

International Association of Crime Analysts (IACA)

# Identifying High Crime Areas

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## About the IACA Standards, Methods, and Technology Committee

The International Association of Crime Analysts (IACA) is committed to a continuing process of professionalization through standards and knowledge development. In 2011, the IACA chartered the Standards, Methods, and Technology Committee (SMT) for the purpose of defining “analytical methodologies, technologies, and core concepts relevant to the profession of crime analysis.”<sup>1</sup> This document is part of a series of white papers produced by the SMT committee that executes this purpose. The methodology for formulating the positions reflected in the white paper series includes 1) development of a draft paper through in-depth meetings and discussions of Subject Matter Experts<sup>2</sup>, 2) review and feedback by the IACA Executive Board, 3) review and feedback from an independent editor with knowledge of crime analysis, and 4) review and feedback by IACA members facilitated through the IACA website ([www.iaca.net](http://www.iaca.net)). Any questions about this process can be directed to the chair of the SMT Committee at [SMT@iaca.net](mailto:SMT@iaca.net).

### Overview

Crime is seldom randomly or evenly distributed across space (Eck, Chainey, Cameron, Leitner, & Wilson, 2005; Paynich & Hill, 2010); for example, some areas have more crime than others, and some areas have different kinds of crimes than others. Identifying high crime areas or hot spots plays a key role in how law enforcement agencies operate and address crime in problem areas. For strategic and problem-solving purposes, identifying high crime areas can be useful for the development and evaluation of police responses, and testing for spatial displacement or diffusion of benefits (Boba, 2009). For tactical purposes, hot spot analysis may signal the presence of a crime pattern and/or help law enforcement agencies better prioritize and allocate resources to specific areas (Eck et al., 2005). Thus, supporting and providing officers with the necessary insight they need to prevent, respond, or investigate crime is at the heart of crime analysis.

Crime analysts are tasked with a number of challenges such as objectively identifying high crime areas, effectively illustrating these areas on a map, and assisting with the understanding of how high crime/problem areas develop and persist. To do this, a crime analyst should understand some of the available methodologies available and consistently try to utilize these methods. Multiple methods of hot spot identification exist. Each has its strengths and limitations and may be appropriate for one area and not another. Whatever the chosen methodology, it needs to be defensible both empirically and theoretically. Therefore, the purpose of this paper is to introduce systematic approaches to identify high crime areas and outline issues to consider when using these methods. It is important that the analyst identify which methodologies should be routinely used in the identification of hot spots and have the ability to justify them using existing research and theory. Establishing such methodology and protocol has profound implications for the nature of policing and the application of the Fourth Amendment in high crime areas (see Appendix A). Techniques discussed in this paper to identify a high crime area(s) reflect those

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<sup>1</sup>This quote comes from the mission statement as written in the initial Standards, Methods, and Technology Strategic Plan completed April 2011.

<sup>2</sup> Subject Matter Experts are identified by the Standards, Methods, and Technology Committee based on special knowledge obtained through publications, presentations, and practical experience and their willingness to participate.

traditionally used to examine hot spots. However, the reader should note that this paper is not a comprehensive examination of all existing methods.

These techniques generally involve the development of crime maps and employing statistical tests to determine the existence of spatial clustering. This paper describes crime maps used to illustrate repeat addresses, hot streets, and hot areas. Analytical techniques used with crime maps explored in this paper include: (1) manual analysis, (2) fuzzy mode analysis, (3) graduated color map or choropleth map analysis, (4) standard deviation analysis and (5) grid cell mapping or density analysis. Statistical testing for clusters described in this paper includes the nearest neighbor index and various spatial autocorrelation techniques. In order to get the most out of this paper, it is important to become familiar with the accuracy of an XY system, geocoding by street segments and other challenges related with converting data spatially. There is an excellent overview of these concepts in Mapping Crime by Harries (1999) (<https://www.ncjrs.gov/pdffiles1/nij/178919.pdf>).

## **Defining a High Crime Area**

High crime areas can be described as an extension of the more commonly discussed hot spots. Although there is no widely accepted definition of a hot spot, for the purposes of this paper, it is defined as a group of similar crimes committed by one or more individuals at locations within close proximity to one another (International Association of Crime Analysts, 2011). Note that this definition involves the clustering of crime incidents. Crime analysts examine more than just crimes; they study arrests, calls-for-service, and various indicators of disorder that although they may not be “official” crimes. In fact the indicator may be directly related to offense data and when clustered, suggest a problematic or emerging high crime area. It is because of this subtle difference that high crime areas and hot spots share many characteristics and hot spot techniques discussed in this paper reflect those traditionally used to explore hot spots. In addition to spatial clustering, high crime areas, like crime hot spots, are noticeable because of their relatively high volume of incidents (Eck et al., 2005; Chainey & Ratcliffe, 2005; Sherman, 1995). As discussed below, there are also temporal aspects of hot spots. Thus, like hot spots, high crime areas are therefore characterized by: (1) a relatively high volume of crime, (2) evidence of spatial clustering, and (3) an observable pattern of time occurrence and duration. This paper provides suggestions on some of the best practices for identifying problem areas. Throughout the remaining sections of this paper, hot spots and high crime area will be used interchangeably.

