Mapping Patterns of Reentry in Forsyth County, North Carolina, 2005 – 2009

In the past 5 years, there were approximately 13,358 releases from North Carolina Department of Corrections custody into Forsyth County, representing 10,770 separate people. This is 1 out of every 32 people in Forsyth County. Of them, more than 3,600 have seen the inside of a prison cell. To where do they return within our neighborhoods? Do they have access to the appropriate services and support to ensure they don't offend again?

The use of GIS in all facets of the justice studies is an evolving phenomenon. The integration of spatial technologies with the institutions to deter, mitigate and sanction those who violate established societal norms serves as a way to better understand social, economic, demographic and spatial dimensions of crime. Through its involvement with the Urban Institute's Reentry Mapping Network, The Center for Community Safety has begun to utilize GIS to map patterns of reentry within Forsyth County, North Carolina.

Given the sometimes tenuous relationship between prison reentrants and the local community, it is necessary that a clear understanding exists regarding the spatial distribution of prison reentrants. GIS is a powerful tool that allows reentry to be mapped using relatively few resources. Basic spatial statistics allow GIS professionals to map concentrations, patterns and trends related to prison reentry, its relationship to other indicators such as demographics, employment, income and education attainment. Not only can the community understand spatial relationships of prison reentry, but also the social phenomenon that contributes to the burgeoning prison reentry rate. By addressing these social factors, law enforcement, schools and researchers can address these issues for the purpose of prevention rather than intervention.

Prior Research

A Geographic Information System (GIS) serves as the tangible and intangible means by which information about spatially related phenomena can be stored, analyzed and mapped. Experts in many dissimilar fields have seen the utility of GIS as a means of quantifying and expanding their research. GIS is used in disciplines such as business, sociology, justice studies, surveying and the environmental sciences (Steinberg and Steinberg 2006). In fact, most data can have a spatial component applied to it. Reentry can be modeled in a variety of different ways. An individual reentrant can be represented as a point based on an absolute location (latitude and longitude). Using a process called Geocoding, relative locations such as addresses can be assigned absolute location and displayed on a map. From there, further analysis discussed later in this paper can be performed on the data. Regardless of the means, each point, in this case reentrant, can have a variety of attributes (type of offense, length of detention, etc.) based on information provided by the DOC. In addition, reentrants can be agglomerated or counted within polygon or areal features such as counties, census tracts, neighborhoods or block groups. The enumeration unit used in this study will be the census block group and serves as the basis for much of the future analysis.

Given the relative ease in which any phenomenon, if provided with information that indicates location, can be mapped in this day and age, the intersection of prison reentry and GIS serves as both an interesting, constructive and practical topic of research in our communities and educational institutions. Previous work in this arena has already been done by the Urban Institute to display spatial dimensions of prison reentry at different scales. Documents and maps by La Vigne et. al. (2003a) and the New Jersey Institute for Social Justice (2003) show prison entry, reentry and prisoner-related expenditures in Illinois and New Jersey at the county level. In addition to displaying raw data for each county, values normalized per 100,000 population are calculated to display reentrant density. Data are shown at the sub-county level around urban areas such as Cleveland, Camden and Newark. Rasterized density maps are used to show high concentrations of prison reentry in Baltimore area (La Vigne et. al. 2003b). Detailed reentry analysis in some cases is available at the census block group level. Other states included in these Urban Institute publications that include some spatial representation of reentry include Georgia, Idaho, Illinois, Massachusetts, Michigan, Texas and Virginia. With the growing need to address spatial dimensions of

reentry, the guidebook to accumulating this type of data was written by La Vigne (2007). She explores various ways to map facets of reentry, ranging from the pure mapping of reentrants to using GIS to determine case worker caseload and travel time to probationers.

Mapping prison reentry serves as a subset to the phenomenon of measuring spatial aspects of crime. The origins of the grand and structural theories, used to explain differences in international crime rates, can be explored at the local level. Quantitative indicators of social constructs such as the measure of civilization, the distribution of various cultural groups (Howard et. al. 2000), and the measure of strain via economic disparity (Neapolitan 1996) help to explain how and why crime occurs where and when it does. These indicators ultimately and unfortunately manifest themselves on the other end through reentry mapping. Empirical studies suggest that crime rates within the same demographic group, age, income level and urban cluster vary from place to place throughout the United States. Being situated in the south, Winston-Salem may experience higher rates of violent crime based in its unique culture and history (Ousey 2000). While homicide rates remain the same between minority males and females compared to their counterparts throughout the county, rural white males do not. Given the rural and urban composition of Forsyth County, comparisons can be made between these segments to see if the same holds true for reentry.

North Carolina Reentry Data

When it comes to reentry in North Carolina, it does not necessarily mean the reentrant had ever set foot in a prison. Information about individuals leaving the Department of Corrections' custody, whether via (1) probation (2) being maxed out of their sentence or (3) parole, is provided by the North Carolina Department of Corrections. In North Carolina, more than 2/3 of reentrants are being released from probationary sentences (Figure 1).

