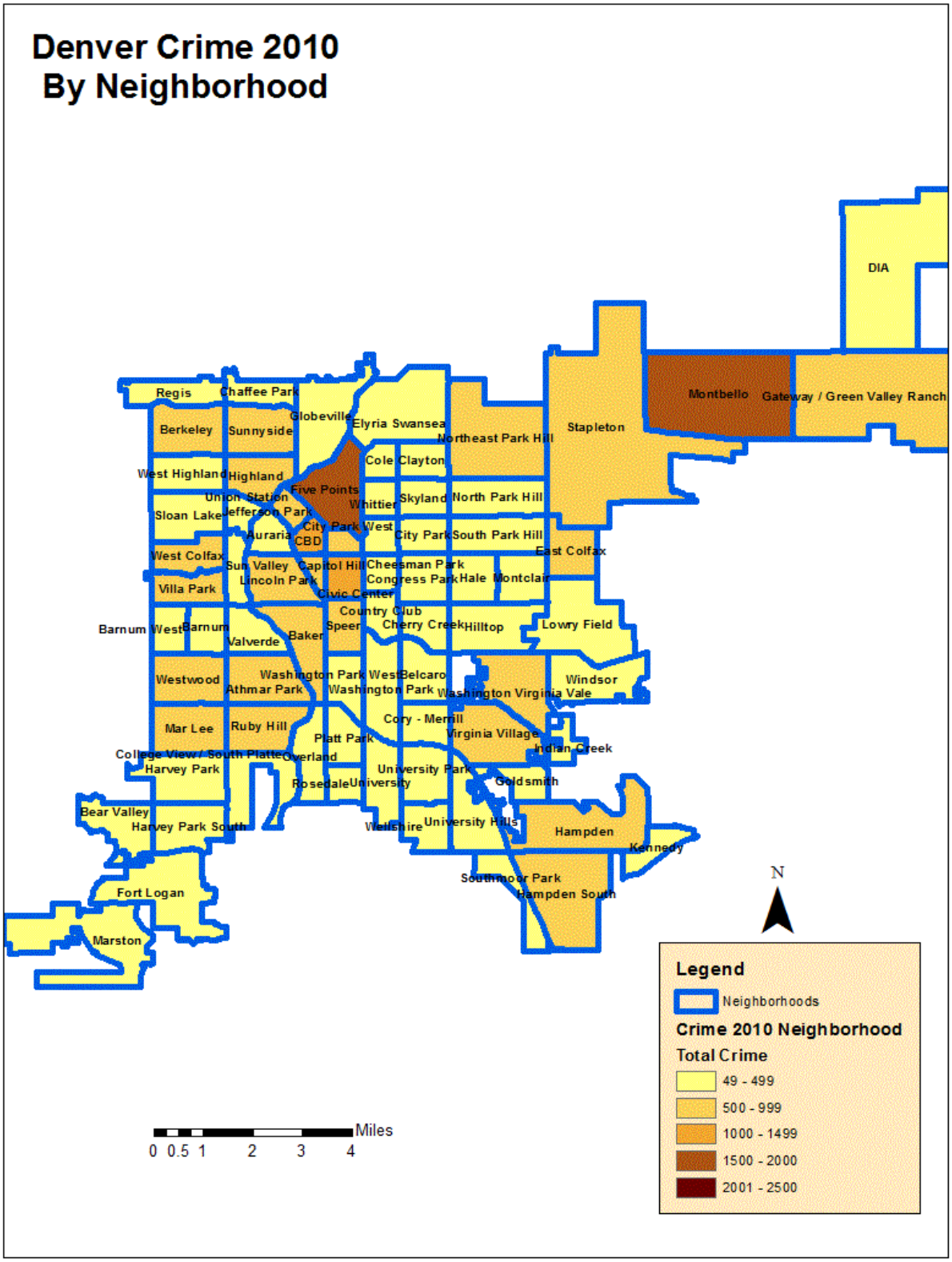


Figure 17 Denver Crime 2010 by Neighborhood

Figure 18 below shows how Montbello has three distinct crime areas, but its overall neighborhood level appears to be from its adjacency to the Stapleton neighborhood. An analysis at the street level may be even more revealing.

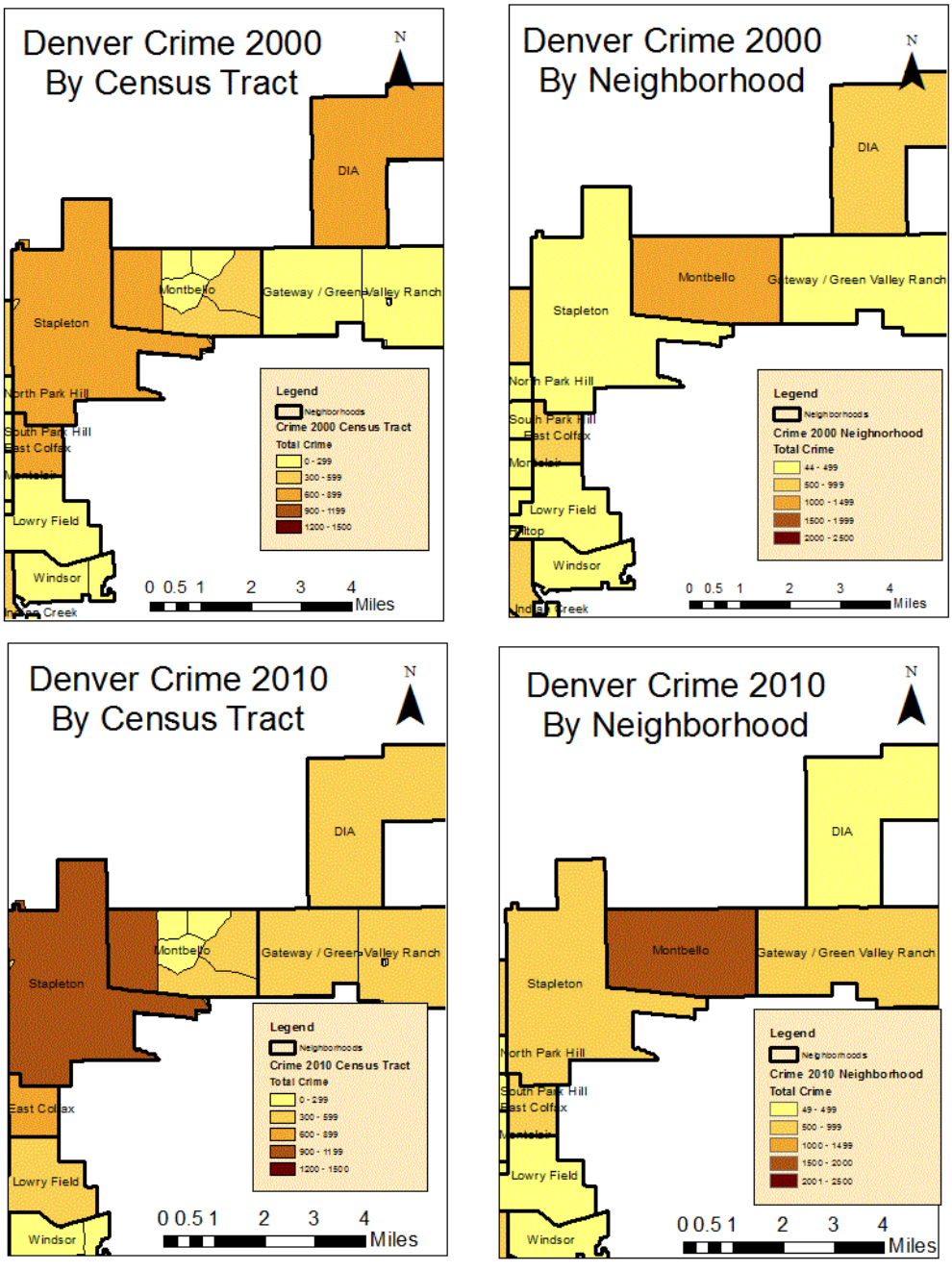


Figure 18 Denver Neighborhood and Census Tract Crime Graphic - Zoom

4.2.3 Denver Crime 2000 to 2010 by Year

The following graph (figure 19) shows the breakout of total crime by year from 2000 to 2010 along with CFS data starting in 2003 (CFS data was not available for 2000 - 2002). The graphs show a relationship between overall crime and CFS. Between 2003 and 2004 you can see an increase from approximately 46,000 to 48,000 crimes. As a response to this increase in crime the CFS Citizen starts to increase followed by a corresponding increase in CFS Officer which is an indication that Police presence in crime areas is increasing. CFS Citizen continues to increase until 2005, while CFS Officer continues to increase until 2007. The relationship shows that in 2005 CFS Citizen decreases (probably due to the decrease in crime from 2005 to 2006). The CFS Officer continues to increase until 2007. Crime continues to fall to a low in 2008. Then as CFS Officer decreases, crime increases from 2008 to 2009 which starts a subsequent increase in CFS Citizen. While the response to this increase in CFS Citizen does not appear to evoke a similar CFS Officer response, crime does go down indicating some sort of police response that may not be related to increase CFS, although the CFS Officer response remains above 2005 level that started the reduction in crime. This graph indicates that CFS Citizen reflects an increased involvement of citizens with reporting crime. Perhaps there is some threshold of crime that forces citizens to become involved. That threshold is probably related to the average crime that citizens in a particular neighborhood are accustomed. For example high crime neighborhoods have a higher threshold for crime, while relatively low crime neighborhoods respond to smaller increases in crime. This could indicate that CFS Citizen is a leading indicator of increasing crime in the neighborhood, and that police response (CFS Officer) is a lagging indicator.

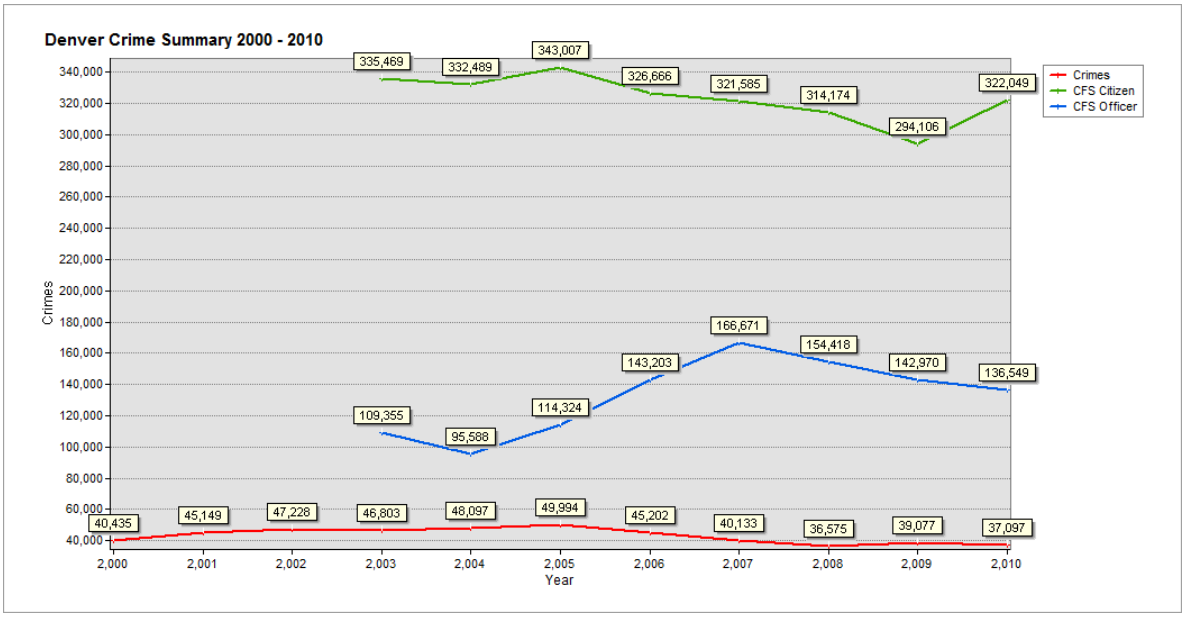


Figure 19 Denver Crime / CFS 2003 - 2010 Incident Comparison

The density plots in Figures 20 through 25 indicate the highest area of activity is centered on the CBD and the surrounding consistently high crime neighborhoods. They also show the how CFS are coincident with crime. In addition the difference in CFS Citizen and Officer is shown for 2003 and 2010 which shows that CFS Citizen is more coincident than CFS Officer which is primarily concentrated in the high crime areas of the city center.