## **Identifying High Crime Areas: Crime Mapping and Hotspot Analysis Techniques**

Before exploring the various types of techniques used to analyze hot spots, Boba (2009) and Chainey and Ratcliffe (2005) point out that currently there is no standard threshold for what constitutes a hot spot, nor is there clarity about what the best method is to identify them. Both suggest that “areas appearing to be hot spots will vary depending on the unit of analysis, scale of the map, and the amount of data mapped” (Boba, 2009, p. 267). Nonetheless, technological advancements such as computerized databases and automated crime mapping can assist analysts in identifying crime clusters (Braga, 2006). The National Institute of Justice (2010) outlines two general ways that an analyst can identify a hot spot: (1) through the use of GIS (geographic information system) maps and (2) the by applying statistical tests.

## Visualizing High Crime Areas with Crime Maps

Crime maps that detect high crime areas and crime are useful when they answer analytical questions based on crime theories and subsequently guide appropriate police action (Eck et al., 2005). For example, questions such as identifying which businesses have been burglarized more than once in a single year would be best answered using a point map that suggests potential tactics that focus on improving place management. In comparison, questions such as demonstrating which hot streets are characterized by frequent drug deals and prostitution would require a street level (line) map that suggests the possible use of high visibility patrols on key streets. Finally, if senior police administrators were interested in which police beat had the most amount of crime in the past month, an area (polygon) map would be most appropriate. Hot spots and high crime areas can therefore be illustrated using varying levels of geography such as a specific address/intersection, single blocks, clusters of blocks, streets, or neighborhoods (Eck et al., 2005; Paynich & Hill, 2010). Eck et al. (2005) suggest that analysts begin their exploration of hot spots by plotting points before examining larger areas of geography, since maps showing hot streets and areas may hide more minute point patterns of concentration.

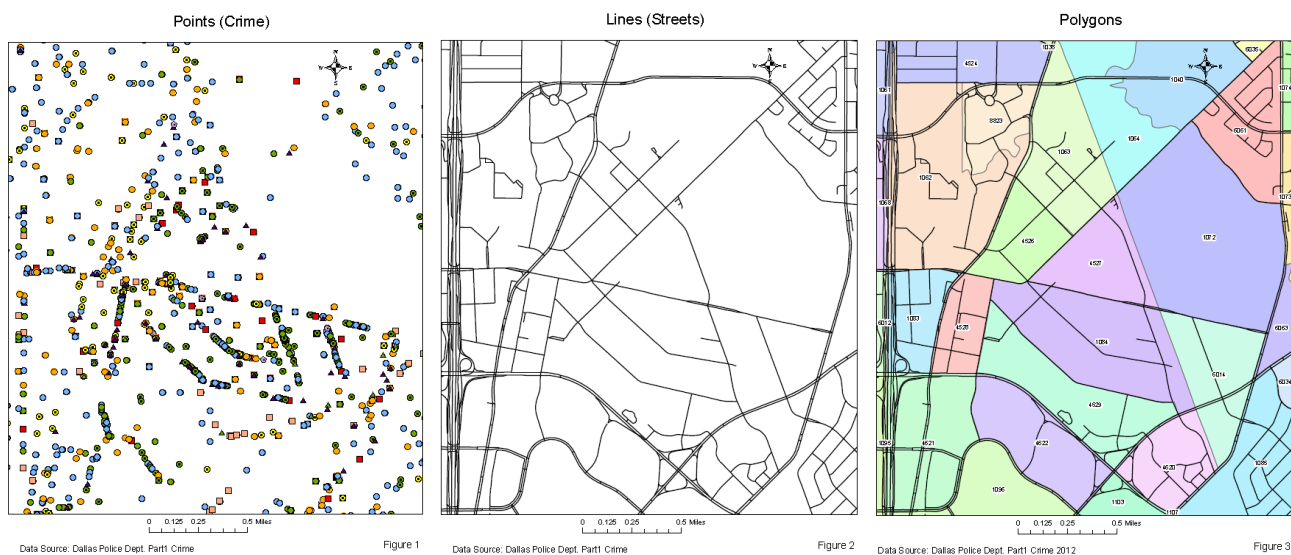


Figure 1 (Dallas Police Department)      Figure 2 (Dallas Police Department)      Figure 3 (Dallas Police Department)

### Repeat addresses

Point maps can be useful for a variety of purposes such as demonstrating repeat incidents at a single location. However, using single points to represent multiple incidents at the same location would be misleading, as it does not distinguish among locations that have single versus multiple incidents (Chainey & Ratcliffe, 2005; Boba, 2009). Instead, multiple incidents at a single location (repeat addresses) can be represented using graduated symbols/colors (Chainey & Ratcliffe, 2005; Eck et al., 2005; Boba, 2009; Paynich & Hill, 2010), in which differing symbol colors or sizes represent a count or range of values. Many times these multiple locations are at apartment complexes, shopping complexes or office buildings. For example, one would expect a large symbol might exist at an address for a large shopping mall as all of the stores and restaurants share the same address. The analysis would be much better if the analyst could pinpoint the specific locations within these complexes, which would also provide better intelligence for further police action.