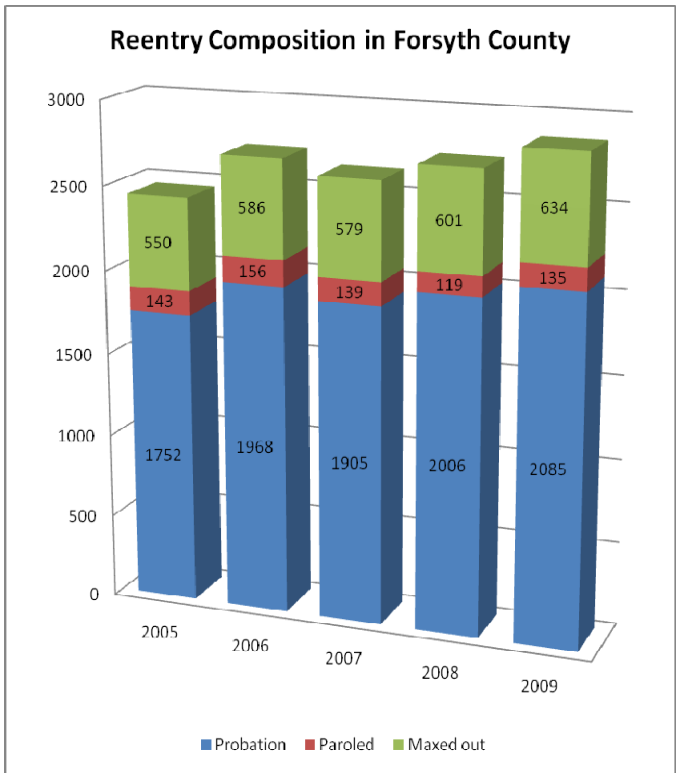

Figure 1

Individual information included the reentrant's name, Department of Correction number, birth date, race, sex offense, address, county and status of release (probation, maxed out or paroled). The North Carolina Department of Corrections provides lists of reentrants on a monthly basis for the 8 county area surrounding Forsyth County. This area includes Guilford, Rockingham, Davidson, Davie, Stokes, Surry and Yadkin Counties. For this 8 county area, there are more than 965 releases per month. As one can imagine, managing these data can be a tedious task.

For each year, all monthly records are merged into a single file in spreadsheet format. From there, each reentrant was mapped based on their address using a process called *Geocoding*. *Geocoding* looks for a match between the addresses listed in the reentrant's address and an existing spatial database representing streets that has attributes for road names and house numbers to a place on a map. The spatial database, representing roads, was provided by the North Carolina Department of Transportation (NC DOT). The Geocoder, i.e. the algorithm to create GIS data from the DOC data and the NC DOT data, was developed by the Center for Community Safety. One problem with this process is that the Geocoding algorithm does not understand spelling errors or naming conventions. In the reentrant database, a city name may be listed as "W-S" to represent "Winston-Salem", which is the correct notation in the roads database. In other cases, the city name was misspelled.

Using a "Find and Replace" function, these errors were addressed when and where a mistake was obvious to the researcher. After all of these issues were rectified, data could be converted to spatial format using the Geocoding techniques. Geocoding essentially converts the reentrants' relative addresses to a latitude and longitude location. The process of Geocoding goes through a number of iterations after the computer algorithm is performed. After all matches are made by the computer (i.e. a reentrant's address can be found in the spatial database), the GIS software allows users to manually look for a potential match. This may not occur for a variety of reasons such as 1) A proper address was not provided 2) Different naming conventions for road names (24TH vs. Twenty-Fourth) 3) The renaming of road names and 4) Newer road names that may not yet exist in the state database. While all efforts were made to match each reentrant with an appropriate location, in some cases they could not.

A GIS data layer where reentrants are modeled as point locations was created after this manual process. These point locations can be mapped in proximity to each other, near our schools or within neighborhoods. In addition to showing the location of the reentrant, information about their status can be displayed and calculated. For this particular project, point locations only lying within Forsyth County were selected using the "Select by Location" tool using the GIS software. This tool finds a geometric intersection between all reentrants and the Forsyth County boundary, returning all reentrants who are located within Forsyth County. A new GIS data layer representing this subset was generated for use in this research for the years 2005 through 2009.

Reentry Statistics for Forsyth County

After generating a subset for only Forsyth County reentrants, maps and statistics about these reentrants can be created. For the entire 5 year time period, Forsyth County saw a total of 13,358 reentrants. However, only 3,642 (27.3%) of these people ever saw the inside of a jail cell. For paroled prisoners, sentences lasting as long as 35 years could be found in the dataset. For prisoners who have maxed out their sentences, they may remain in jail for up to 28 years. The other 9,716 (72.7%) reentrants in Forsyth County were released from a probationary sentence. For this research, the focus will be on reentrants from prison and these other 9,716 people are not included. The composition of these prison reentrants in comparison to total reentrants can be seen in Figure 1 and a map of these prison reentrants can be seen in Map 1.

Results: Central Tendency of Prison Reentrants

A GIS data layer representing almost 700 points per year was created to represent reentrants from prisons for the years 2005 to 2009 in Forsyth County. Point pattern analysis to describe the basic distribution of these points compared to the center of population can be used to describe the spatial patterns of prison reentry in Forsyth County. Polygon analysis will show exactly where this reentry is occurring within Forsyth County.

Using these point phenomena, measures of central tendency were used to help describe the distribution of these features using a singular metric. These measures of central tendency are useful to provide a general spatial description of the data. In addition to a data layer representing all reentrants, analysis will describe centrality measures by years using 4 different metrics. They are the spatial mean, spatial median, center of minimum distance and the central figure. The spatial mean, spatial median and center of minimum distance were derived using CrimeStat software. The central figure was determined using the Statistical Analyst Extension for ArcGIS, version 9.3.1.

The spatial mean is a centrographic metric used to express the spatial distribution of a phenomenon. The spatial mean measures the center of mass for a set of points or polygon by taking the average of the x and y coordinates (Shaw and Wheeler 1994). The x-value of the spatial mean is derived from the arithmetic mean of all longitudinal values of prison reentrant locations. The y-value can be found in the same manner using the latitudes of these points. These values can be derived by using a short VBScript to create these locational values and then using the *Summarize* functions in the ArcGIS table view (or *Calculate Geometry* for newer versions) if the user does not have access to the CrimeStat software.