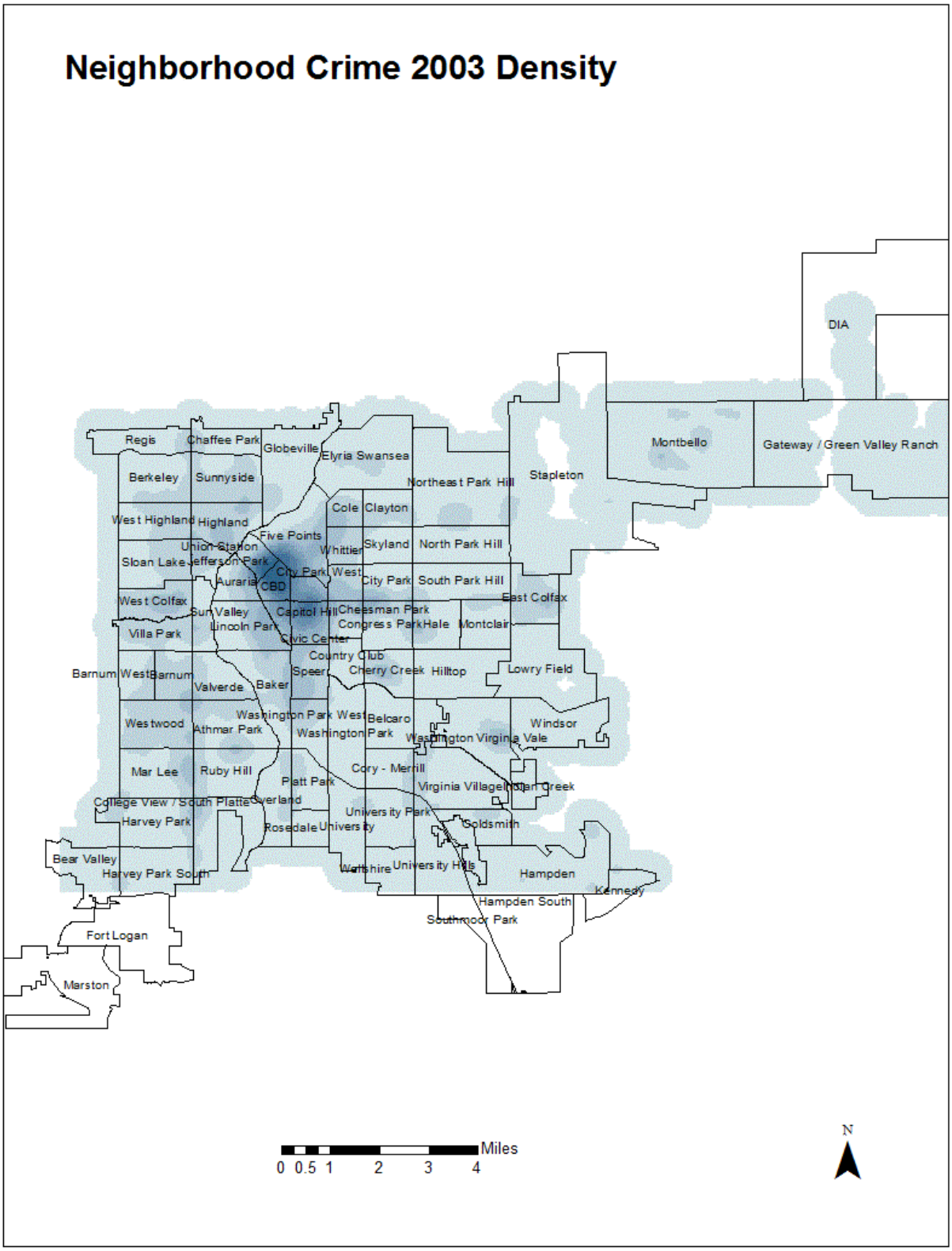


Figure 20 Neighborhood Crime 2003 Density

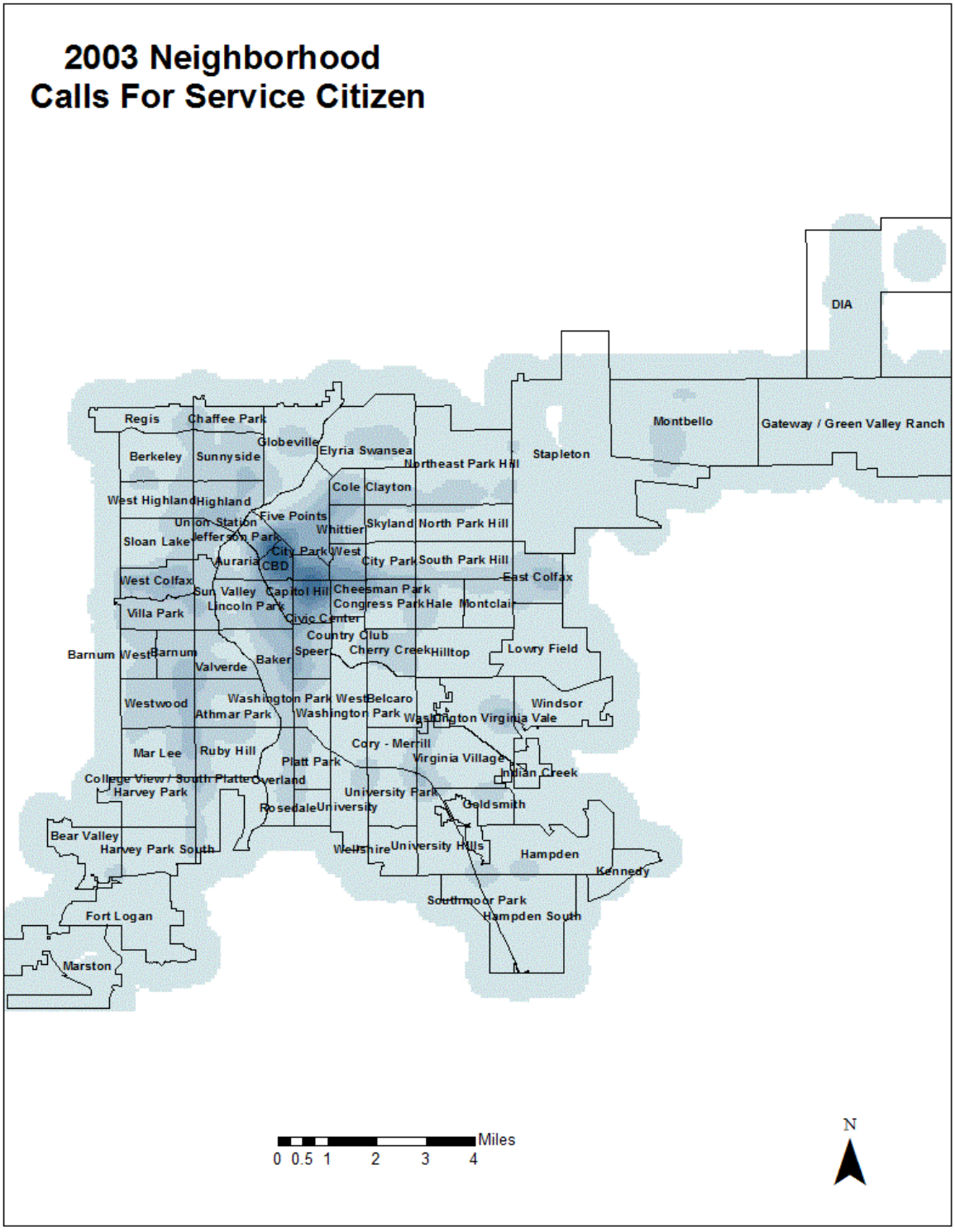


Figure 21 2003 Neighborhood Calls For Service Citizen

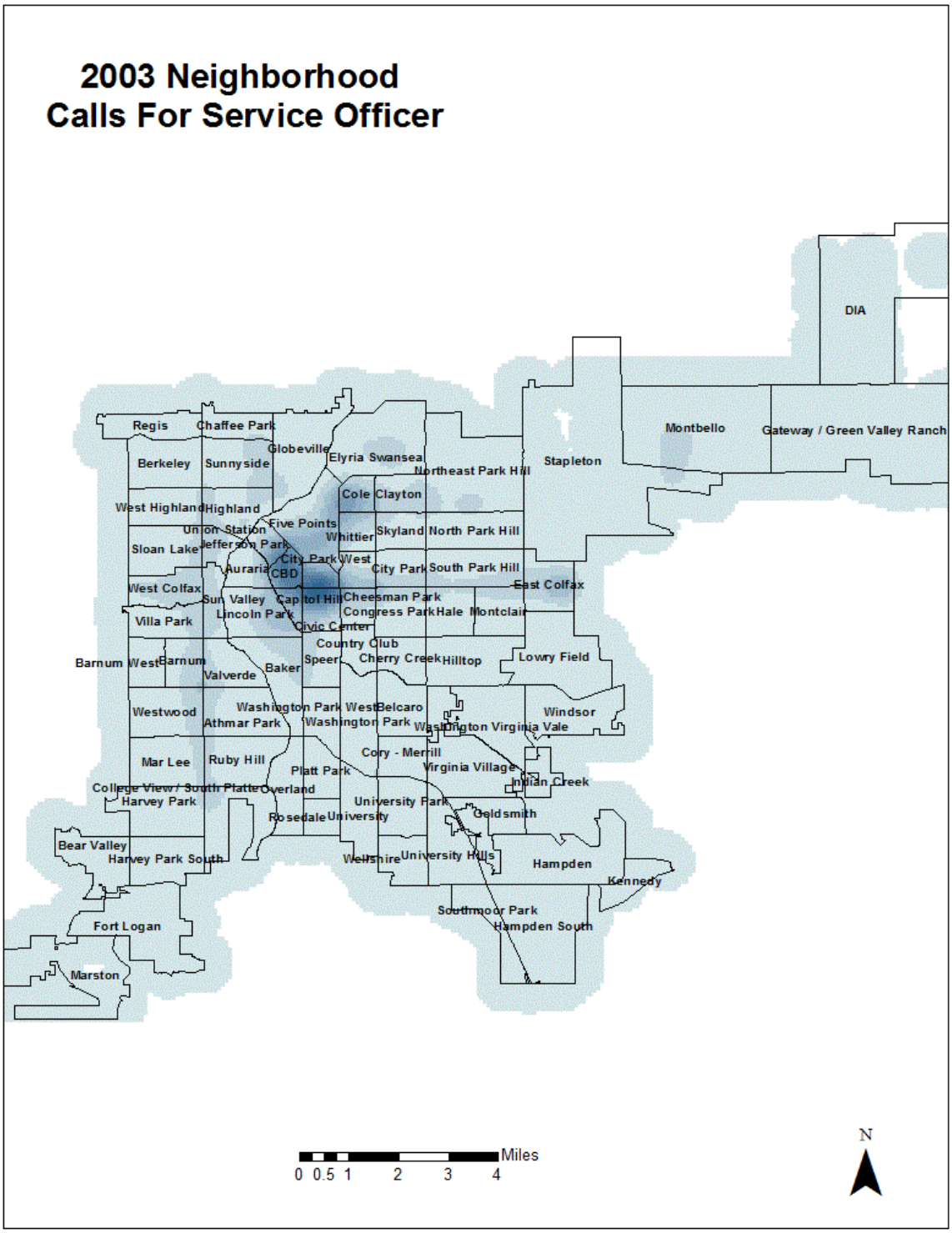


Figure 22 2003 Neighborhood Calls For Service Officer

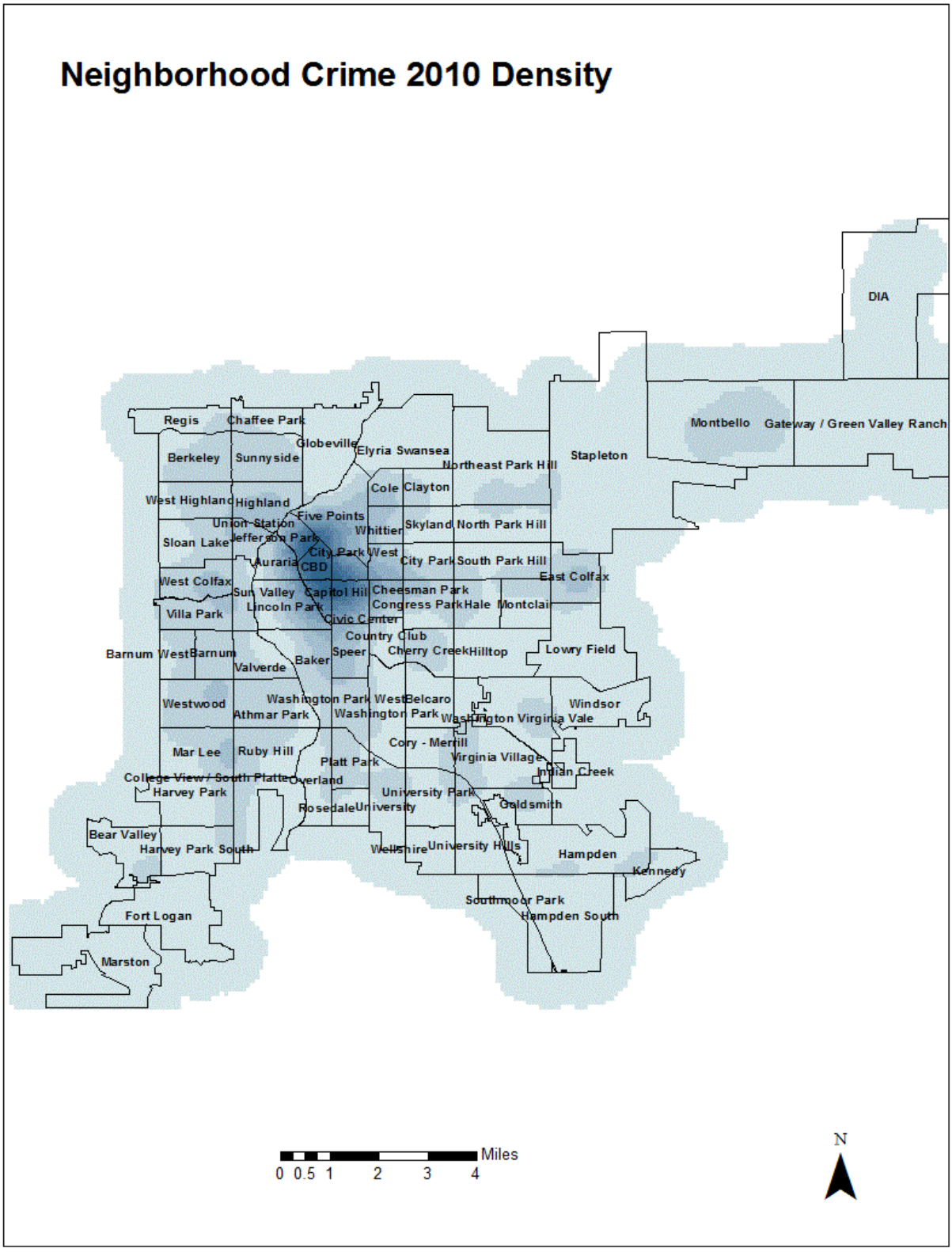


Figure 23 Neighborhood Crime 2010 Density

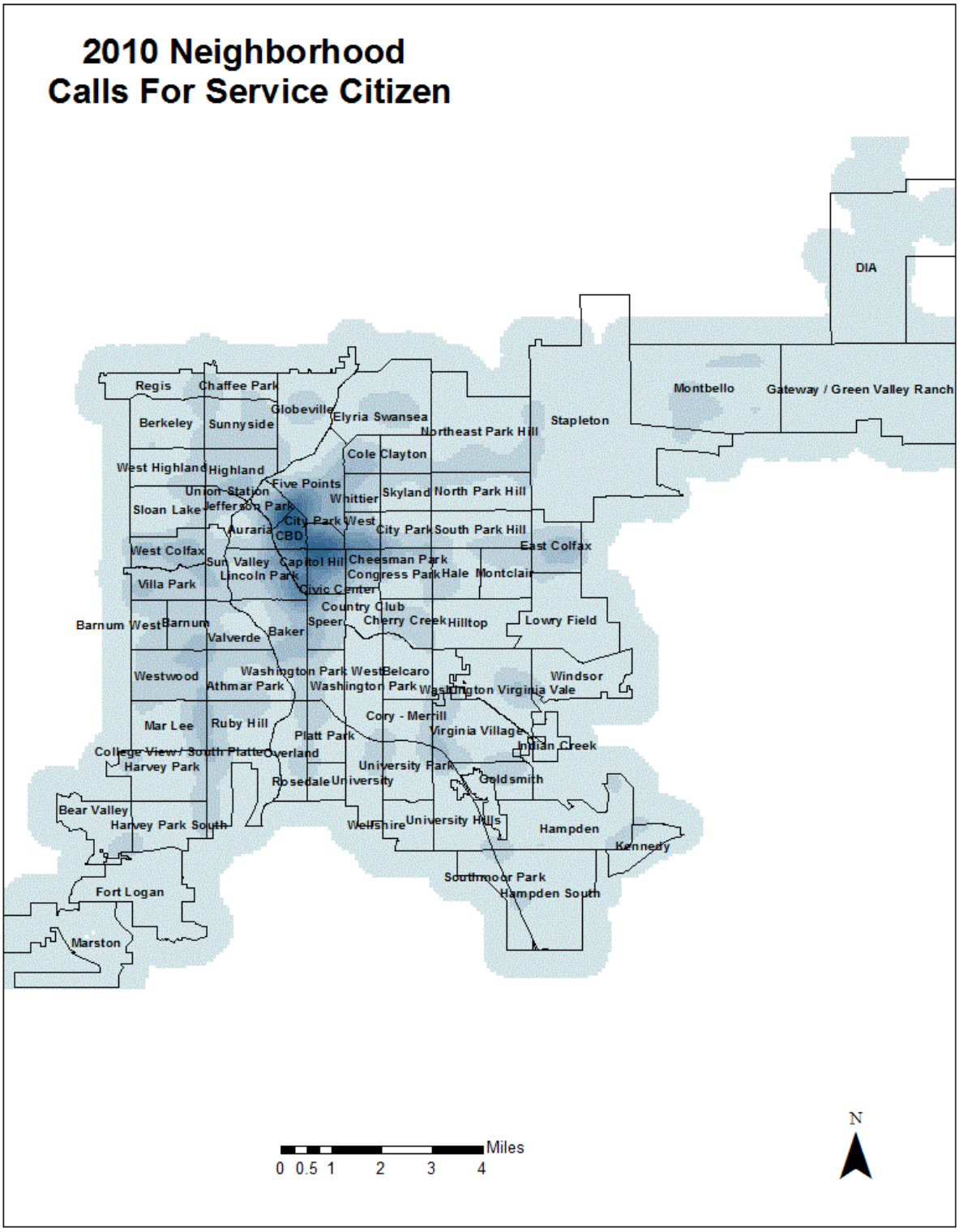


Figure 24 2010 Neighborhood Calls For Service Citizen

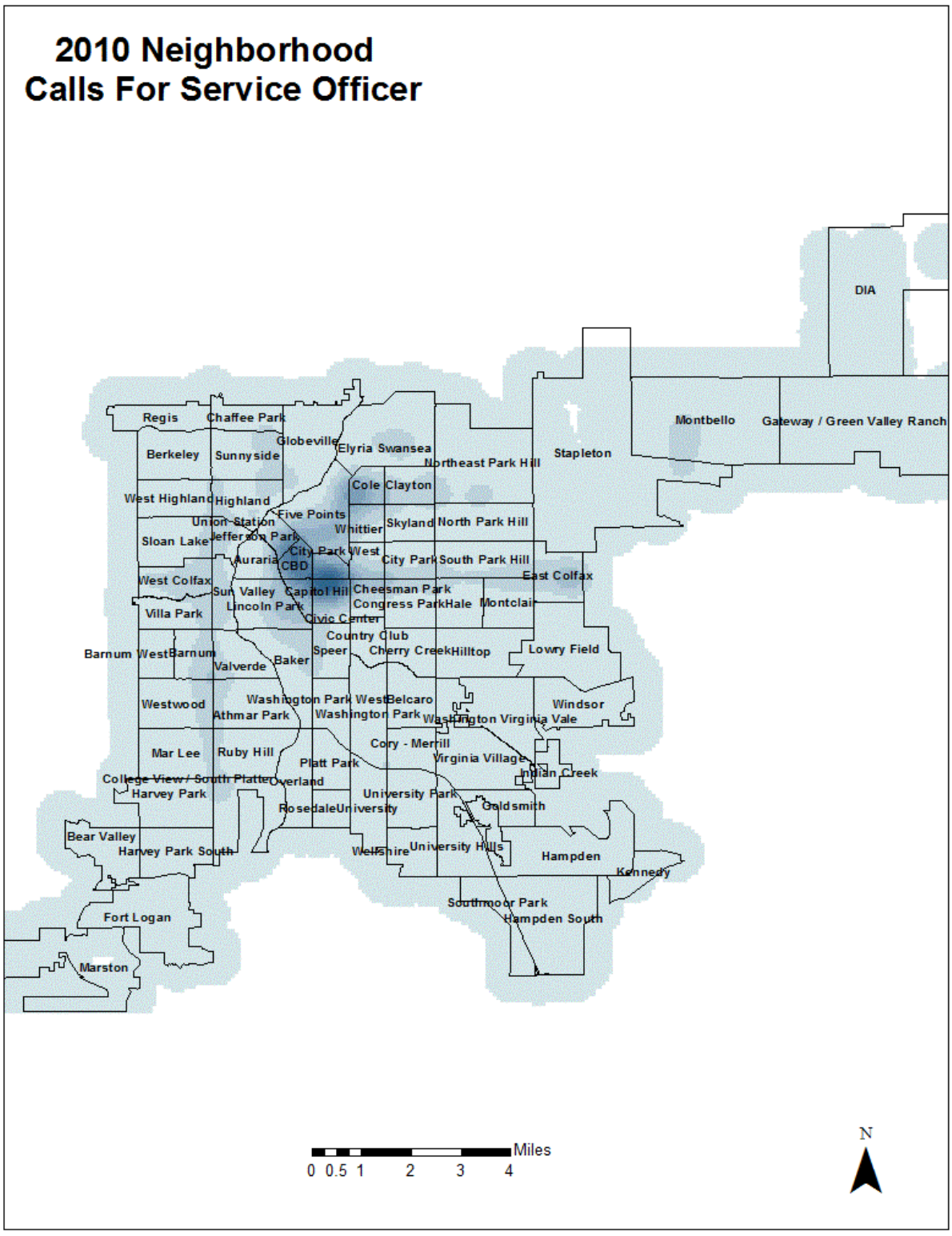


Figure 25 2010 Neighborhood Calls For Service Officer

Figure 26 shows that while there was an overall decrease in crime from 2000 – 2010, the drop is not uniform against all categories.

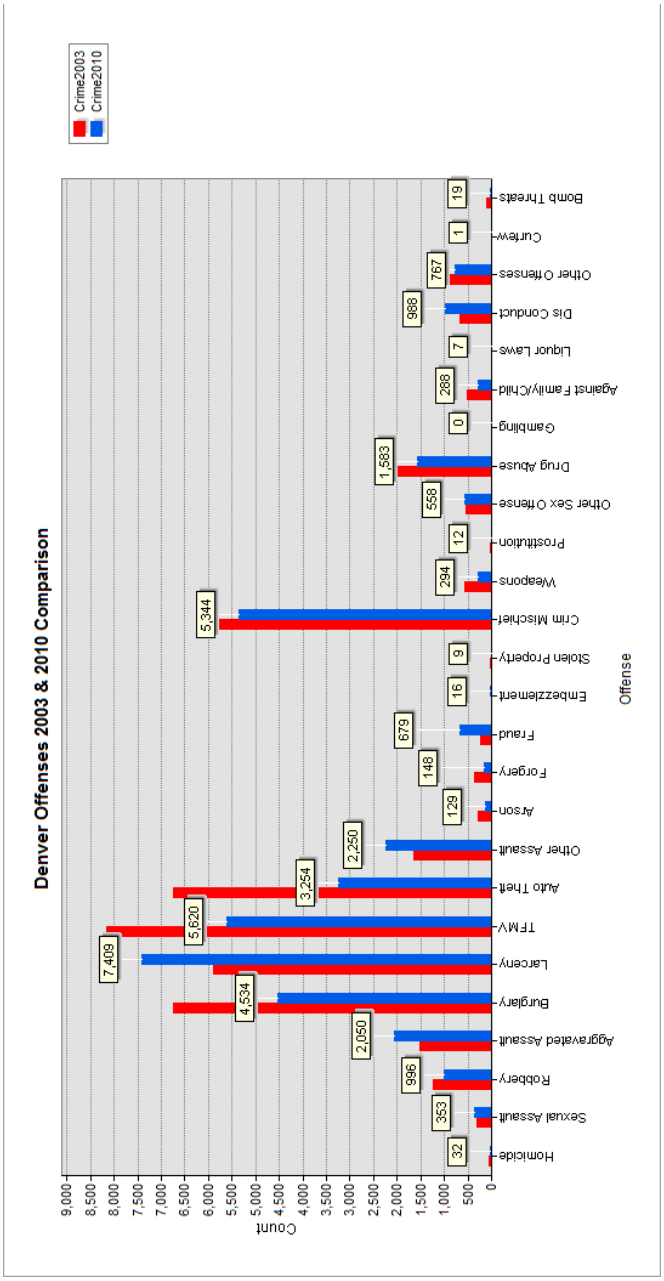


Figure 26 Denver Offenses 2003 and 2010 Comparison

4.2.4 Neighborhood Crime and Crime Mobility Index (CMI) Comparison

The following tables show the overall crime rank, CMI, and crime rate (based on 2000 Census). The overall crime rank was calculated by ranking each neighborhood for each year from 2000 to 2010 and then adding up the ranks for each neighborhood. The lowest score was the neighborhood with the highest overall rank, and the highest score was the neighborhood with the lowest overall crime rank (low score high crime, high score low crime). The CMI was then calculated to identify neighborhoods that that had little change in crime from 2000 to 2010, and the neighborhoods that experienced the greatest change in crime (either from high crime top low crime, or from low crime to high crime). The CMI ranges for -1 to +1 , a high negative indicate a decrease in crime for example going from number 1 in crime to number 10), and a high positive change indicates an increase in crime for example going from number 10 in crime to number 1). The data is presented in 3 similar tables; each is sorted by a different column (Crime Rank, CMI, and Crime Rate). While crime rate is only applicable to the 2000 Census population it is a good illustration that what constitutes high crime can vary by how you determine the number. For example counting by neighborhood, census tract, or actual crime rate based on population can yield different results. The first table lists the neighborhoods by Crime Rank, followed by tables sorted by CMI, and Crime Rate. They are all aggregated to the neighborhood level.