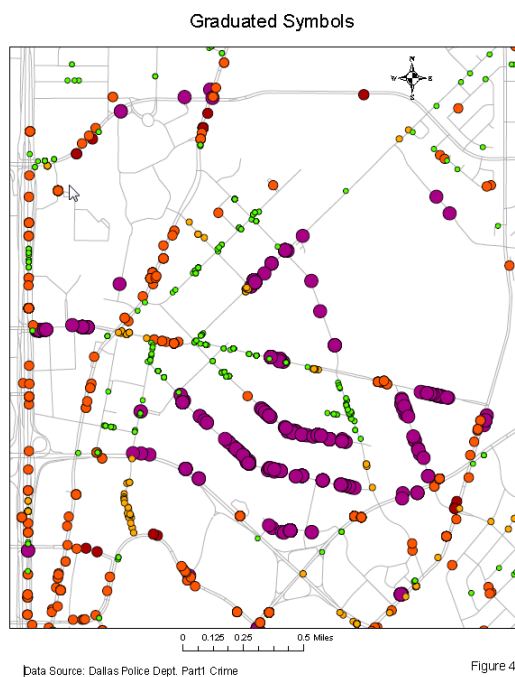


Figure 4 (Dallas Police Department)

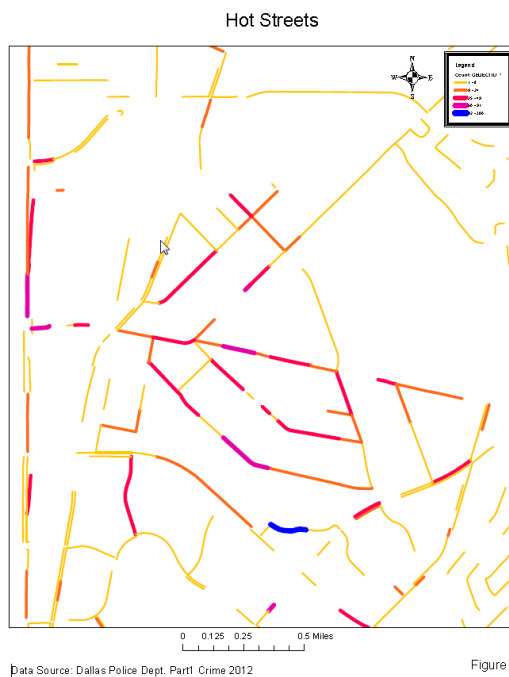


Figure 5 (Dallas Police Department)

Using graduated symbols though may result in larger dots obscuring smaller dots and therefore should be restricted to large-scale maps (Eck et al., 2005). An alternative method for illustrating repeat addresses is determining a threshold (or minimum number of crimes) before a point is displayed (Eck et al., 2005; Paynich & Hill, 2010). For example, the map could be designed to only show locations where there have been three or more incidents. When using this method, the careful selection of a threshold will affect the discovery of a high crime area. Analysts should utilize existing research, theory, and the spatial context of the area they are working with in selecting a threshold that makes empirical and theoretical sense.

### Hot streets

Hot streets are slightly more challenging to demonstrate with most commonly-used GIS (See Figure 5). This is because they do not easily allow users to depict hot streets (Eck et al., 2005). Alternatively analysts can plot crime incident locations and match them to street layouts. Another method to identify hot streets would be to join the points file to the street segments file of the map (for those unfamiliar with joins, the process essentially aggregates the count of incidents that occur within a street segment). If geocoding is based on a street file, there will be no issues. If geocoding is based on addresses, there will be an issue as many points will not overlay the street segments and hence not join properly. One option is to set the join for approximate distance between the point and the street segment. This may cause the points to be assigned to a street segment that is not part of the actual street address. Careful review of these results is suggested. Once the points and street segments are joined, there will be a count of points per street segment. Analysts can display the hot streets by line width and/or color of the street segments. This type of analysis assists in narrowing the size of a targeted neighborhood or area of your jurisdiction.

## Analytical Methods with Crime Maps

In conjunction with point and line maps, crime analysts use the following analytical mapping techniques to identify crime hotspots and high crime areas.

**Manual analysis**, also called “eyeball analysis” involves “visually scanning the distribution in search of points that are clustered together” (Paynich & Hill, 2010). This approach is commonly used in crime analysis and policing (Boba, 2009). However, it is far from an accurate technique. It may be “difficult to clearly identify the location, relative scale, size and shape of hot spots when crime data are presented as points” (Chainey & Ratcliffe, 2005, p. 148). Although Harries (1999) noted concerns regarding overlapping points and points that are completely on top of each other (reflecting multiple incidents at one location), analysts can employ the techniques noted above regarding repeat addresses and estimation techniques noted below to compensate for these limitations.

Another approach that analysts use is **fuzzy mode analysis** (Paynich & Hill, 2010). This involves choosing an appropriate search radius around a point (one that is not too small or too big) and then totaling the number of points within that radius. Aggregating these points then would summarize points that are very close if not overlapping each other. The results or hotspots would then be illustrated using graduated symbols. This technique can also be useful for comparing high crime or hot spot locations. For example, a city’s police administration may know that bars contribute to a large number of incidents but want to figure out the top bars with the most frequent incidents at or near the bar within a certain radius (perhaps one or two city blocks). Fuzzy mode analysis would not only show the events in and around individual bars but would also allow comparisons between the two. This type of analysis can be utilized for a variety of purposes such as examining drug calls for service around schools, the number of drug arrests near a methadone clinic, shots fired near a park, etc.