Another measure of central tendency is the spatial median. However, the way in which the spatial median is derived is a source of debate. Hammond and McCullagh (1974) define the spatial median as the intersection of two perpendicular lines whose points are evenly distributed about a north-south line and east-west line using the median or middle of x-values (longitude) and y-values (latitude). As a median does for aspatial statistics, outliers which may skew the data upwards or downwards are removed when computing the median. For the spatial median using this set of data, the spatial median will remove the outliers that would tend to skew the spatial mean in one direction or another. Others such as Smith (1975), Neft (1966) and the ESRI Guide to Spatial Statistics (Mitchell 2005) define the spatial median as a 'minimum aggregate travel' distance using an iterative process to determine a point at which the minimum travel distance between this spatial median point and the sample points are minimized (Shaw and Wheeler 1994). For this analysis the spatial median (median value of latitude and longitude) and center of minimum distance are two unique and separate measures. The fourth and last measure of central tendency is the central feature. The central feature is the reentrant that has the shortest total distance to all other features. It is essentially the feature located closest to the center of minimum distance (Mitchell 2005).

Using the same types of methods, the center of population for Forsyth County can be computed from polygons at the census block group level and compared to these centrality metrics. Popular with the United State Census Bureau, this center of population essentially represents the center of the county's population . It uses a centroid of each of the 205 census block groups composing Forsyth County and the 2009 population to calculate the center of population. Population for the year 2009 was provided by Teleatlas, using United States Census Bureau estimates.

In addition to showing the mean population center for Forsyth County, Map 2 shows the spatial distribution for the spatial mean, spatial median, center of minimum distance and central features for all prison reentrants in selected years. The inset of Map 2 shows the mean population center and mean center of 2005 prison reentrants with relation to Forsyth County and Winston-Salem. Only the years 2005 and 2009 are shown because increasing symbology from interim years on a map of this scale would greatly confuse the map reader. To dispel any confusion, however, all metrics are located within close proximity of each other and the years 2005 and 2009 are used as bookends to show general migration trends in that time period rather than obscuring information.

As Map 2 dictates, all but one of the centrality metrics shown are located more than 1 mile east of the mean population center. This difference shows that the spatial distribution of prison reentrants is much different than that of Forsyth County. Prison reentrants are generally congregated towards the eastern part of the county. Why is that? What factors in the eastern part of the county tend to attract prison reentrants to that part of the county? In that same notion, what factors detract prison reentrants from moving to the western part of the county? Is it purely economical? Further analysis at the polygon level should show exactly where these prison reentrants are reentering Forsyth County.

Polygon Analysis

Showing the locations of all prison reentrants on the map of Forsyth County may have aesthetic value, but has little functional value. While point pattern analysis provides a general description of the entire data set, it has little to no computational value and does not describe what is happening within the data. These points can be grouped within polygonal divisions of Forsyth County. This agglomeration of data helps to keep information about individual points private and better encapsulates trends. The city of Winston-Salem can be divided into contiguous units. While Winston-Salem does have neighborhoods, the boundaries of these neighborhoods are nebulous and subject to debate. Because of this, polygon analysis will be performed on the census block group in Winston-Salem. A census block group is the 2nd smallest collection unit used by the census. There are 205 block groups in Forsyth County.

While the decennial census, last taken in 2000, provides the most accurate information about a variety of different demographic, economic, housing and social metrics, public agencies and private companies provide updated data on a yearly basis. Information for the year 2009 was provided by Tele Atlas and ESRI, the manufacturer of the software used for the analysis in this project. Block groups in

Forsyth County contain an average of about 1,700 people and have an average size of about 2.01 mi^2 (1,286 acres) In urban areas within Winston-Salem city limits, block groups are as small as .13 mi^2 (83.2 acres). The largest block group is more than 21 mi^2 in the rural Northeastern part of the county.

Reentrants represented as points can be agglomerated or counted within each of these block groups. This was done by *Intersecting* the reentrants and the block group. The resulting layer assigns a FIPS (Federal Information Processing Standards) code to each reentrant. A FIPS code is a unique 12-digit number used to identify each and every census block group in the United States using a combination of the state, county, census tract and census block group identifiers. Once each reentrant has been assigned a FIPS code, the *Summarize* function in ArcGIS was used to create a table representing the frequency of reentrants within each census block group. The resulting table was *Joined* to the GIS data layer used to census block groups.

Having the raw number of reentrants for each block group is problematic because block groups vary in population. Two block groups containing the same number reentrants may not necessarily tell the same story. Normalization with population, or some other field for that matter, is necessary to provide an adequate frame of reference. Using the *Field Calculator* tool in ArcGIS, reentrant density (reentrants / 1,000 population) by block group can be calculated. Given the various dimensions at which the Department of Corrections provides data, other variables such as the type of crime, race/sex of each reentrant and the length of sentence can also be mapped.

Map 3 in the Appendix shows the spatial distribution of the 3,642 prison reentrants in Forsyth County from 2005 to 2009. Prison reentrant density ranges from a high of 130.3 prison reentrants per 1,000 population, primarily in the Waughtown neighborhood, down to a low of 0 reentrants per 1,000 population, which occurred in 6 of the county's 205 census block groups.

Within Forsyth County, high prison reentry typically occurs in the eastern part of the city of Winston-Salem. To the west of State Highway Route 52, which serves as the main north-south thoroughfare in Forsyth County, prison reentry is concentrated just south of the Lawrence Joel Memorial Coliseum Complex in the neighborhoods of North Winston-Kimberly, Drayton Pines and Old Cherry.

