Maximizing Community Policing Resources using Spatial Analysis to Identify Areas of High Property Crime in Winona, Minnesota.

Nicole DeMotto
Department of Resource Analysis, Saint Mary's University of Minnesota, Winona, MN 55987

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Abstract: Using spatial statistics, hot spot analysis and overlay analysis property crime data for Winona, Minnesota was analyzed for spring 1996 and spring 1998. The intent was to examine the influence businesses with an On-Sale liquor license, also known as a bar or tavern, had on property crime. The results show an influence on property crime, however property crime may be a greater externality of university students than of bar patrons.

Introduction

Community Oriented Policing Strategies, (COPS), have been attributed with reducing the crime rate throughout the country. COPS has a number of components which make them successful in crime reduction. COPS is in essence a collaboration between the police and the community that identifies and solves community problems (Community Policing Consortium, 1994). Research is an integral part of selecting the appropriate COPS. Availability of federal funding has allowed researchers to challenge many of the "old school" beliefs and practices of police departments. The results of the research seem to reaffirm the value of COPS or "new school" policing, as a number of retired officers like to call the new philosophy of policing. Technology is also playing an increasingly important role in policing. One of the technologies showing significant promise as a crime fighting tool is the Geographic Information System (GIS).

GIS can provide administrators and officers with a visualization of crime in their municipality. It can help law enforcement officials visualize where crime is occurring, who might be victims of crime and who might be committing crime. Knowledge of spatial patterns of crime can help police identify COPS, which might be effective in reducing crime. Once a strategy is in place, the police will want to know how effective it might be. New patterns may form based on the fact that the criminal element has to take their "business" elsewhere. Prediction of new patterns is a key factor in an effort to combat crime, rather than simply redistributing crime. GIS can assist police in identifying a problem, evaluating a response to a problem and predicting where future problems may occur.

The study this paper is outlining is an effort to reduce property damage in the City of Winona, Minnesota. The police department suspects most of the crime in Winona is related to alcohol, but has not been able to adequately support their long held suspicions. The first step in understanding property crime is to identify the location of the incidents and identify spatial patterns. After the spatial patterns were examined temporal patterns were briefly addressed. The problem identifying temporal patterns lies in the

fact that incidents are reported when they are discovered, not necessarily when they were committed. As a result, dates were examined rather than times. The spring months, which include, March, April and May, were studied at a greater extent because that season had the highest number of property crimes. The overall goal of this paper is to provide WPD with a graphical picture of where property crime occurs, with the intent of either implementing or changing community policing strategies. Location of property crimes can offer an idea as to where a strategy should be implemented. The paper must accomplish answering two questions. Is there a connection between alcohol and property crime? If property crime in general can be connected to alcohol, is the property crime in Winona the result of alcohol?

Background

City of Winona Demographics

The City of Winona is located in Southeastern Minnesota. The city is built on a sand bar with the Mississippi River to the north and picturesque bluffs to the south. The economy is supported primarily by education and industrial engineering. Winona State University, Saint Mary's University of Minnesota and Red Wing/Winona Technical College employ hundreds of people. The three schools combined bring over 8,500 students to the area. A number of factories produce products made from composite materials, fiberglass, galvanized metal and graphite. In 1996, the State of Minnesota Demographic Center estimated Winona had 26,612 residents and 9,992 households. In 1998, the estimated number of residents was at 26,590, while the number of households reached 10,033.

Alcohol and Property Damage

The first question to ask is whether or not alcohol influences a person to commit crime. Research suggests many people commit crimes under the influence of alcohol. Two theoretical explanations, for the connection between alcohol and crime, have been put forward. The first is a psycho-pharmacological explanation, which suggests alcohol use leads to a cognitive impairment. Alcohol chemically impairs the effective processing of stimuli. It is thought that alcohol use temporarily impairs an individual's ability to correctly recognize internal norms. Internal norms prevent a person from behaving inappropriately, allowing the submersion of impulses maintaining a sense of decorum. In other word, inhibitions, which are normally accessible, are no longer accessible (Hutchinson, 1999).

The second explanation, for the connection between crime and alcohol, is the Social-Psychological explanation. Alcohol becomes an excuse for poor behavior. Alcohol provides a socially acceptable excuse for aberrant behavior. The theory goes so far as to suggest drunken behavior is learned. As a society, we expect people to act more aggressive, as a result drunken individuals behave aggressively. Others see such behavior and it is assumed that type of behavior is acceptable. Since acceptable behavior is the model by which other are taught, it reinforces poor behavior (Parker, 1998).

An alternative view of this theory, based on economic theory suggests the inappropriate behavior is perpetuated because the costs of drunken behavior are relatively low. In essence, crime appears to be an externality to alcohol consumption. An intoxicated person is less likely to face the consequences of his

actions, than a sober person. A rational person will seek to maximize his utility. In the case of alcohol and crime, maximizing utility is a function of alcohol consumption and crime, which is affected by the tastes and preferences of the perpetrator (Markowitz, 1998).