**Graduated Color Map or Choropleth Map Analysis.** Choropleth maps are sometimes called “area symbol maps or statistical surface maps” (Gwinn, Bruce, Cooper, & Hicks, 2008, p. 301) See figure 6. This type map is divided up into various polygons based on administrative or political boundaries, for example a neighborhood or a police beat. Analysis is based on the areas or polygons that make up the map. Data values are calculated for each of the polygons are based on various classification schemes, such as equal count, equal range, equal area, natural breaks, standard deviation, quantile, or custom ranges (Eck et al., 2005; Gwinn, Bruce, Cooper, & Hick, 2008; Paynich & Hill, 2010) See Figure 6. There are strengths and limitations for each of these classification schemes, but they all, in different ways, display the variable (e.g., crime) in an ordinal fashion ranging from lowest to highest. Each polygon is colored differently to thematically represent these classifications (Eck et al., 2005). Clearly, the classification scheme used will affect the outcome of the map and consequently the presence or absence of a hot spot or high crime area (Harries, 1999). Careful consideration is therefore made to ensure that a meaningful classification scheme is chosen and that it best matches what the analyst is trying to represent and communicate to their intended audience. An analyst must be cognizant that not all areas/polygons are the same size and that comparisons between unequal sized areas are erroneous and not advised (Harries, 1999). For example, it would not be correct to say that two areas with the same number of incidents are equal when there areas are not the same. Alternatively, analysts can compensate for this limitation by using a normalizing variable such as neighborhood size before assigning a value to a polygon (Boba, 2009). For example, the burglary rate per capita could be calculated for each polygon. However, occasionally choropleth maps based on simple counts are used for administrative summary purposes (Eck et al., 2005), for example, showing the amount of crime in a reporting



police district (Gwinn, Bruce, Cooper, & Hick, 2008). Finally, recall that this technique is limited in that the boundaries are argued to be artificial and rarely reflect actual criminal patterns.

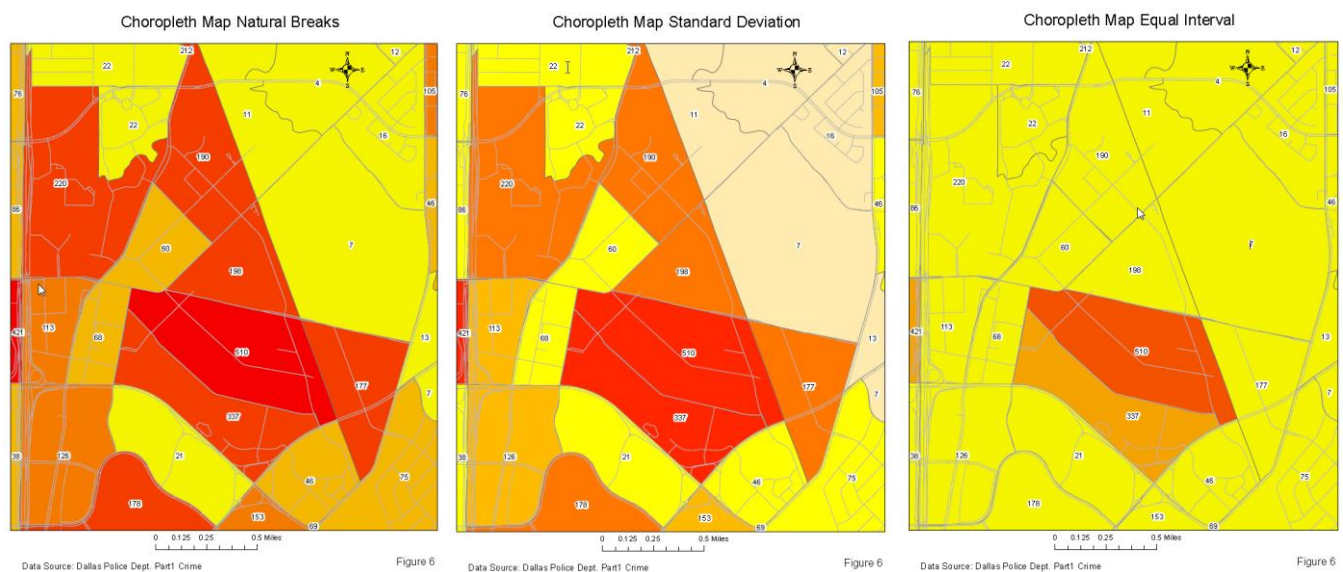


Figure 6 (Dallas Police Department)

### Hot areas

Hot areas can be depicted using bounded areas such as polygons (e.g., see choropleth and standard deviation ellipse maps discussed below). However, analysts need to be aware that these bounded areas are artificial. Eck et al., (2005) argue that criminal activity does not necessarily conform to geographic boundaries. As such, hot area maps are not useful for showing crime patterns that cross boundaries (Eck et al., 2005). Boba (2005) also points out that these boundaries are usually artificially-created administrative or political boundaries, which are constant or static (Eck et al., 2005). Analytical methods such as grid cell mapping or density analysis (discussed below) can be used to compensate for this limitation.

These hot areas could develop at the block level, a set of blocks, neighborhoods, schools, etc. They might be affected by natural boundaries (rivers, cliffs, forests, etc.), government boundaries, manmade boundaries (highway, walls, fences, etc.) and social boundaries like gang territories.

**Standard Deviation Analysis.** This approach involves determining the mean center of the series and drawing rectangles or ellipses around the mean center showing the areas that represent one or two standard deviations away from the mean (Boba, 2009). They are drawn to demonstrate clusters of points that would not be expected from random chance (Paynich & Hill, 2010).

Like choropleth mapping, a limitation to depicting hot spots using ellipses is that hot spots are rarely depicted accurately with bounded polygons (Eck et al., 2005; Paynich & Hill, 2010). However they can be useful for making comparisons of hot spots across time (Paynich & Hill, 2010). For example, an analyst can be tasked with evaluating the effects of a police operation on a hot spot. As part of their evaluation the analyst creates standard deviation

ellipses with incident data before and after a police operation. The analyst can then determine whether there was a reduction or displacement in crime.