Given a standard metric (rates per 1,000 population) for each individual year between, change can be calculated and mapped. While different permutations of intervals can be calculated and mapped (2007 to 2008, for example), the interval between for the 5 year period between the years 2005 and 2009 was calculated. The change for each block group is calculated by merely subtracting the 2005 rate from the 2009 reentry rate. If it is a positive number, then crime has increased. This change is shown in Map 4. Block groups shown in red articulate the highest increase in prison reentry. Green areas show the highest decrease in prison reentry during this time period. While the peripheral parts of the county show the same general trend, inner city areas are experiencing both increases and decreases in prison reentry. In some of these high reentry neighborhoods east of Route 52, reentry density has actually decreased in this 5 year period. However, that is not the case for the entire area. In previous work performed by the Center of Community Safety (Mulrooney and Carmichael 2009), it has been shown that crime rates have been increasing in a large area South of Interstate Route 40 and East of State Highway 52. What is common about this particular area near in and around the Easton neighborhood?

Cluster Analysis

Using prison reentry rates from 2005 to 2009 at the block group level, statistical metrics exist to measure how much clustering occurs within Forsyth County. In this case, clustering measures the location and degree of prison reentry in Forsyth County. The *Geostatistical Analyst Tool* using ESRI GIS software has allowed users to measure these metrics. Metrics such as Moran's I and Geary's c quantitatively compute the amount of spatial autocorrelation for data for an entire data set, returning a single value for the entire layer that could be compared to other metrics or other counties. Spatial autocorrelation measures spatial dependency and Tobler's (1970) First Law of Geography. Tobler surmises that phenomena closer to each other will be more related than distant phenomenon. Cluster analysis measures this closeness.

Further expounding on the concept of spatial autocorrelation, Local Moran's I is a Local Indicator of Spatial Autocorrelation (LISA) and calculates local variation based on adjacency patterns. A LISA returns an individual value for each polygon, showing whether it is near other like values. In the case of Local Moran's I, patterns that are similar and located near each other will return a high value for Local Moran's I. This is regardless of the fact that adjacent reentry rates may be high or low. If census block groups with low reentry rates are located near each other, Local Moran's I will return a similar value as if high reentry rates are located near each other.

Further expounding on Local Moran's I is another LISA that further delineates the high-high and low-low relationships of clusters. The Getis-Ord Gi* metric (pronounced G-I star) uses the prison reentry rate from 2005 to 2009 with a neighborhood function (user defined distance), z-score and p-values to determine hot spots (high reentry census blocks surrounded by other high reentry census blocks) and cold spots, representing low reentry census blocks surrounded by other low reentry census blocks (Mitchell 2005).

A cluster map of prison reentry from 2005 to 2009 using the Gi* metric is shown in Map 5. The highest cluster of reentrants has occurred in the eastern and northeastern Winston-Salem neighborhoods of East Winston, Northeast Winston and Southeast Winston neighborhoods. While the census block near the Waugtown neighborhood experienced the highest amount of prison reentry from 2005 to 2009, it is not within this high cluster area because it is located near some census block groups with low prison reentry rates. The cluster of low prison reentry mainly occurs in the western part of Winston-Salem, in addition to the communities of Clemmons and Lewisville to a lesser extent. There also exists another low cluster near the town of Kernersville in the eastern part of the county.

While Map 5 shows combined reentry rates for the entire time period from 2005 through 2009, Map 6 shows the difference in clustering patterns from reentry for 2005 and 2009. Most noticeable is that the high cluster in East Winston is migrating to the south. This also represented the highest area of negative change (greatest increase) when it comes to crime in Forsyth County. This area looks to be a major powder keg on both ends of the criminal justice continuum, from both a preventative and monitoring standpoint. This area experiences both increased crime and reentry. What factors contribute to this increased crime rate and reentry? Further demographic modeling, as well as qualitative analysis from those familiar with this area can help answer that question.

Conclusion

The interest in prisoner reentry is based on the assumption that the approximately 700 prisoners being released to Forsyth County pose a risk to the public. Statistics show that more than 2/3 of prisoners will reoffend within 3 years, and that half will eventually return to prison at some point in time (The Urban Institute 2004). However, it extends much more than this and requires multi-faceted approach in order to address all dimensions of reentry.

Prisoners reentering into society have many unmet needs, such as lack of employment prospects, unaddressed mental health concerns, family instability and difficult finding adequate housing. These challenges manifest themselves in different forms (Ditton 1999). With these unmet needs, the necessary resources and services need to be available to these people. Showing the spatial distribution of this unique population can better give social services a better understanding of where to place these appropriate services. Within neighborhoods that generate a large percentage of prison reentrants, there exist commonalities and common threads such as low high school graduation rates, high unemployment and single parent homes. Perhaps studies of this nature can address some of the tangible roots of prison reentry before it ever becomes a problem.

In Forsyth County, prison reentry was derived from tabular information about individual reentrants from the North Carolina Department of Corrections. Using previously mentioned GIS techniques, these reentrants were represented as points and mapped within Forsyth County. Within Forsyth County, prison reentry is concentrated in the eastern part of Winston-Salem. Using point pattern analysis, the center of

population, using a variety of metrics, for prison reentrants is well east of the population center for the entire county. This shows a general trend or concentration east of the population distribution of Forsyth County.

Using the census block group as the enumeration unit, these prison reentrants can be grouped by census block group, standardized by population and displayed. Map 3 shows the spatial distribution prison reentrants between 2005 and 2009. Furthermore, clustering can be measured by extending basic principals of statistics to a spatial domain. From this analysis, prison reentrants have been congregating further and further south within our county in the past 5 years.