In looking at the tables you can see that some neighborhoods have an overall crime rank that is consistent with their ranking from 2000 to 2010 (Table 1). These neighborhoods include the top 3 crime neighborhoods (Five Points, Montbello, and Central Business District (CBD), and the 2 lowest crime neighborhoods (Indian Creek, and Wellshire).

NAME	RANK 2000	RANK 2010	COMB RANK 2000-2010	CMI 2000 - 2010	CRIME RATE 2000 Census
Five Points	1	1	1	0.0000	0.2449
Montbello	2	2	2	0.0000	0.0480
Capitol Hill	3	3	3	0.0000	0.0960
CBD	4	4	4	0.0000	0.5940
Westwood	7	8	5	-0.0667	0.0602
West Colfax	6	13	6	-0.3684	0.0867
Lincoln Park	5	5	7	0.0000	0.1577
Hampden	16	10	8	0.2308	0.0412
East Colfax	8	12	9	-0.2000	0.0881
Highland	13	11	10	0.0833	0.0784
Sunnyside	15	15	11	0.0000	0.0679
Union Station	17	7	12	0.4167	0.3285
Speer	12	16	13	-0.1429	0.0711
Northeast Park Hill	14	19	14	-0.1515	0.1021
Baker	11	17	15	-0.2143	0.1415
Athmar Park	22	20	16	0.0476	0.0746
Mar Lee	28	18	17	0.2174	0.0446
Elyria Swansea	18	33	18	-0.2941	0.1052
North Capitol Hill	10	21	19	-0.3548	0.2110
Gateway / Green Valley Ranch	55	6	20	0.8033	0.0364
Stapleton	35	9	21	0.5909	0.0000
Washington Virginia Vale	20	24	22	-0.0909	0.0518
Virginia Village	24	22	23	0.0435	0.0427
Hampden South	19	23	24	-0.0952	0.0493
Berkeley	26	26	25	0.0000	0.0653
Congress Park	31	28	26	0.0508	0.0496
Ruby Hill	43	27	27	0.2286	0.0433
Harvey Park	46	30	28	0.2105	0.0360
Cherry Creek	21	35	29	-0.2500	0.1309
West Highland	30	29	30	0.0169	0.0608
College View / South Platte	32	31	31	0.0159	0.0873
Villa Park	33	25	32	0.1379	0.0511

Civic Center	45	14	33	0.5254	0.6624
Sloan Lake	42	34	34	0.1053	0.0525
City Park West	25	32	35	-0.1228	0.1356
Cheesman Park	27	37	36	-0.1563	0.0664
Globeville	23	52	37	-0.3867	0.1836
South Park Hill	38	38	38	0.0000	0.0514
Barnum	40	42	39	-0.0244	0.0701
Washington Park West	37	46	40	-0.1084	0.0704
DIA	9	45	41	-0.6667	217.25
Whittier	29	53	42	-0.2927	0.0996
Auraria	41	36	43	0.0649	3.4472
North Park Hill	47	56	44	-0.0874	0.0401
Hale	34	57	45	-0.2527	0.0668
Valverde	36	41	46	-0.0649	0.1133
Cole	39	55	47	-0.1702	0.0758
University	59	47	48	0.1132	0.0345
Sun Valley	44	50	49	-0.0638	0.2761
Washington Park	54	40	50	0.1489	0.0498
Harvey Park South	60	43	51	0.1650	0.0338
Windsor	49	49	52	0.0000	0.0286
Platt Park	52	48	53	0.0400	0.0646
Bear Valley	64	44	54	0.1852	0.0326
Jefferson Park	53	58	55	-0.0450	0.1015
Clayton	50	63	56	-0.1150	0.0692
Goldsmith	51	39	57	0.1333	0.0593
University Hills	56	54	58	0.0182	0.0578
City Park	48	66	59	-0.1579	0.1705
University Park	67	59	60	0.0635	0.0352
Marston	57	70	61	-0.1024	0.0323
Montclair	62	60	62	0.0164	0.0493
Barnum West	58	62	63	-0.0333	0.0558
Lowry Field	66	51	64	0.1282	0.0842
Regis	63	65	65	-0.0156	0.0629
Overland	61	61	66	0.0000	0.1302
Chaffee Park	65	64	67	0.0078	0.0556
Fort Logan	70	67	68	0.0219	0.0211
Hilltop	71	69	69	0.0143	0.0235
Skyland	68	71	70	-0.0216	0.0708
Cory - Merrill	72	72	71	0.0000	0.0473
Kennedy	74	68	72	0.0423	0.0427
Belcaro	69	75	73	-0.0417	0.0580

Country Club	73	76	74	-0.0201	0.0525
Rosedale	76	74	75	0.0133	0.0439
Southmoor Park	75	73	76	0.0135	0.0493
Indian Creek	77	77	77	0.0000	0.0147
Wellshire	78	78	78	0.0000	0.0145

Table 1 Denver Neighborhood Sorted by Crime Rank 2000 - 2010

In looking at the following table you can see the volatility in crime within a neighborhood. The CMI's are sorted from low to high. The lower the CMI the greater the decrease in crime. For example Globeville went from 23rd to 52nd (DIA was discounted because it is primarily the airport and is not consistent with a typical neighborhood). At the other end of the spectrum are Gateway / Green Valley Ranch which went from 55th to 6th (the neighborhood with the greatest increase in crime). The neighborhoods with a CMI of 0 had no change in rank from 2000 to 2010. The neighborhoods with a CMI of 0, and a combined rank that is different from their Rank in 2000 and 2010 indicate neighborhoods that retained their rank from 2000 to 2010 but had some volatility in between that caused their combined rank to be different.

NAME	RANK 2000	RANK 2010	COMB RANK 2000-2010	CMI 2000 - 2010	CRIME RATE 2000 Census
DIA	9	45	41	-0.6667	217.25
Globeville	23	52	37	-0.3867	0.1836
West Colfax	6	13	6	-0.3684	0.0867
North Capitol Hill	10	21	19	-0.3548	0.2110
Elyria Swansea	18	33	18	-0.2941	0.1052
Whittier	29	53	42	-0.2927	0.0996
Hale	34	57	45	-0.2527	0.0668
Cherry Creek	21	35	29	-0.2500	0.1309
Baker	11	17	15	-0.2143	0.1415
East Colfax	8	12	9	-0.2000	0.0881
Cole	39	55	47	-0.1702	0.0758
City Park	48	66	59	-0.1579	0.1705

Cheesman Park	27	37	36	-0.1563	0.0664
Northeast Park Hill	14	19	14	-0.1515	0.1021
Speer	12	16	13	-0.1429	0.0711
City Park West	25	32	35	-0.1228	0.1356
Clayton	50	63	56	-0.1150	0.0692
Washington Park West	37	46	40	-0.1084	0.0704
Marston	57	70	61	-0.1024	0.0323
Hampden South	19	23	24	-0.0952	0.0493
Washington Virginia Vale	20	24	22	-0.0909	0.0518
North Park Hill	47	56	44	-0.0874	0.0401
Westwood	7	8	5	-0.0667	0.0602
Valverde	36	41	46	-0.0649	0.1133
Sun Valley	44	50	49	-0.0638	0.2761
Jefferson Park	53	58	55	-0.0450	0.1015
Belcaro	69	75	73	-0.0417	0.0580
Barnum West	58	62	63	-0.0333	0.0558
Barnum	40	42	39	-0.0244	0.0701
Skyland	68	71	70	-0.0216	0.0708
Country Club	73	76	74	-0.0201	0.0525
Regis	63	65	65	-0.0156	0.0629
Wellshire	78	78	78	0.0000	0.2449
Indian Creek	77	77	77	0.0000	0.0480
Windsor	49	49	52	0.0000	0.0960
Cory - Merrill	72	72	71	0.0000	0.5940
Montbello	2	2	2	0.0000	0.1577
South Park Hill	38	38	38	0.0000	0.0679
Berkeley	26	26	25	0.0000	0.0653
Sunnyside	15	15	11	0.0000	0.0514
Capitol Hill	3	3	3	0.0000	0.0286
Overland	61	61	66	0.0000	0.1302
Lincoln Park	5	5	7	0.0000	0.0473
Five Points	1	1	1	0.0000	0.0147
CBD	4	4	4	0.0000	0.0145
Chaffee Park	65	64	67	0.0078	0.0556
Rosedale	76	74	75	0.0133	0.0439
Southmoor Park	75	73	76	0.0135	0.0493
Hilltop	71	69	69	0.0143	0.0235
College View / South Platte	32	31	31	0.0159	0.0873
Montclair	62	60	62	0.0164	0.0493
West Highland	30	29	30	0.0169	0.0608
University Hills	56	54	58	0.0182	0.0578

Fort Logan	70	67	68	0.0219	0.0211
Platt Park	52	48	53	0.0400	0.0646
Kennedy	74	68	72	0.0423	0.0427
Virginia Village	24	22	23	0.0435	0.0427
Athmar Park	22	20	16	0.0476	0.0746
Congress Park	31	28	26	0.0508	0.0496
University Park	67	59	60	0.0635	0.0352
Auraria	41	36	43	0.0649	3.4472
Highland	13	11	10	0.0833	0.0784
Sloan Lake	42	34	34	0.1053	0.0525
University	59	47	48	0.1132	0.0345
Lowry Field	66	51	64	0.1282	0.0842
Goldsmith	51	39	57	0.1333	0.0593
Villa Park	33	25	32	0.1379	0.0511
Washington Park	54	40	50	0.1489	0.0498
Harvey Park South	60	43	51	0.1650	0.0338
Bear Valley	64	44	54	0.1852	0.0326
Harvey Park	46	30	28	0.2105	0.0360
Mar Lee	28	18	17	0.2174	0.0446
Ruby Hill	43	27	27	0.2286	0.0433
Hampden	16	10	8	0.2308	0.0412
Union Station	17	7	12	0.4167	0.3285
Civic Center	45	14	33	0.5254	0.6624
Stapleton	35	9	21	0.5909	0.0000
Gateway / Green Valley Ranch	55	6	20	0.8033	0.0364

Table 2 Denver Neighborhood Crime Sorted by CMI 2000 - 2010

The next table illustrated how neighborhood crime rate and crime rank can tell a different story. For example by looking at the Auraria neighborhood you can see that in 2000 it had the highest crime rate based on its 2000 Census population but when ranked by number of crimes it was 41st. This shows the disparity between measuring crime by different criteria. This could be an instance of a Modifiable Criteria Area Unit Problem (MCAUP).