**Grid Cell Mapping Analysis.** This method is sometimes described as density analysis and compensates for the limitations noted above with choropleth mapping and standard deviation analysis. This approach uses surface estimation techniques and illustrates the surface of a geographical area (Ratcliffe, 2004) with rasters<sup>3</sup> (Gorr & Kurland, 2012).

This process first involves an analyst calibrating two parameters, specifically cell size and search radius, so that the results are meaningful and useful (see figures 7 & 8). The method involves placing a grid or fishnet on top of a map (creating a matrix of cells). Then a mathematical function visits the center of each cell and performs a calculation on that cell as well as within a pre-determined search radius or bandwidth (Harries, 1999; Eck et al., 2005; Paynich & Hill, 2010).

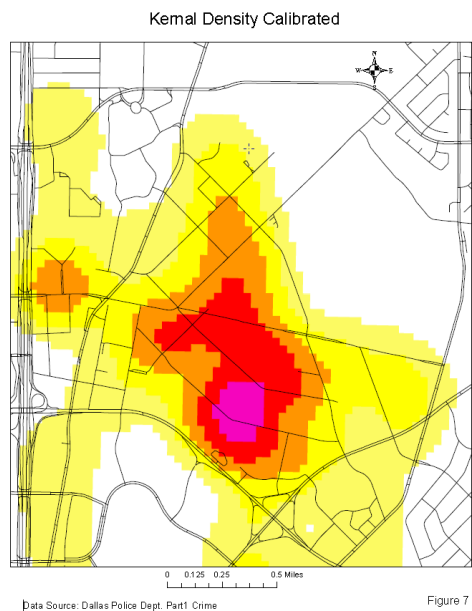


Figure 7 Calibrated (Dallas Police Department)

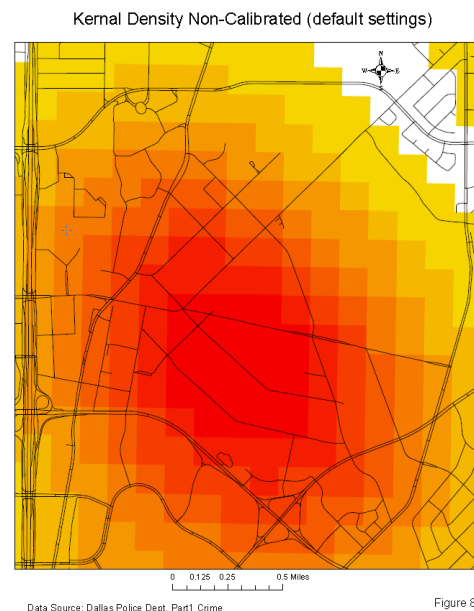


Figure 8 Default settings (Dallas Police Department)

In simple density analysis, when the mathematical function is applied to each cell, the number of incidents within a given radius are added together and then divided by the area of the radius; this value is then assigned to the cell (Harries, 1999; Mitchell, 1999; Eck et al., 2005; Boba, 2009; Gwinn, Bruce, Cooper, & Hick, 2008). Therefore “a cell's score does not represent the number of incidents in that cell but the number of incidents 'near' that cell divided by the area 'around' that cell, approximating the concentration of activity” (Boba, 2009, p. 271). In other words, the cell's density value is an estimate and is influenced by incidents found within the search radius placed on top of the grid cell (Boba, 2009).

<sup>3</sup> “a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information” ([http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=What\\_is\\_raster\\_data%3F](http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=What_is_raster_data%3F))



Another approach to density analysis is **kernel density interpolation or smoothing techniques**. Instead of simply adding up all the points within a radius as with simple density analysis, a bell-shaped function or kernel is applied over every cell (Gorr & Kurland, 2012). In other words, greater weight is given to incidents closer to the center of the radius (Eck et al., 2005; Gwinn, Bruce, Cooper, & Hick, 2008; Paynich & Hill, 2010). *Dual kernel density interpolation* is similar but involves producing “a risk value associated with crime density” (Paynich & Hill, 2010, p. 378) and allows for comparative density analysis. In other words, comparisons can be made between two different crime types or crimes at two different time periods) (Paynich & Hill, 2010).

It is apparent that density analysis does not depict physical boundaries and is consequently a “much more realistic image of the shape of the hot spot distribution” (Paynich & Hill, 2010, p. 378). It is also advantageous over point maps because overlapping points or stacked points are added together and represented with a single color (Harries, 1999). However, analysts must still consider three parameters when constructing density maps. First, the analyst must determine a threshold for what defines a hot spot. Values are assigned to the output raster cells and it is at the discretion of the analyst to determine the numerical value at which a location is considered a hot spot. In other words, those areas of greater density above this threshold are then considered hot spots (Gorr & Kurland, 2012).

Second, changes to either the search radius or grid cell size can yield different maps (Harries, 1999; Boba, 2009). A smaller search radii will reveal greater local variation or more specificity (Eck et al., 2005) while a larger selection will show long rolling hills for the surface (Gorr & Kurland, 2012). Likewise, the choice of cell size or spatial resolution (Gwinn, Bruce, Cooper, & Hick, 2008) will affect the smoothness of the surface, with smaller cell sizes showing finer resolution. A third consideration is the size of the study area. Choosing different study areas can have an effect on the appearance of the computed density surface. As an example, an analyst could choose as their study area an artificially drawn square on a GIS map to represent a city's boundaries. Alternatively, if an analyst uses a more accurate GIS shape file containing the official boundaries of a city, kernel density calculations would then be more accurate, but produce a different type of map.