Discussion

Analyses of these types are only as good as the data themselves. It would irresponsible to ignore the processes that go into creating the GIS data used in the process. While information about reentrants is supplied by the North Carolina Department of Corrections, matches may not be able to be made to a reentrant's address in the community. This occurs for a variety of reasons, including not knowing where they are returning to or putting in an incorrect or fraudulent address. Those errors, if needed to be rectified through the Department or Corrections, are done later in the process. As previously discussed, there were also technical issues revolving around finding an absolute location via the *Geocoding* techniques. Regardless of these issues, only less than 4% (140 out of 3642) of all addresses supplied by prison reentrants could not be matched to a corresponding address and displayed on a map. This is encouraging news.

Care must be taken when determining an appropriate aggregation unit in which to display data. The aggregation unit used in this study is the census block group. It is within these block groups that reentrants were counted and displayed in Maps 3 - 6. Given a goal of thematic choropleth maps such as these is to highlight regional differentiation, the use of different scale units which may show different patterns may tell completely contradictory stories. Openshaw (1984) coined this term as the 'Modifiable Areal Unit Problem' (MAUP). For example, there may be a cluster of high reentrants at the census block level that can be detected. However, these blocks may lie in different census block groups and their rates' interactions other census blocks within the same block group may obfuscate these high values and more importantly this cluster. It is important that issues of MAUP be addressed by using a scale that adequately dictates and explains transparency between results rendered at various scales. In looking at reentrant density at different scales (block, block group, tract, zip code), they show the same general trends as highlighted in this research.

Lastly, the time intervals used in time-series analysis (2005 – 2009) and displayed in Map 4 merely show the general trends over this 5 year time period. If different intervals (2006 – 2008, for example) were used, they may show different trends. However, there are many different permutations of intervals that could be shown. As with the issues of MAUP, all efforts were taken to display transparency with these data. The interval shown in Map 4 was used because it encompassed all data from both a spatial and time aspect. Please contact the author if you wish to view or see data from other time periods besides those shown.

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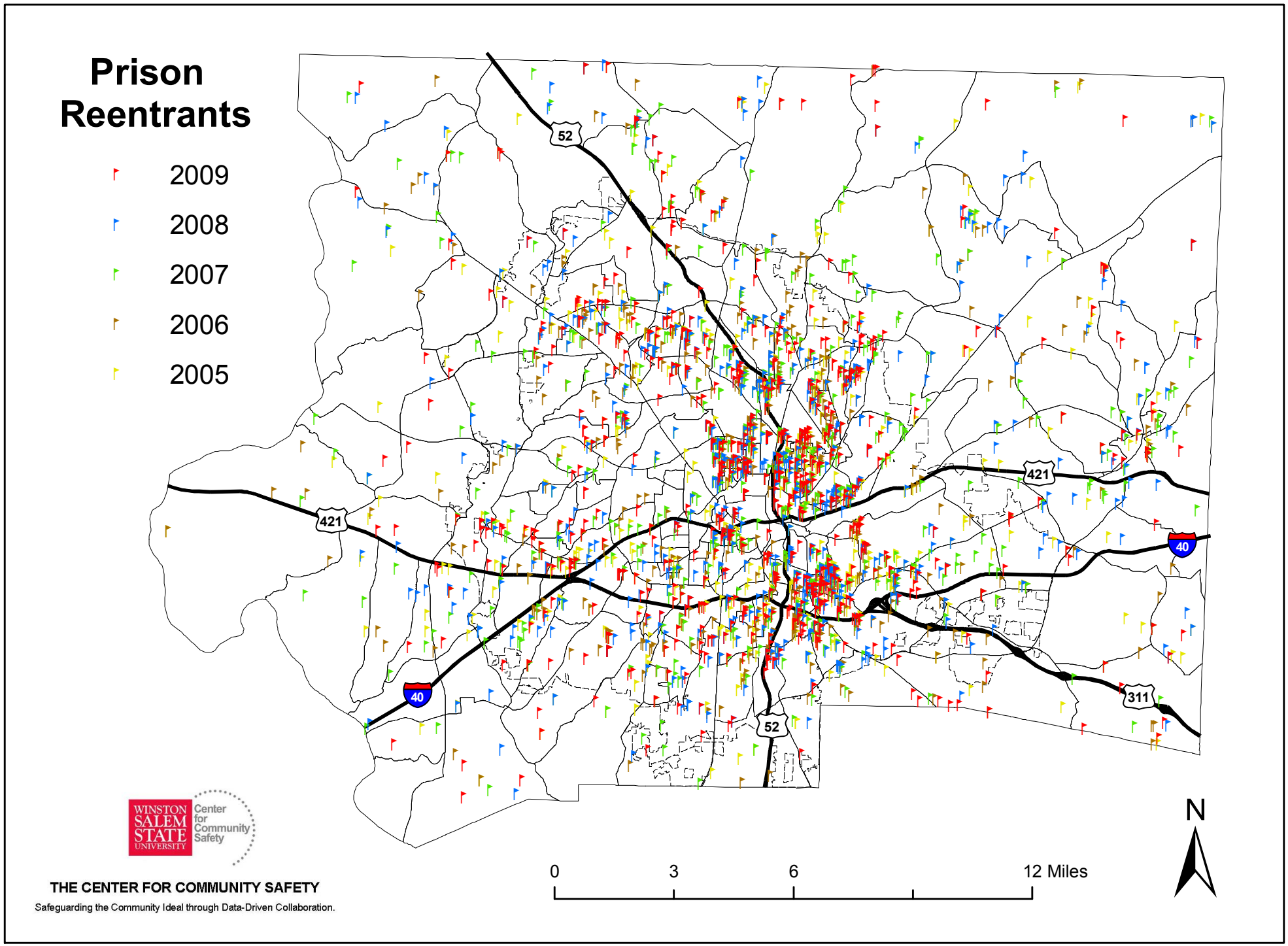
Map 1: Forsyth County Prison Reentrant Locations



Map 2: Point Pattern Analysis

These points represent centrality metrics for prison reentry in Forsyth County, North Carolina. Given the close proximity of these point to each other, only the years 2005 and 2009 are shown.