NAME	RANK 2000	RANK 2010	COMB RANK 2000-2010	CMI 2000 - 2010	CRIME RATE 2000 Census
DIA	9	45	41	-0.6667	217.25
Auraria	41	36	43	0.0649	3.4472
Civic Center	45	14	33	0.5254	0.6624
CBD	4	4	4	0.0000	0.5940
Union Station	17	7	12	0.4167	0.3285
Sun Valley	44	50	49	-0.0638	0.2761
Five Points	1	1	1	0.0000	0.2449
North Capitol Hill	10	21	19	-0.3548	0.2110
Globeville	23	52	37	-0.3867	0.1836
City Park	48	66	59	-0.1579	0.1705
Lincoln Park	5	5	7	0.0000	0.1577
Baker	11	17	15	-0.2143	0.1415
City Park West	25	32	35	-0.1228	0.1356
Cherry Creek	21	35	29	-0.2500	0.1309
Overland	61	61	66	0.0000	0.1302
Valverde	36	41	46	-0.0649	0.1133
Elyria Swansea	18	33	18	-0.2941	0.1052
Northeast Park Hill	14	19	14	-0.1515	0.1021
Jefferson Park	53	58	55	-0.0450	0.1015
Whittier	29	53	42	-0.2927	0.0996
Capitol Hill	3	3	3	0.0000	0.0960
East Colfax	8	12	9	-0.2000	0.0881
College View / South Platte	32	31	31	0.0159	0.0873
West Colfax	6	13	6	-0.3684	0.0867
Lowry Field	66	51	64	0.1282	0.0842
Highland	13	11	10	0.0833	0.0784
Cole	39	55	47	-0.1702	0.0758
Athmar Park	22	20	16	0.0476	0.0746
Speer	12	16	13	-0.1429	0.0711
Skyland	68	71	70	-0.0216	0.0708
Washington Park West	37	46	40	-0.1084	0.0704
Barnum	40	42	39	-0.0244	0.0701
Clayton	50	63	56	-0.1150	0.0692
Sunnyside	15	15	11	0.0000	0.0679
Hale	34	57	45	-0.2527	0.0668
Cheesman Park	27	37	36	-0.1563	0.0664
Berkeley	26	26	25	0.0000	0.0653
Platt Park	52	48	53	0.0400	0.0646
Regis	63	65	65	-0.0156	0.0629
West Highland	30	29	30	0.0169	0.0608

Westwood	7	8	5	-0.0667	0.0602
Goldsmith	51	39	57	0.1333	0.0593
Belcaro	69	75	73	-0.0417	0.0580
University Hills	56	54	58	0.0182	0.0578
Barnum West	58	62	63	-0.0333	0.0558
Chaffee Park	65	64	67	0.0078	0.0556
Country Club	73	76	74	-0.0201	0.0525
Sloan Lake	42	34	34	0.1053	0.0525
Washington Virginia Vale	20	24	22	-0.0909	0.0518
South Park Hill	38	38	38	0.0000	0.0514
Villa Park	33	25	32	0.1379	0.0511
Washington Park	54	40	50	0.1489	0.0498
Congress Park	31	28	26	0.0508	0.0496
Hampden South	19	23	24	-0.0952	0.0493
Montclair	62	60	62	0.0164	0.0493
SouthmoorPark	75	73	76	0.0135	0.0493
Montbello	2	2	2	0.0000	0.0480
Cory - Merrill	72	72	71	0.0000	0.0473
MarLee	28	18	17	0.2174	0.0446
Rosedale	76	74	75	0.0133	0.0439
Ruby Hill	43	27	27	0.2286	0.0433
Kennedy	74	68	72	0.0423	0.0427
Virginia Village	24	22	23	0.0435	0.0427
Hampden	16	10	8	0.2308	0.0412
North Park Hill	47	56	44	-0.0874	0.0401
Gateway / Green Valley Ranch	55	6	20	0.8033	0.0364
Harvey Park	46	30	28	0.2105	0.0360
University Park	67	59	60	0.0635	0.0352
University	59	47	48	0.1132	0.0345
Harvey Park South	60	43	51	0.1650	0.0338
Bear Valley	64	44	54	0.1852	0.0326
Marston	57	70	61	-0.1024	0.0323
Windsor	49	49	52	0.0000	0.0286
Hilltop	71	69	69	0.0143	0.0235
Fort Logan	70	67	68	0.0219	0.0211
Indian Creek	77	77	77	0.0000	0.0147
Wellshire	78	78	78	0.0000	0.0145
Stapleton	35	9	21	0.5909	0.0000

Table 3 Denver Neighborhood Sorted by Crime Rate for 2000 based on Census 2000

4.2.5 Selected Neighborhood Analysis

In order to try and understand the relationship to crime and CFS eight neighborhoods were selected to plot crime and CFS for each year. There are 78 neighborhoods in Denver and for the purpose of this study a select subset was analyzed. The neighborhoods were selected from four categories; always at the top of the rank, always at the bottom, never changed; and with high CMI's (one low to high, and one high to low). This method assumes that these neighborhoods will be representative of all neighborhoods.

The selected neighborhoods includes consistently high crime areas: Five Points and Montbello; consistently low rank: Indian Creek, and Wellshire; same rank: South Park Hill; high negative CMI: Globeville; high positive CMI: Gateway /Green Valley Ranch.

The following table repeats the crime information for the previously reported tables.

NAME	RANK 2000	RANK 2010	COMB RANK 2000-2010	CMI 2000 - 2010	CRIME RATE 2000 Census
Five Points	1	1	1	0.0000	0.2449
Montbello	2	2	2	0.0000	0.0480
Indian Creek	77	77	77	0.0000	0.0147
Wellshire	78	78	78	0.0000	0.0145
South Park Hill	38	38	38	0.0000	0.0514
Globeville	23	52	37	-0.3867	0.1836
Gateway / Green Valley Ranch	55	6	20	0.8033	0.0364

Table 4 Selected Neighborhood Crime CFS Analysis

The following map shows the Neighborhoods highlighted on a Denver map.

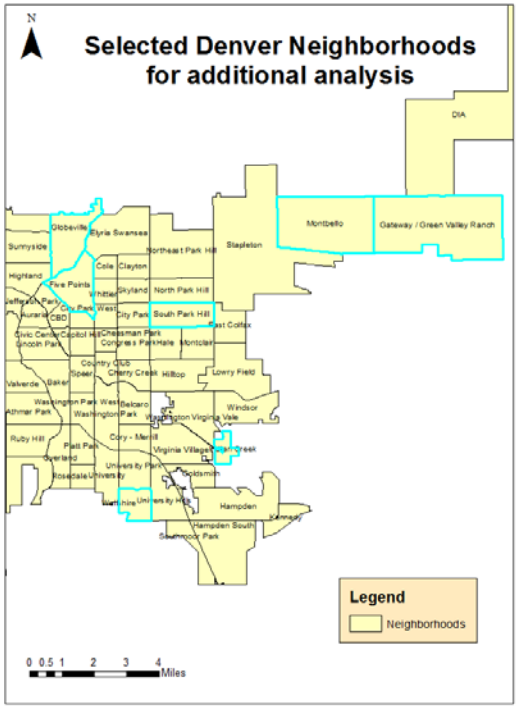


Figure 27 Select Denver Neighborhoods

Starting with the two consistently high crime rank areas (Five Points and Montbello), from the table it can be seen that they have relatively high values across the board and have not changed significantly since 2000. Although Five Points has seen a significant decrease in crime (a victory for Police in and of itself), it still remains number one in the city. It also has by far the highest Calls for Service. Montbello is a close second, its crime has actually slightly increased since 2000, and its calls for service are close behind Five Points.

Figure 28 shows Five Points from 2000 to 2010. The CFS and crime show the cause and effect pattern of increased CFS Citizen in response to perceived or actual criminal activity, followed by increased police presence, which results in decreased crime.

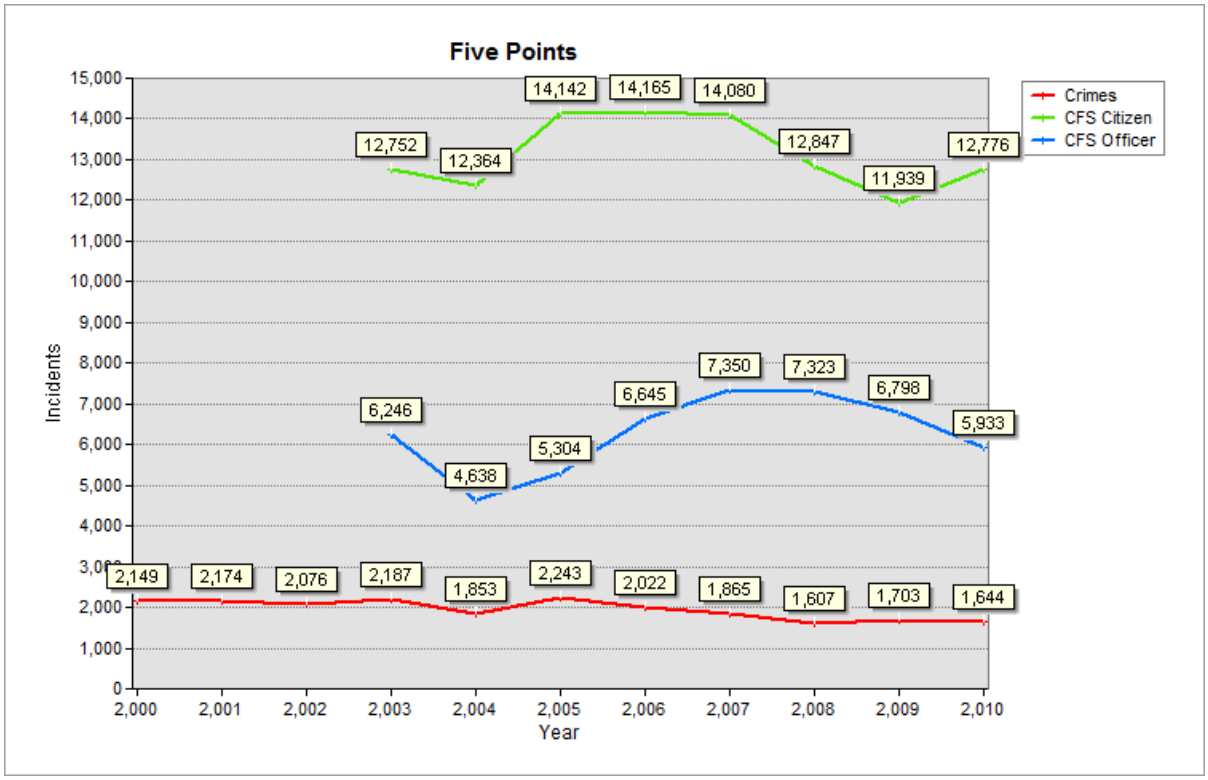


Figure 28 Five Points Crime CFS Summary

The following figure 29 breaks down Five Points by month for the years 2003 to 2005 which saw crime fluctuate from 2,187 in 2003 down to 1,853 in 2004, and then back up to 2,243 in 2005. What the graph shows is that in 2003 (months 1-12) CFS Citizen, CFS Police, and Crime declined. In 2004 (months 12-24) CFS Citizen started to rise along with Crime. The CFS Police remained low with the exception of month 19 which resulted in decreased crime in the months following. In 2005 (months 25-36) CFS Citizen and Crime started to rise, a subsequent CFS Officer response resulted in reduced Crime. While the yearly summary shows a somewhat smoother curve. The analysis at the monthly level shows how Crime fluctuates during the year, and there is a clearly defined CFS Citizen spike that occurs during the summer months. While the overall Crime for a particular year may be low, there can be variations not visible when aggregated at the yearly level.

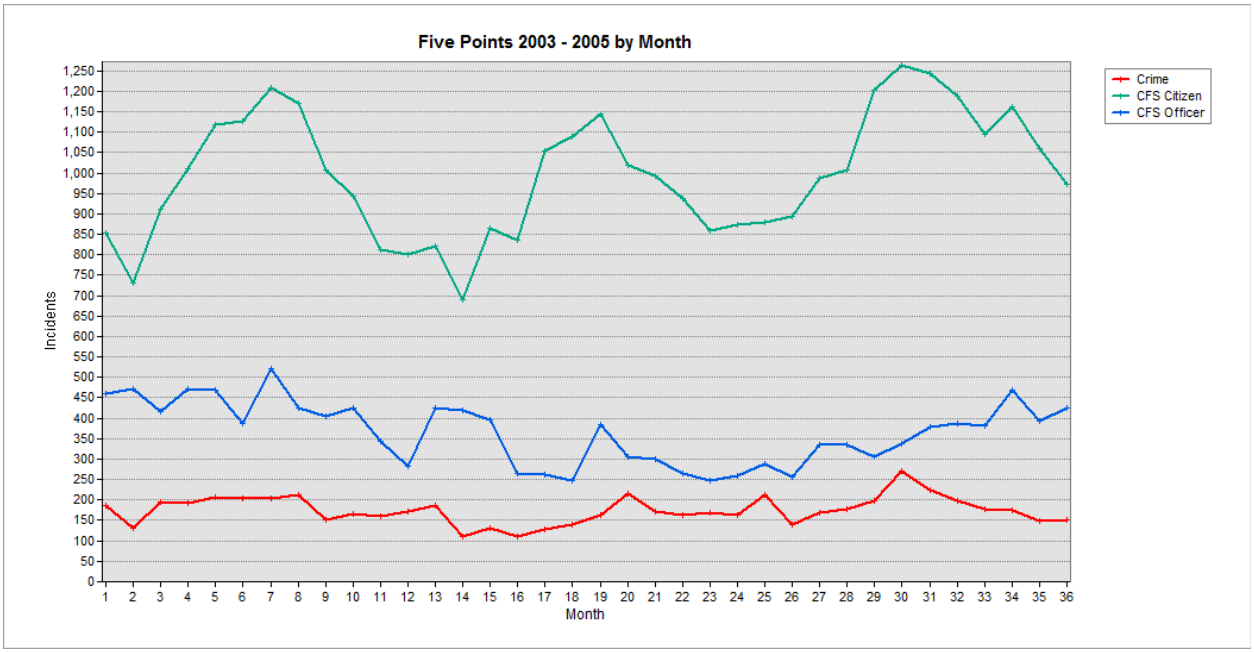


Figure 29 Five Points 2003 - 2005 Crime and CFS by Month

Montbello (figure 30) is a close second, its crime has actually slightly increased since 2000, and its calls for service are close behind Five Points. The CFS Officer response is probably an indication that the Police continue to be active in the area. It shows the Officer CFS approaching the Citizen CFS.