Currently, there are no hard rules for how analysts decide on setting these parameters in a GIS. Analysts first study crime points and visually determine the boundaries of hot spots. The analyst then calibrates parameter values in the GIS for density analysis until they resemble the analyst's expert judgment as to where the boundaries are (Gorr & Kurland, 2012). One limitation of density analysis and another reason for why density maps need to be calibrated manually is that they do not consider “natural or manmade barriers that may affection directionality of data density” (Gwinn, Bruce, Cooper, & Hick, 2008, p. 303). In other words, the radius or cell grid that is placed on top of a map does not conform to the presence of nature or manmade barriers such as a body of water, a freeway or a wall

A potential solution to this problem is to incorporate raster masking in GIS. The analyst builds a mask around areas that are not appropriate for inclusion in the density analysis. For example, a large body of water is unlikely to have a many crimes occurring in the center. A mask for this body of water would exclude that area in calculating the density surface. The result is a density surface based on a more realistic risk of crime.

A final consideration of analysts when producing density maps is their audience. If audience members are not familiar with density analysis, it is recommended that a legend with labels such as “low density”, “medium density”,

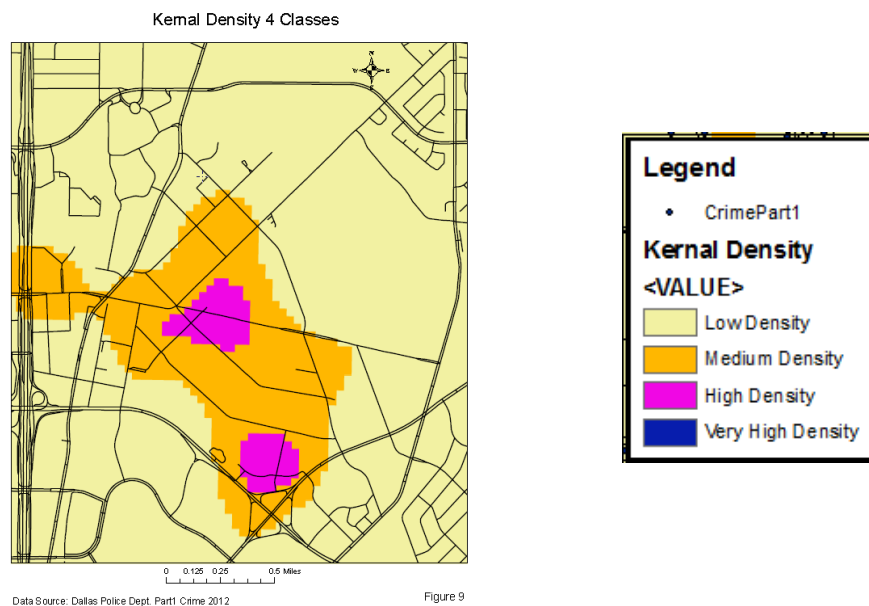


Figure 9 (Dallas Police Department)

and “high density” should be used instead of numerical ranges associated with the raster values (Boba, 2009) See Figure 9.

### Statistical Testing for Hot spots

In addition to crime mapping approaches, analysts are also able to draw upon spatial statistical testing to objectively determine the presence of high crime areas or hot spots. These tests generally determine whether clustering is occurring and whether or not the clustering is attributable to random chance.

**Point Pattern Analysis.** One approach to identifying a high crime area is using a point map (See Figure 1). A map of points can demonstrate patterns of points that are clustered, uniform, or randomly distributed (Harries, 1999; Chainey & Ratcliffe, 2005; Boba, 2009). Point pattern analysis involves analysts developing a graduated point map and confirming clusters with spatial correlation statistics (see below) (Gorr & Kurland, 2012). Such statistical tests identify whether clustering of crimes is random or not (National Institute of Justice, 2010); points that cluster together more than what would be expected from random chance would then be considered a hot spot.

### Tests for Clustering

Analysts searching for hot spots or high crime areas can test for clusters of points, lines, or polygons. There are at least two methods to test for clustering the nearest neighbor index and testing for spatial autocorrelation.

**The Nearest Neighbor Index (NNI).** This index is a test that compares the actual distribution of crime data against a randomly distributed data set of the same sample size (Eck et al., 2005). For both the actual and randomly distributed data set, distances are calculated between a point and its nearest neighbor. The process is repeated for all of the points. The average distance is then calculated for both the actual and randomly distributed sets. The NNI is the ratio between the average distance for the actual data set and the random data set. Overall, the results of the NNI test examines whether or not points are closer than expected under spatial randomness (Eck

et al., 2005); one limitation though is that this test does not directly point out where clusters are but instead whether or not they exist.

Some computer programs such as *CrimeStat III* (Levine, 2010) allow users to perform hierarchical clustering where analysts can search for clusters of clusters based on nearest neighbors. Analysts first identify initial clusters using ellipses (i.e., first order clusters). After initial clusters are identified, hierarchical clustering then attempts to identify clusters of clusters (i.e., second order clusters) (Eck et al., 2005; Paynich & Hill, 2010). This is done until “all crime points fall into a single cluster or when the grouping criteria fails” (Eck et al., 2005, p. 22).

**Spatial autocorrelation.** Spatial autocorrelation is another term for spatial dependency (Chainey & Ratcliffe, 2005). Spatial autocorrelation techniques assume that “criminal events that occur in different locations (yet in close proximity) are related” (Paynich & Hill, 2010, p. 382; Harries, 1999; Eck et al., 2005). Positive spatial autocorrelation suggests that “areas with high crime rates are clustered together, and areas with low crime rates are clustered together” (Paynich & Hill, 2010, p. 382; Chainey & Ratcliffe, 2005; Eck et al., 2005).