These centrality metrics are shown in their spatial relation to the mean population center for Forsyth County.

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Year

- 2005
- 2009

Forsyth County Mean Population Center (2009)

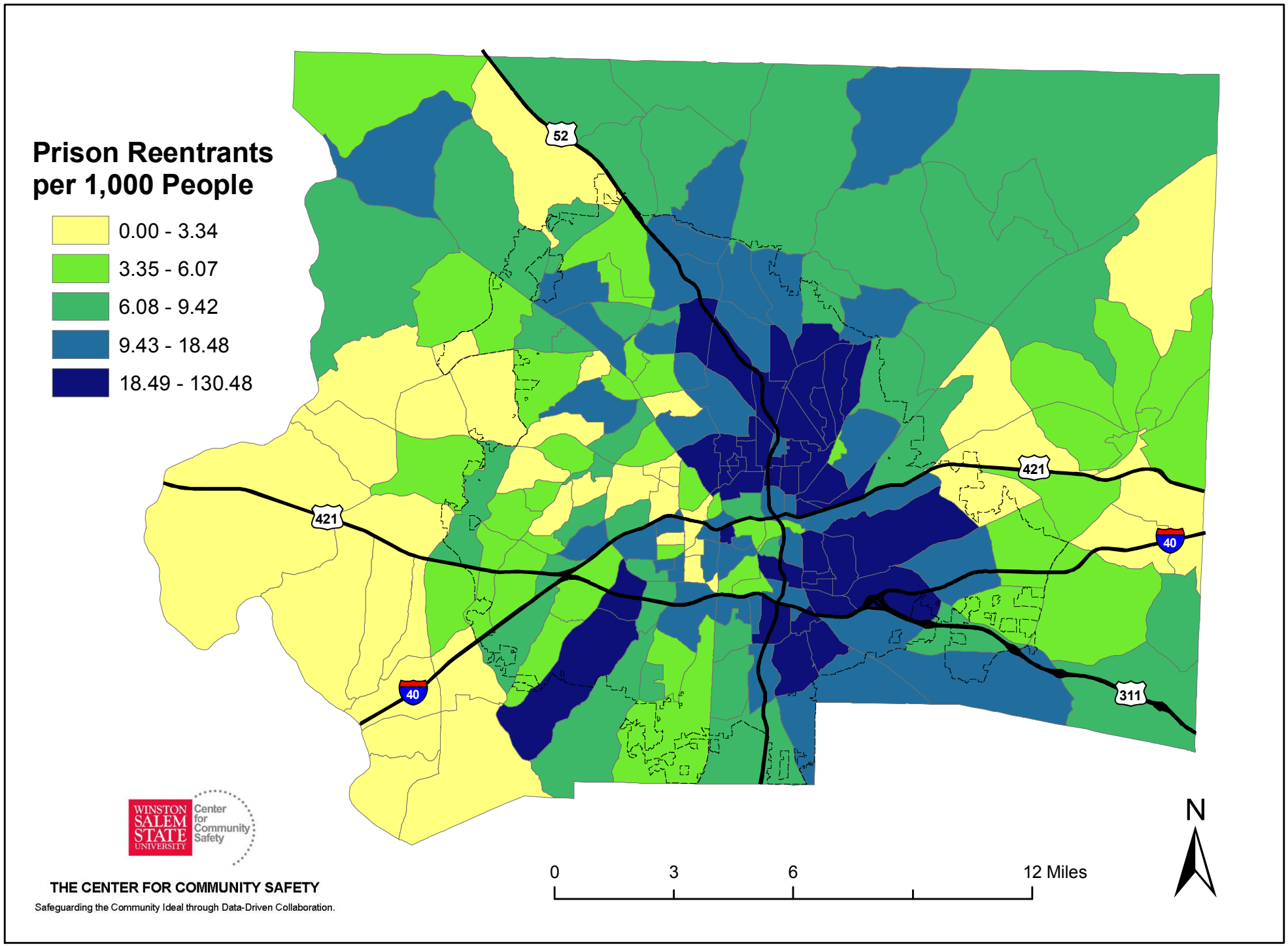