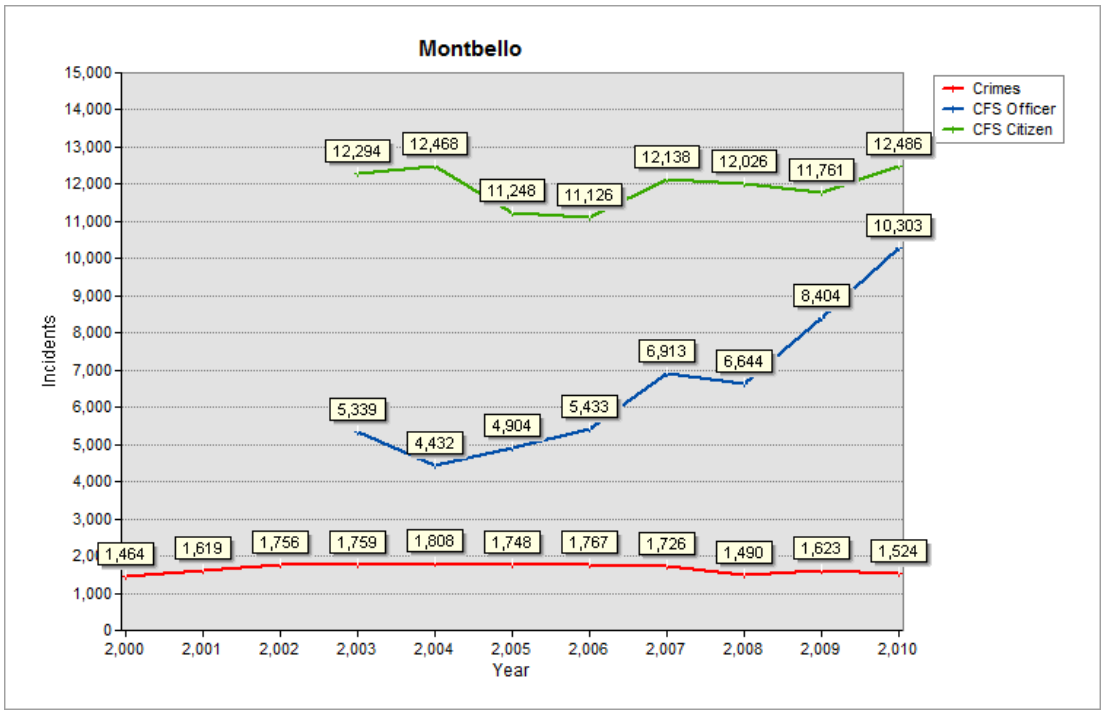


Figure 30 Monbello Crime / CFS Summary

Figure 31 shows Monbello for 2007 showing the predicted cause and effect of CFS and Crime. There is also the summer spike that was present in the Five Points analysis.

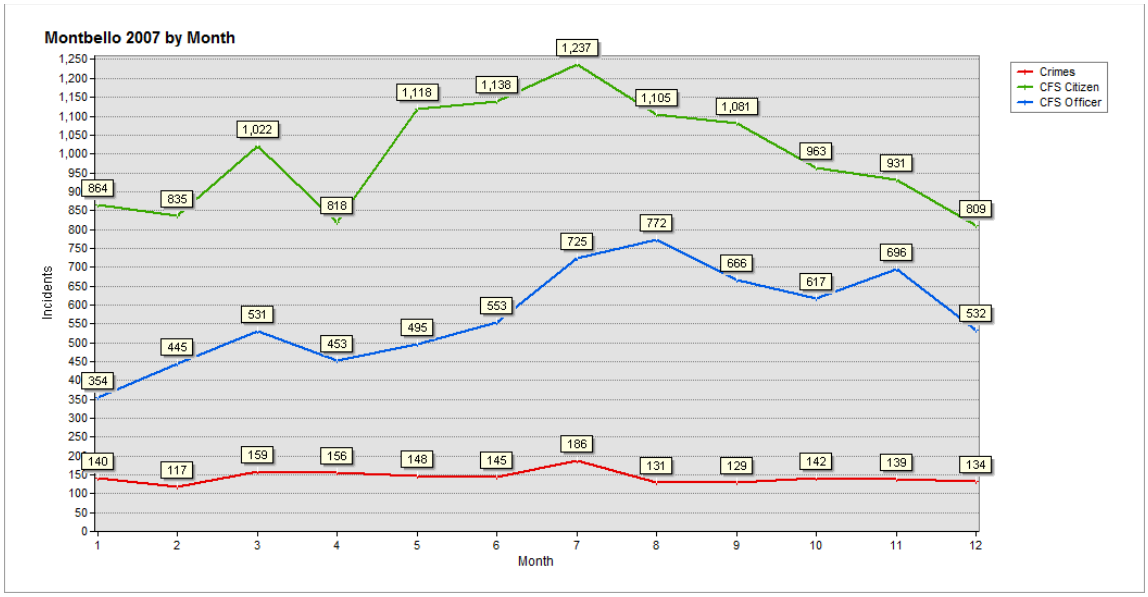


Figure 31 Montbello 2007 by Month

Figure 32 below shows Police presence keeping crime down; 2008 was a low year for crime in Montbello

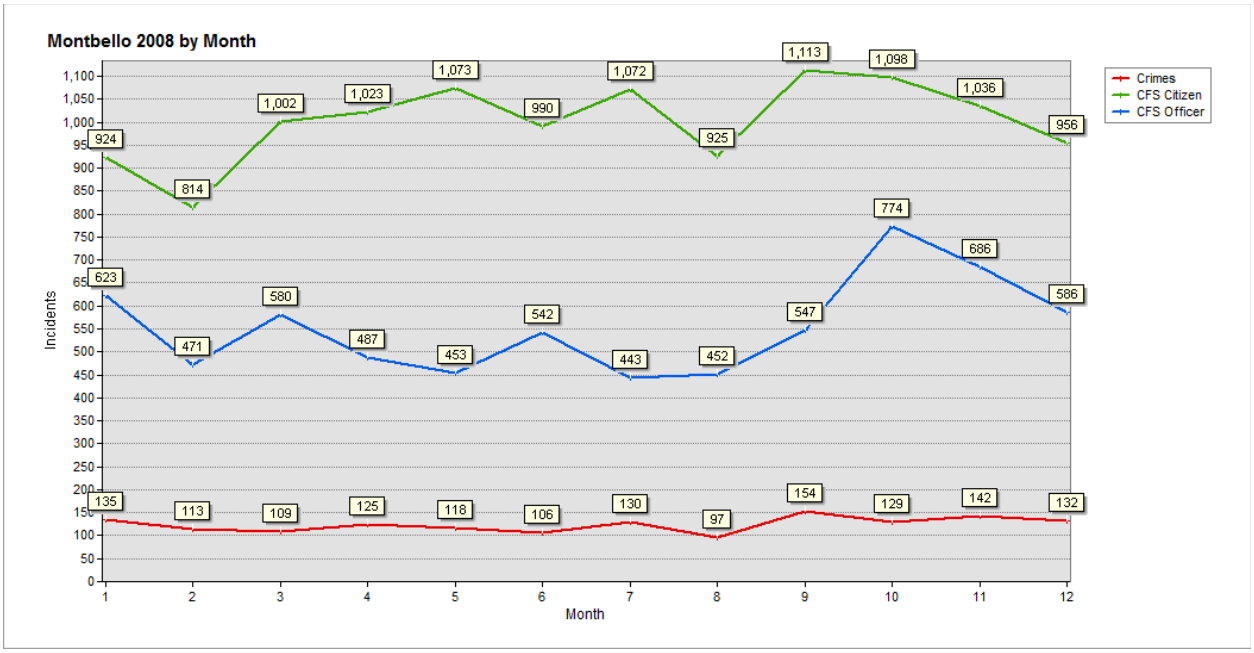


Figure 32 Montbello 2008 by Month

The following consistently low crime areas (Indian Creek, Wellshire) are difficult to interpret because of the low number of data points.

Indian Creek, a consistently low crime area shows the typical Citizen Police CFS response to keep crime in check. Because of the low crime and CFS calls there are 2 graphs, the first at a scale to show the differentiation, and the other normalized to the other Denver neighborhoods. It is difficult to see the cause and effect for low crime neighborhoods because of the low volume of crimes and calls for service. The cause and effect is more difficult to detect. You have to look closer at the reason for the CFS. In some of the lower crime areas a lot of the CFS was for silent alarms. Figure 33 and 34 give the aggregated numbers for Indian Creek, and figure 35 gives a

monthly summary for 2003. Although not part of the research it is interesting to note that the summer spike that was evident in Five Points and Montbello is also present for Indian Creek. Crime may be seasonal work.

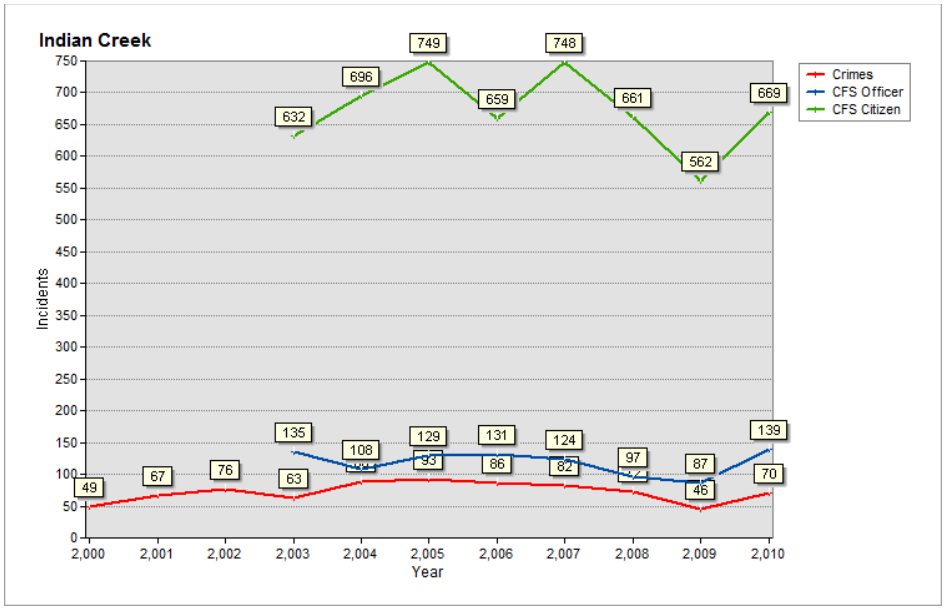


Figure 33 Indian Creek Crime CFS Summary Graph 1

The following graph shows Indian Creek data at the same scale as other neighborhoods.