Moran’s I and Geary’s C are spatial autocorrelation statistics that require aggregate data (Eck et al., 2005; Paynich & Hill, 2010).

- **Moran’s I:** This is a global statistic that shows “whether the pattern...[is] clustered, dispersed, or random” (ESRI, 2009). An intensity value is assigned to each aggregate point and requires some variation in the values for this statistic to be computed. Points that have similar values are reflected in high Moran’s I values (positive or negative) (Eck et al., 2005). Moran’s I closer to +1 indicate clustering while those closer to -1 reflect dispersion. Significance can be tested by comparing it against a normal distribution.
- **Geary’s C:** This statistic is used for analyzing small neighborhoods and for describing the dispersion of hotspots (Eck et al., 2005). Computations for Geary’s C is similar to that of variance in non-spatial statistics (Paynich & Hill, 2010) in that it “is a measure of the deviations in intensity values of each point with one another” (Eck et al., 2005, p. 19). Like Moran’s I, the Geary’s C coefficient can also be tested for significance (Eck et al., 2005). Results indicate positive or negative spatial autocorrelation (Eck et al., 2005; Paynich & Hill, 2010).

Another group of spatial association statistics is the Local Indicators of Spatial Association (LISA) statistics. Two statistics from this group are the Gi and Gi\* statistics, which perform computations on a grid cell output such as those of a density map or at least aggregate data. Recall that the output of a density map is a grid of raster cells. These tests examine each cell in the grid and assume initially that the values within that cell and its surrounding neighbors are similar to those values anywhere else on the grid; i.e., they are not unusually different than would be expected from random chance (Chainey & Ratcliffe, 2005). On the other hand, if local spatial autocorrelation exists as well as clustering, we would see spatial clustering of high values with high values and low values with low values (Chainey & Ratcliffe, 2005). In this way, “LISA statistics assess the local association between data by comparing local averages to global averages” (Eck et al., 2005, p. 30).

One parameter that analysts need to calibrate when using LISA statistics is determining the distance from the target cell and its neighbors (Eck et al., 2005); in other words, how far is and what is considered a “neighbor”. In sum, LISA statistics reflect the idea that “a single block may have a high crime count, but it is not considered a hot spot unless there are other nearby blocks that also have high crime counts (that is, there is a significant positive spatial correlation)” (Gorr & Kurland, 2012, p.129).

## Temporal Considerations

High crime areas can be acute or chronic (Clarke & Eck, 2005, Step 23) and “just as hot spots can be described geographically, they can also be defined using time-related criteria” (Harries, 1999, p. 114). They can change shape over time, leading to periods of emergence, persistence, and declines (Gorr & Kurland, 2012). As a consequence, the time range an analyst chooses to explore the high crime area will affect its presence and size. Analysts should therefore consider the time of day, day of week, considering weekends, holidays and seasonal activity of high crime areas. Analyzing time in conjunction with high crime areas can be useful following a police response to determine whether or not there has been a displacement or reduction of crime (Chainey & Ratcliffe, 2005). As previously noted, it’s possible for an analyst to compare the nature of a high crime area (location, volume, and pattern) before and after a police operation to determine its effectiveness (i.e., if there was displacement or a reduction in crime).

## Exploring High Crime Areas

Crime analysts are encouraged to use other data sets besides crime or disorder data to identify and explore high crime areas. Analysts can combine street maps with geographical features (e.g., schools, bus stops) to create multi-layered maps (National Institute of Justice, 2010). Guided by criminological theories, analysts can query these multi-dimensional crime maps to understand high crime areas.

Spatial analysis can assist in initial crime pattern identification (Bruce, 2003), but crime analysts simply looking for patterns among traditional crime data may miss out on crucial geographical clues to a crime pattern. Overlaying non-crime/disorder related data can lead the analyst to realize more commonalities/factors associated with a pattern. For example, an analyst reviewing a series of robberies might realize that many of them are occurring at bus stops. The analyst might then explore the relationship between the bus stops and the robberies by overlaying locations of robberies and locations of bus stops. As a consequence, they may then realize that these robberies primarily occur on a single bus route.

Furthermore, high crime areas are notable because of “non-crime” data, for example, a high number of arrests or incidents of disorder that crime analysts consider. Although an area might not necessarily have a pattern of official crime, analysts can still determine that an area is a high crime area due to the volume, clustering, and time of incidents like traditional crime hot spots. For example, a problematic neighborhood might have only a few number of official crimes, but in conjunction with numerous calls for service (e.g., disturbances) would constitute a problematic area.

Analysts seeking patterns and high crime areas can similarly benefit from mapping non-spatial data, such as the type of property taken from burglaries to show that an offender only seeks for specific property in certain geographical areas. As another example, plotting incidents of commercial robberies might show general hot spots, but a keen analyst reviewing these incidents might also notice that the robber is targeting a specific business spread across a city (e.g., specific convenience stores). Indeed, Bruce (2003) points out that crime patterns can be found using (1) MO commonalities, (2) 'exceptional volume', and (3) spatial analysis.

Therefore, using non-crime/disorder related data and mapping non-spatial data can provide alternative ways for analysts to identify high crime areas. Boba (2009) recommends that “analysts need to consider more than just geographic locations of incidents when conducting pattern identification; to identify initial patterns, they must further examine characteristics such as place, time/day, and MO” (p. 208).