0 0.1 0.2 0.4 Miles

Legend

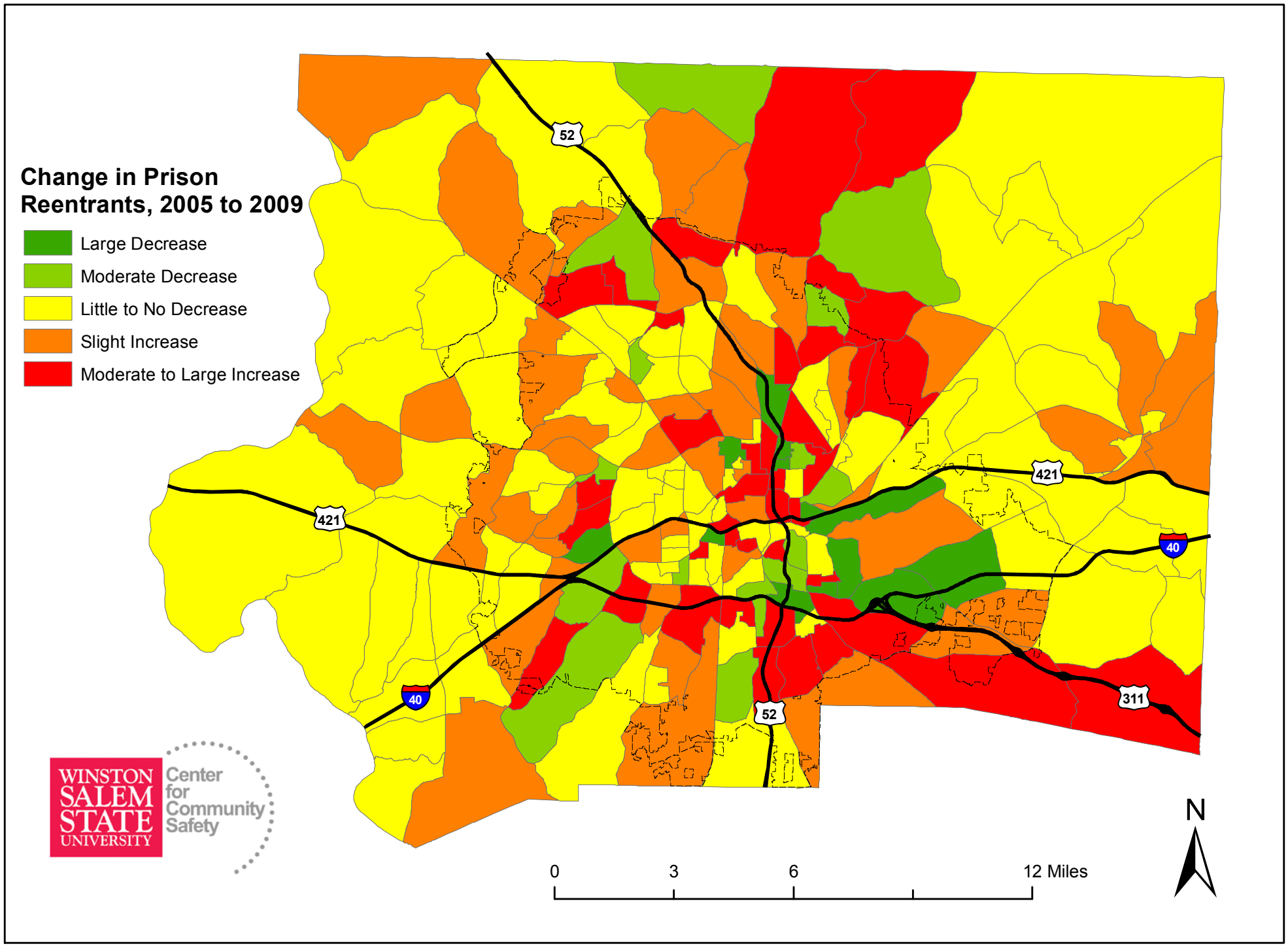
- Mean Center
- Median Center
- Center of Minimum Distance
- Central Feature

N

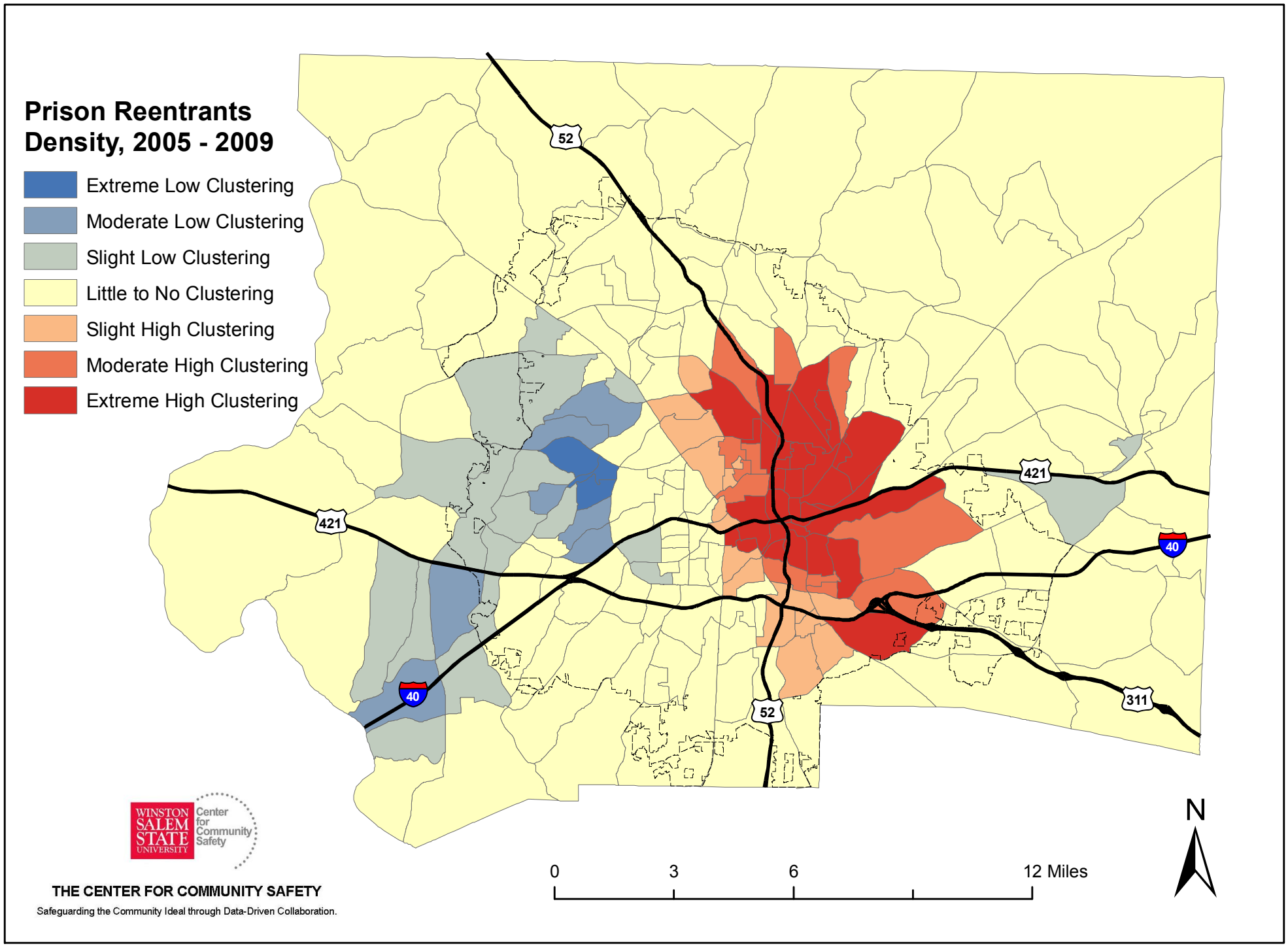
Map 3: Forsyth County Prison Reentrant Density