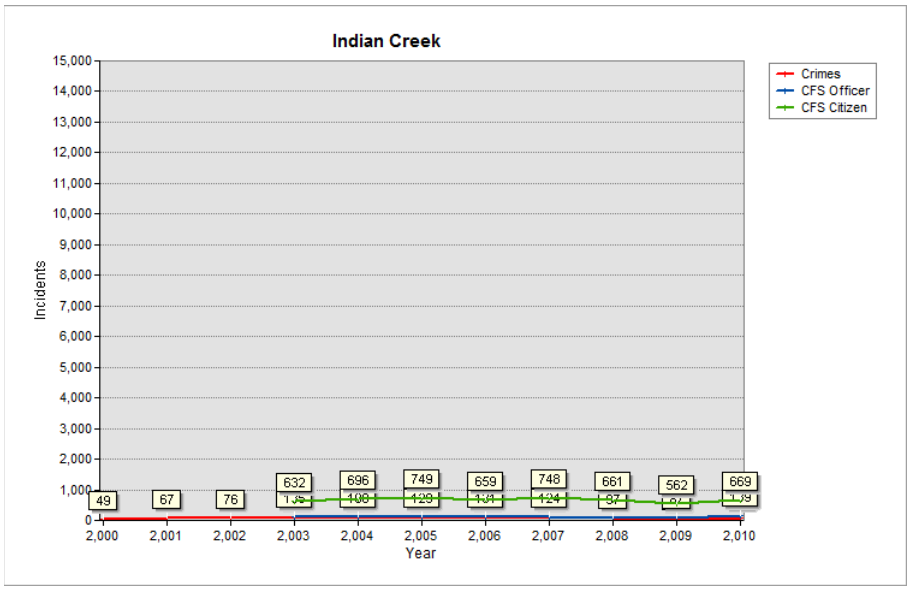


Figure 34 Indian Creek Crime CFS Summary Graph 2

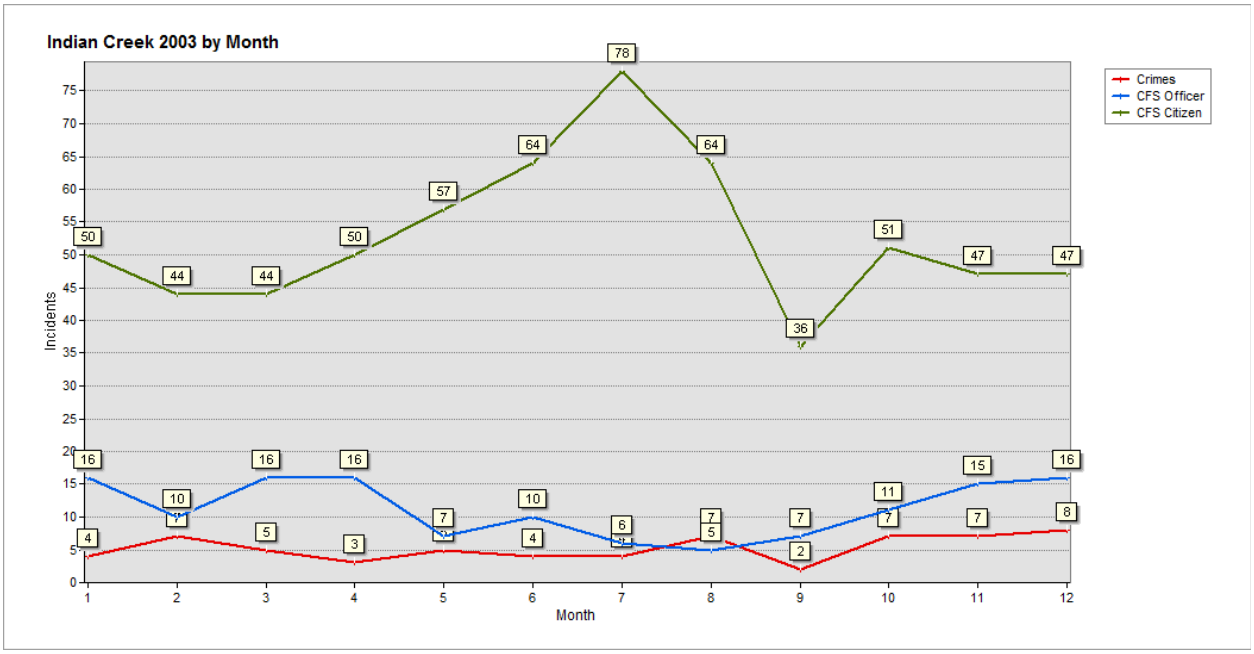


Figure 35 Indian Creek 2003 Crime and CFS by Month

The Wellshire neighborhood (figures 36,and 37) confirms the CFS Crime response pattern from the other neighborhoods. As crime increases in 2004, CFS Citizen increases, followed by an increase in CFS Officer which results in a lowering of crime. This cause and effect relationship appears to hold in both the high and low crime neighborhoods, although the low level of crime in Wellshire may not show the pronounced effect that aggregation at the annual level for the entire city tends to show. The Wellshire, graph is shown at two different scales one to show the relationship of crime and CFS, and the other normalized to show its relationship to the other neighborhoods.

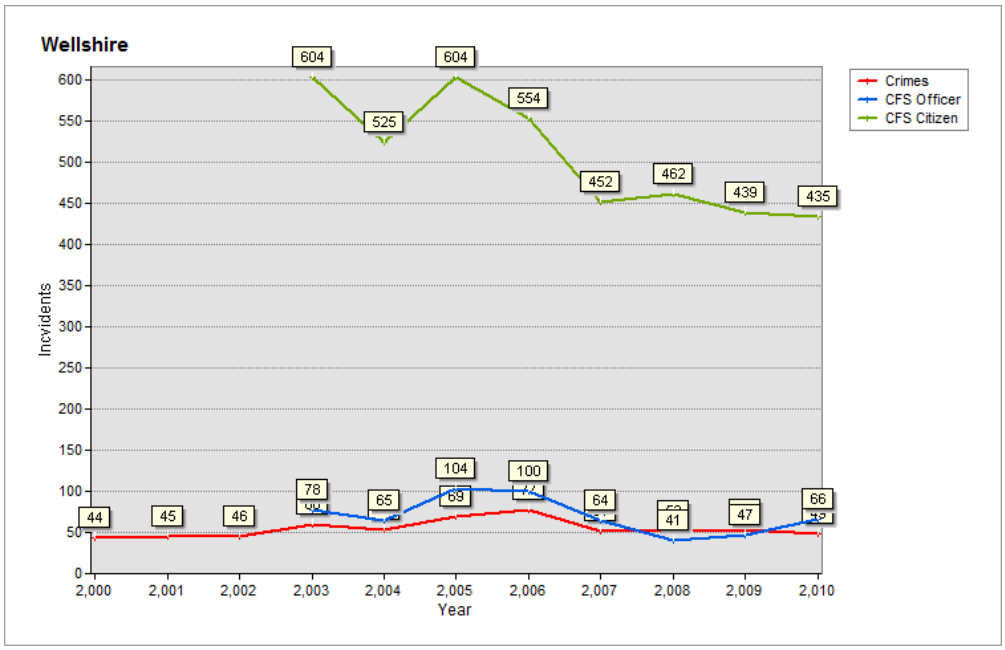


Figure 36 Wellshire Crime CFS Summary Graph 1

The following graph shows Wellshire at the same scale as the other neighborhoods.

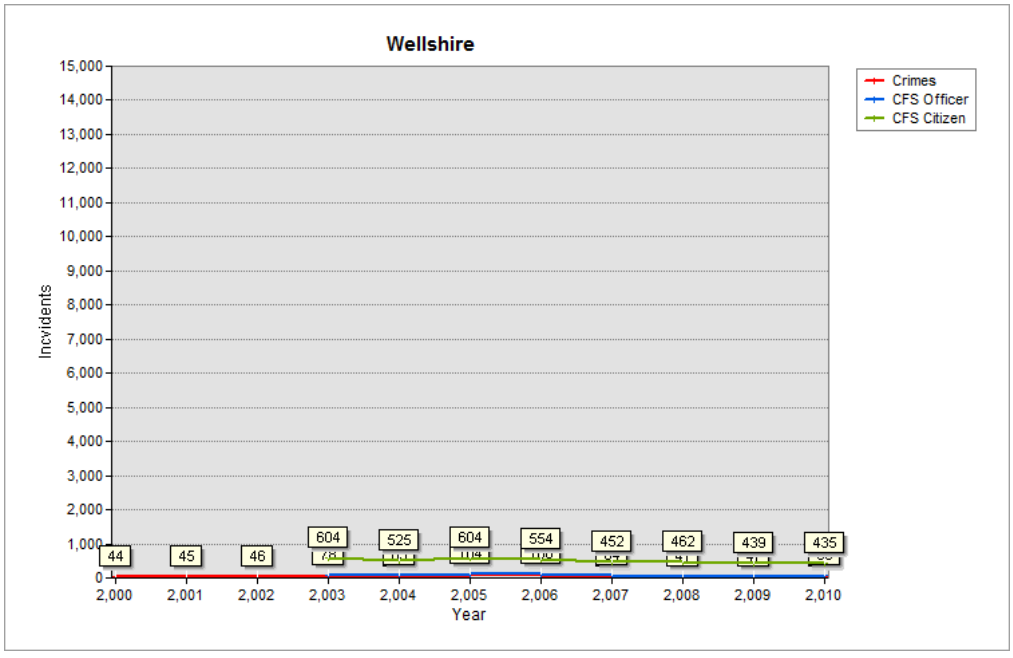


Figure 37 Wellshire Crime CFS Summary Graph 2

South Park Hill is in the middle of the neighborhood pack, and the Crime CFS ratios show that as Citizen CFS goes up, Police response follows and that as Police response increases, Citizen CFS goes down and crime continues to subside with the increased police presence.

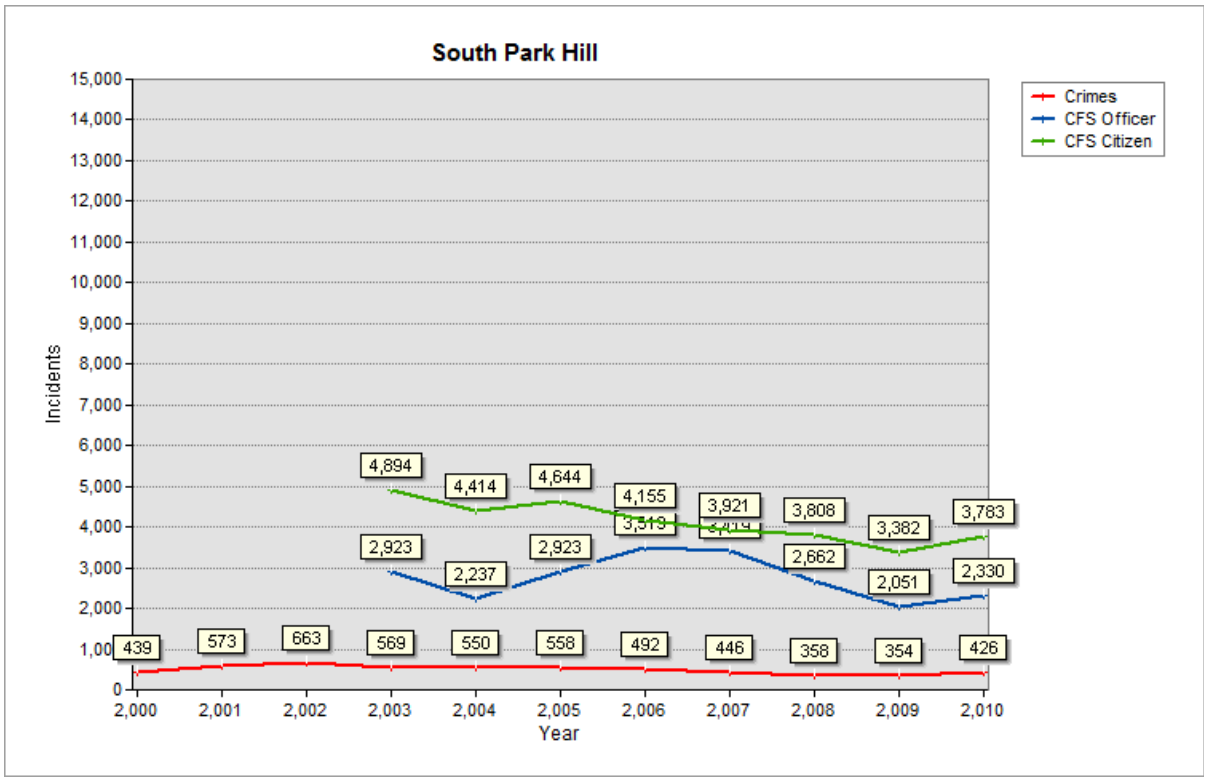


Figure 38 South Park Hill Crime CFS Summary

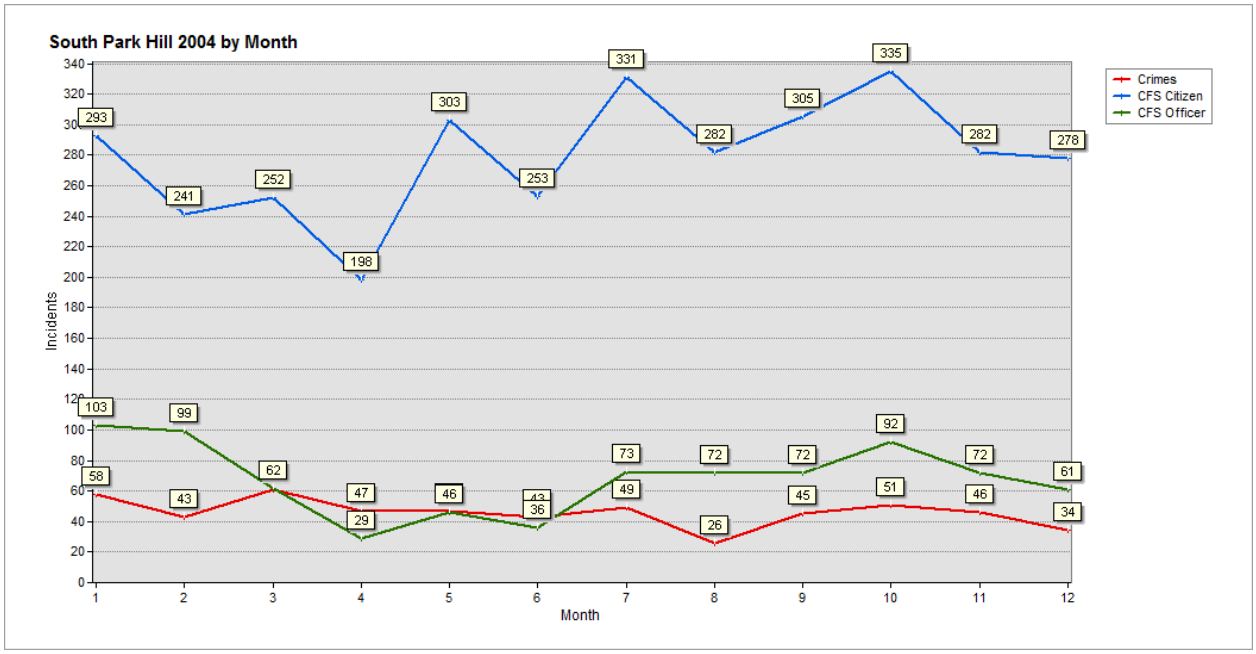


Figure 39 South Park Hill 2004 Crime and CFS by Month

Globeville crime has significantly decreased from 2000, and the increased CFS Officer from 2004 to 2010 appears to have kept crime falling.