Crime analysts and the police alike have identified problems areas within their jurisdiction that have existed for many years. These areas are in need of much more than just police action and in future papers we will discuss some of the possible solutions for turning these long-term hotspot locations into safer areas.

## **Summary**

This document outlined the IACA’s definition of hot spots to describe high crime areas, but also noted other characteristics such as high volume, spatial clustering, and time. The focus of this paper was to bring awareness to analysts about the various methods to identify high crime areas. While there is no one best method to determine a hot spot or a high crime area, an analyst should be aware of the multiple methods we have discussed and use their discretion before deciding on the most appropriate method for their analysis. It is recommended that multiple datasets be considered when examining areas of your jurisdiction. Finally, this paper encouraged analysts to incorporate non-crime/disorder data in addition to crime/disorder data when they are analyzing high crime areas.

## References

- Boba, R. (2009). *Crime Analysis with Crime Mapping*. Thousand Oaks, CA: Sage Publications.
- Braga, A.A. (2006). The Crime Prevention Value of Hot Spots Policing. *Psicothema*, 18(3), 630-637.
- Bruce, C. (2003). Identifying Crime Patterns. Massachusetts Association of Crime Analysts. Accessed at: <http://www.macrimeanalysts.com/articles/identifyingcrimepatterns.pdf>. Date Retrieved August 12, 2011.
- Chainey, S., & Ratcliffe, J. (2005). *GIS and Crime Mapping*. London: Wiley Publishing.
- Clarke, R.V., & Eck, J. (2005). *Crime Analysis for Problem Solvers in 60 Small Steps*. Washington, D.C.: Office of Community Oriented Policing Services, United States Department of Justice.
- Eck, J., Chainey, S., Cameron, J., Leitner, M., & Wilson, R. (2005). *Mapping Crime: Understanding Hotspots*. Washington, DC: U.S. Department of Justice, National Institute of Justice.
- ESRI. (2009). Spatial Autocorrelation (Morans I)(Spatial Statistics). Retrieved from [http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?id=1692&pid=1689&topicname=Spatial%20Autocorrelation%20\(Morans%20I\)%20\(Spatial%20Statistics\)](http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?id=1692&pid=1689&topicname=Spatial%20Autocorrelation%20(Morans%20I)%20(Spatial%20Statistics))
- Ferguson, A. G. (2011). Crime Mapping and the Fourth Amendment: Redrawing High-Crime Areas. *Hastings LJ*, 63, 179.
- Gorr, W.L., & Kurland, K.S. (2012). *GIS Tutorial for Crime Analysis*. Redlands, CA:ESRI Press
- Gwinn, S.L., Bruce, C., Cooper, J.P., & Hick, S. (2008). *Exploring Crime Analysis: Readings on Essential Skills* (2nd ed). Overland Park, KS: International Association of Crime Analysts.
- Harries, K. (1999). *Mapping Crime: Principle and Practice*. Washington, DC: National Institute of Justice (NCJ 178919).
- International Association of Crime Analysts. (2011). *Crime pattern definitions for tactical analysis* (White Paper 2011-01). Overland Park, KS: Author.
- Mitchell, A. (1999). *The ESRI Guide to GIS Analysis* (Volume 1: Geographic Patterns and Relationships). Redlands, CA: ESRI Inc.
- National Institute of Justice. (2010). How to Identify Hot Spots. Retrieved from <http://www.nij.gov/nij/topics/law-enforcement/strategies/hot-spot-policing/identifying.htm>
- Ned Levine (2010). *CrimeStat: A Spatial Statistics Program for the Analysis of Crime Incident Locations* (v 3.3). Ned Levine & Associates, Houston, TX, and the National Institute of Justice, Washington, DC. July.
- Paynich, R., & Hill, B. (2010). *Fundamentals of Crime Mapping*. Sudbury, MA: Jones and Barlett.
- Ratcliffe, J.H. (2004). The Hotspot Matrix: A Framework for the Spatio-Temporal Targeting of Crime Reduction. *Police Practice and Research*, 5(1), 05-23.
- Sherman, L.W. (1995). Hot Spots of Crime and Criminal Careers of Places. In J. Eck and D. Weisburd (Eds.), *Crime and Place* (p. 35-53). Monsey, NY: Criminal Justice Press.



## Figures:

All figures are from the Dallas Police Department unless otherwise noted.

## Appendix A:

The importance of this issue – the methods and protocols surrounding the designation of a high crime area – goes beyond the mere utility of data-driven policing. Following the U.S. Supreme Court’s decision in *Illinois v. Wardlow* (Ferguson, 2011), such a designation has profound implications for the nature of policing and the application of the Fourth Amendment in those designated areas. In essence, *Wardlow* declares that mere presence in a high crime area may be sufficient cause to conduct a stop-and-frisk of a citizen on the street. As Ferguson points out in a recent law review article, the state of police GIS technology is such that high crime areas can be designated with reasonable, empirical certainty. In some cases, this process can be accomplished in near real-time and for any number of crime types. However, as the article points out, there is not a consistent methodology or standard used by crime analysts in determining the definition and designation of a high crime area. It then becomes incumbent on the crime analysis unit to have a specified methodology in place and to consistently utilize this methodology. The methodology needs to be defensible both empirically and theoretically. One purpose of this paper is to suggest systematic approaches to developing an appropriate protocol for the designation of high crime areas. While this legal decision only has direct implications for U.S.-based analysts, taking a formalized approach to the designation of high crime areas is just good practice.