Map 4: Forsyth County Prison Reentrant Change



Map 5: Forsyth County Prison Reentrant Clustering

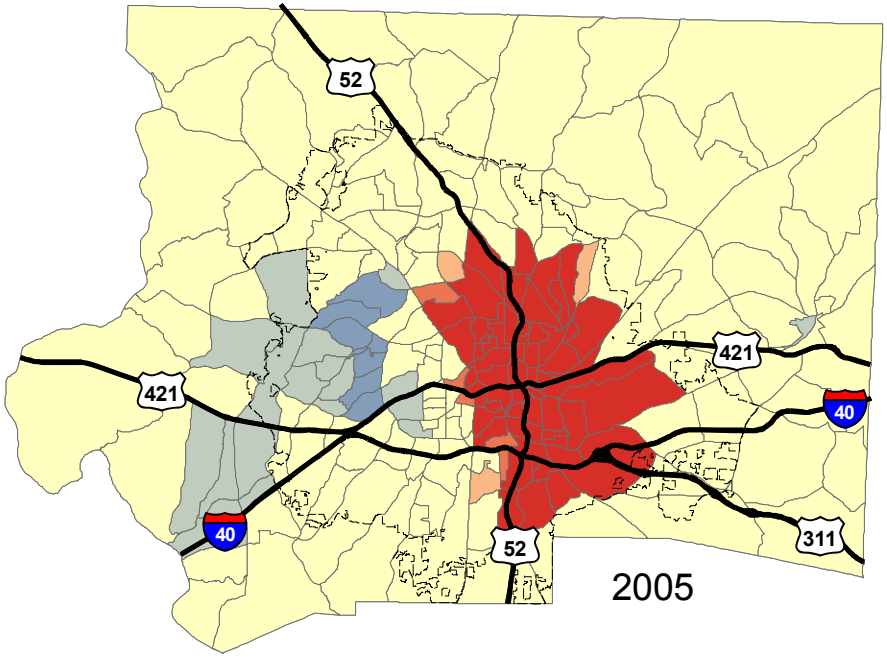


Map 6: Forsyth County Prison Reentrant Clustering

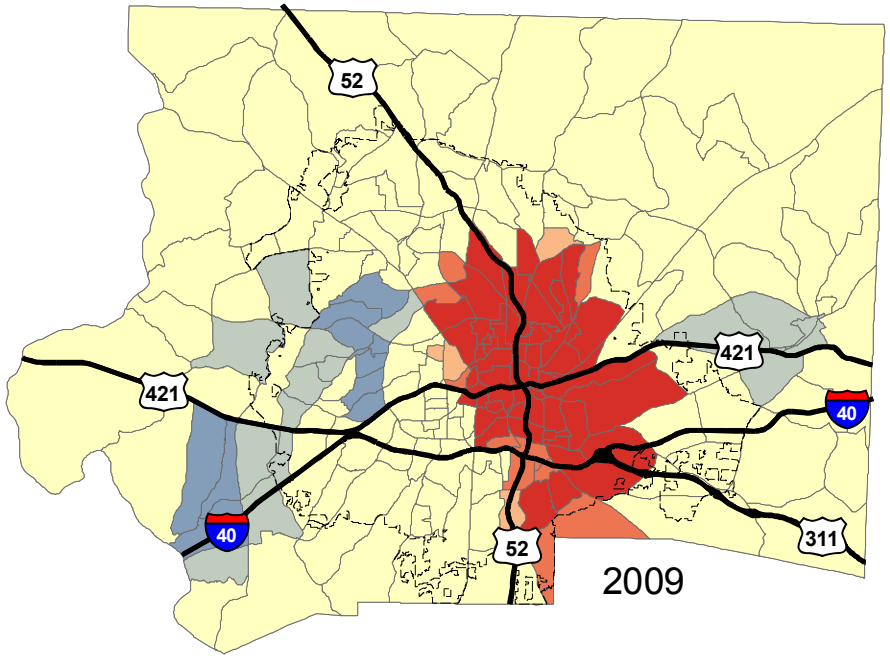
Prison Reentrants Density, 2005 & 2009

- Extreme Low Clustering
- Moderate Low Clustering
- Slight Low Clustering
- Little to No Clustering
- Slight High Clustering
- Moderate High Clustering
- Extreme High Clustering

0 4 8 16 Miles



2005



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WINSTON SALEM STATE UNIVERSITY Center for Community Safety

THE CENTER FOR COMMUNITY SAFETY

Safeguarding the Community Ideal through Data-Driven Collaboration.