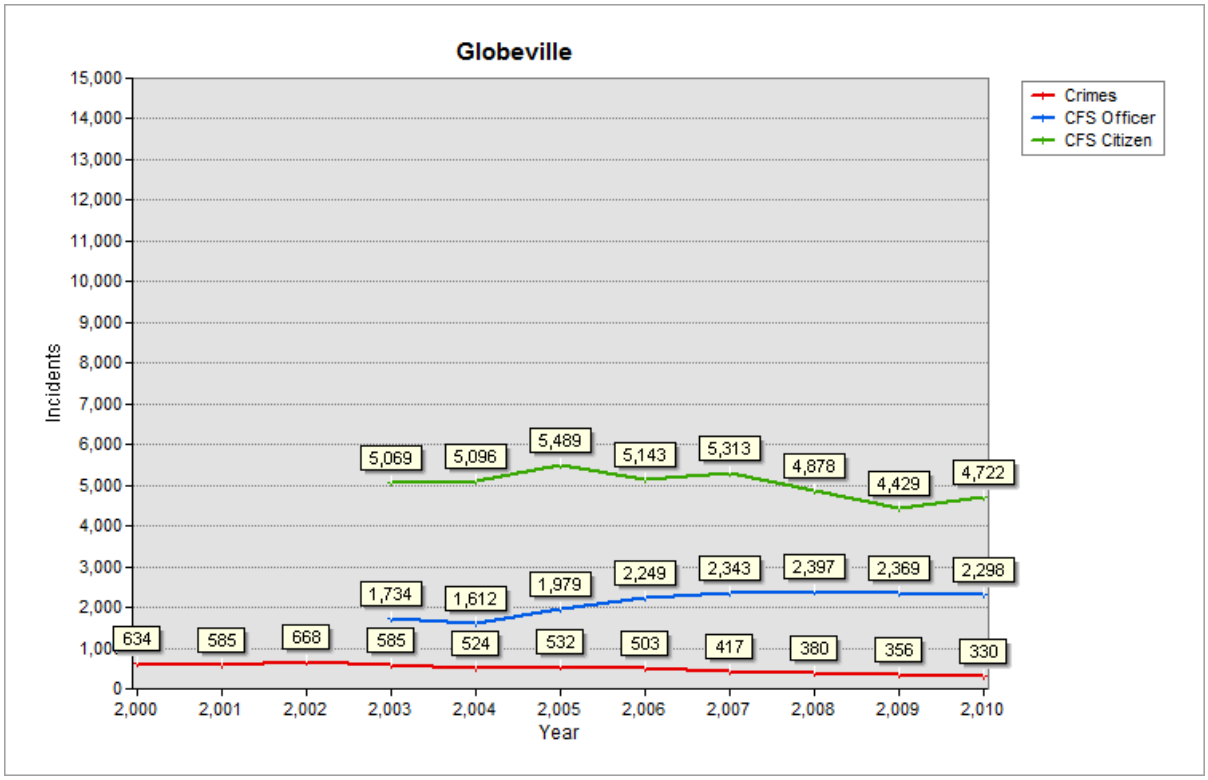


Figure 40 Globeville Crime CFS Summary

The Gateway / Green Valley Ranch neighborhood has seen the greatest increase in crime since 2000. It shows an ever increasing level of CFS Citizen and no response from the Police until 2008. The lack of increase in Police CFS resulted in crime continuing to grow. This supports what the other neighborhood CFS plots show; that when CFS Citizen goes up in response to crime, a subsequent CFS Police response results in keeping crime down. In this case the data suggests that the police response did not happen.

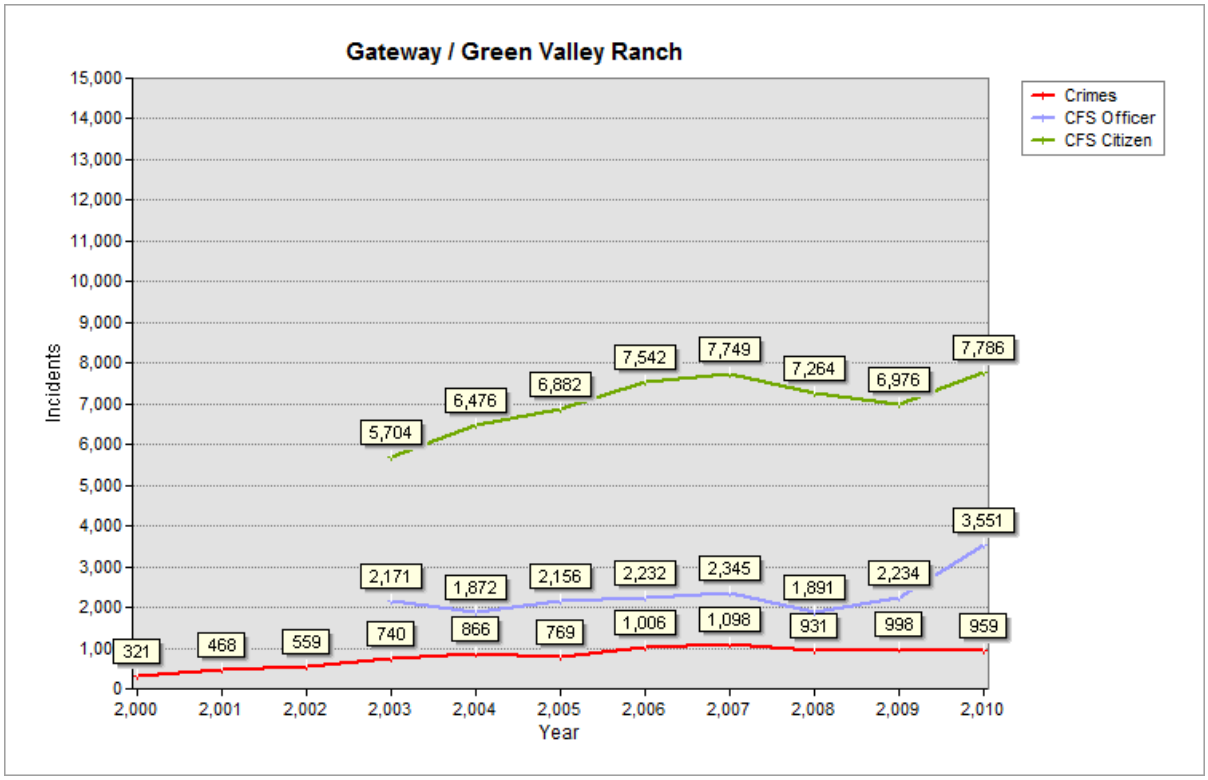


Figure 41 Gateway / Green Valley Ranch Crime CFS Summary

5.0 Challenges

Perhaps there is a low point at which crime cannot be driven below. Since crime is primarily a behavioral problem it may be the case that no matter what is done it cannot be lowered below a certain point. Perhaps certain sociopaths cannot be deterred or stopped; look at the world's oldest profession - prostitution, substance abuse, and gambling. Crime can only be managed to an acceptable level. The amount of resources needed for 100 percent compliance is probably not possible.

- Crime is difficult to quantify over time because crime also transforms and adapts; like a virus it typically adapts prior to a suitable cure. In the case of counting and attacking traditional victim / criminal co-located at the same place and time, there are emerging virtual crimes where the victim and criminal are not co-located in time and space. In fact the actual crime may not be realized for some time, if ever at all. In regards to the social aspects of crime, does it exist at all levels of the socio-economic spectrum? We typically identify crime with laws to attempt to provide protection against overt acts. But what about subvert acts. Does taking office supplies from work, mischarging for time worked, or false travel claims constitute a crime. What about the banker or fund manager who takes money because they can even though not specifically prohibited. Perhaps what kind of crime or unethical behavior displayed by society is based on where you are in the social hierarchy. Your place in the social hierarchy may affect what is considered a crime, and it may also determine the response from society. This behavioral aspect of crime would be an interesting area

for future research.

- Crime analysis breaks down along geographic seams, i.e. neighborhoods, census tracts, cities towns, and other separate jurisdictions. Depending on how you break up your study area has an impact on the results. This is a classic example of the MAUP. During this analysis it was apparent that while neighborhoods is how the City of Denver is geographically defined, by looking at crime at the Census tract level it is evident that the finer resolution and consistency of Census tracts leads to a different crime breakout than with neighborhood boundaries. The data indicated that crime could vary widely within a neighborhood when looking at the Census tract level and that homogeneous crime neighborhoods could be indentified both within and between traditional neighborhood boundaries.

- Normalizing data between years and sources can be a problem. The Denver Police data sometimes changes codes between years, these codes are not backward compatible so if a comparison is needed with a specific year, manual intervention may be required to properly compare the data.. Standardized and backward compatible data formats would make it easier to compare data over a long period.

- Not all crime is reported to the police. This has been reported in work by Colman & Moynihan, (Coleman, 1996) Sometimes the amount of crime reported may differ in different neighborhoods. For example a typically high crime area may be sensitized to crime and may have a high threshold before reporting.

6.0 Results

1. How has crime moved between Denver neighborhoods between 2000 and 2010? The CMI seemed to accurately quantify the neighborhoods with the greatest transition over time. It was able to identify those with increased as well as those with decreased crime. This could provide a good starting point in identifying the measurable changes in each neighborhood during the period that could be related to crime.
2. What is the neighborhood response to crime? It appears that Citizen CFS is a leading indicator to crime. The time delay between the increase and the CFS response may be varying by a particular neighborhoods tolerance to crime.
3. What is the police response to crime and citizen CFS? The data shows that Police typically increase response following citizen calls. This indicates a reactive versus proactive law enforcement strategy. There was no data to suggest a proactive response in any neighborhood. For example there was no indication of any significant police presence in the absence of increased CFS Citizen.

7.0 Discussion

The primary value of this study is that it shows that a Rank Mobility Index that is traditionally used to track changes in a city's population rank can be used to track crime changes in crime between neighborhoods within a metropolitan area. The change can indicate a neighborhood in transition. The transition can be positive, in the case of a neighborhood moving toward more

social structure, or negative, a neighborhood disintegrating social structure. This index in conjunction with readily available Call for Service Data (CFS) and crime data can be used to identify how citizens report in response to crime, how police respond to citizen reporting, and what effect this has on crime. It appears from this research that there is a "Crime Cycle" that is probably in place in many Metropolitan areas in which as crime rises, citizen call to police increases, if police respond the crime starts to decline, and citizen calls subsequently subside as crime declines. This could mean that citizen calls are a leading indicator to police that crime is on the rise. This could be used by law enforcement to respond more aggressively to an increase in calls by maintaining historical CFS data on individual neighborhoods. The data may suggest that higher crime neighborhoods have a higher tolerance for crime and may react more slowly to increases, while relatively low crime neighborhoods may respond more rapidly. Calibrating this sensitivity could allow for law enforcement quickly respond to crime increases based on the neighborhood profile. This crime cycle can be analogous to the human immune system as when crime is occurring (infection), the event is reported (CFS Citizen), and the police are notified (antibodies), the police respond and typically stay around the area and continue to address the crime with increased presence (CFS Officer). The crime subsides, the criminals adapt, and the cycle starts over. There is no indication that police continue pressure until crime gets to zero. This may support the notion that it may be impossible to get to zero, or that there are not enough resources to get to zero. You simply reduce the crime to an acceptable level and move on. The acceptable level may be different for different neighborhoods (social economic status).

8.0 Areas for Further Research

- Calls for service seem to be in a relationship with crime. For example CFS Citizen appears to be 5 to 10 times the crimes. The 5 times is more indicative of low crime areas, and the 10 times indicative of the high crime areas. CFS Officer response seems to be between 2 to 4 times the crimes; again the lower associated with low crime areas. In addition CFS Citizen seems to be 2 to 4 times the CFS Officer response. Establishing a relationship between the number of crimes, and the number of Calls for Service (both Officer and Citizen) may help understand how a particular community responds to crime, and how police response effects the number of crimes. The accuracy of such a formula / ratio may help police respond in a preemptive manner to changes in Calls for Service by citizens.

- How do crime prevention initiatives between the police and the community affect the Calls for Service for the community to help police get a jump on crime?

- Are high crime neighborhoods where the criminals come from or where they work? Where do the criminals live who commit the crimes (in their own neighborhood?)

- Break down crime by police district to see if there is a major difference in law enforcement effectiveness.

- More analysis at the Census Tract level for better refinement within a neighborhood.

- Break down CFS by type of call for each neighborhood and develop a profile. A weight can be assigned to the type of call (personal, or property related) to help understand the neighborhood, and develop and effective crime strategy.

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