The perpetrator maximizes his utility when total income is equal to the price of alcohol times the amount of alcohol consumed plus other goods consumed. The consumption of other goods is normalized at $1.00. Demand functions show that both alcohol consumption and consumption of other goods are functions of the price of alcohol and income. Crime is a function of alcohol consumption, thus crime can be substituted for alcohol in the equation, whereby crime is a function of the price of alcohol, income and tastes for crime. Part of the price of alcohol is the freedom from responsibility of an individuals actions. The price of aberrant behavior, therefore decreases while intoxicated .

Methods

Preparation of Data

Before analysis of the data could begin, a few steps were taken to prepare the data sets. The first step in creating a GIS to examine crime is to develop a database of crime. The City of Winona Police Department, (WPD) began storing their crime data in digital format in 1996. WPD issued the data in text format, which is also known as a .txt file. The data was converted to a database file, also known as a .dbf file, using Microsoft Excel. The data was converted to a .dbf because the Arcview, is able to read .dbf files most effectively. The data were formatted in such a way that Arcview was able to process the information correctly. For example, property damage at an intersection might be listed as “Main/3”, but Arcview processes intersections as “Main & 3rd”. Police officers often use landmarks rather than addresses to describe where an incident takes place. Street addresses were found for many of these landmarks. Once the database preparations were complete, the data were imported into Arcview for geocoding.

Geocoding is when a point coverage is created using addresses, which have a spatial reference or coordinates associated with each point. The point coverage visually depicts incidents of crime. In other words, it links an incident on the map to the place on the Earth where the incident took place. The base coverage should have the first address on the right side of the street and the last address on the right side of the street, as well as the first and last address on the left side of the street. The geocoding process will then look for the block that address should be on and match it to the correct location or possible locations. Geocoding is a rather complex process. The 1996 and 1998 property damage locations were geocoded, in addition a listing of all businesses holding a liquor license was geocoded.

After the records were geocoded, the first picture of where property crimes were located was produced. The picture at first glance was pretty bleak. The number of incidents was too overwhelming to identify a specific pattern. The data set was too large and needed to be subset. A query was run to select incidents by month. A new shapefile or point coverage was created from the selected records.

The data were classified according to season. Winter consisted of December, January and February for calendar year 1996 and 1998. Winter, as characterized by this study, was not continuous. In other words, a normal winter would be classified

by December 1995 and January and February of 1996. Ordinarily, it would have made more sense to categorize Winter as December 1995, January 1996 and February 1996, however, data were not available for 1995. Spring was March, April and May. Summer was June, July and August. Finally, Fall was categorized as September, October and November. Limitations on time and space only allowed for the analysis of the spring season for both years.

Creating a Model

Since the goal of the study was to gage the influence of businesses with a liquor license on property crime, a liquor license coverage was created. The addresses and type of liquor license were provided by the clerk's office. The addresses were geocoded to create a point coverage. "Neighborhoods" were created from a series of assumptions.

A number of assumptions, based on a rational model, were used to create the neighborhoods. First, assume a rational bar patron would walk to the bar, if his home were within a 200 meter radius from a given bar. 200 meters is roughly two city blocks. As a result, a neighborhood was created with a 400 meter diameter around each bar. Assume a rational bar patron would have a designated driver, if he would decide to go to a bar that was further away. One must also assume the designated driver would have the ability to control the behavior of the bar patrons and influence their decisions, in such a manner, that all engage in legal behavior.

It is established that alcohol has a connection to crime. Next, a connection between alcohol and property crime in Winona must be established. This can be established through examining the spatial relationship between crime and proximity to businesses with an on-sale liquor license. GIS offers a number of methods to test whether or not a relationship may exist.

Methods of Analysis

Four methods of analysis were performed using three different software applications. The first software package, Spatial Analyst, was developed by the Environmental Research Institute; commonly known as ESRI. Spatial Analyst can be purchased from ESRI.

The second software package, the Hot Spot Extension, is available from the United States Department of Justice, free of charge. It is a customization of Spatial Analyst. As a result, the Hot Spot Extension requires Spatial Analyst. The final software tool, CrimeStat, was developed by a Ned Levine and Associates. CrimeStat was made possible through a grant from the National Institute of Justice. CrimeStat is also distributed free of charge. CrimeStat uses shapefiles to create graphical representations of crime statistics.

Spatial Analyst was used for a crime density analysis. The Hot Spot Extension, the Nearest Neighbor Hierarchical Cluster Analysis and K-Means Cluster Analysis, from CrimeStat, was used for hot spot analysis. Spatial Distribution Analysis was performed by CrimeStat; in addition to Distance Analysis.

The first method examines where areas of crime density exist. The Spatial Analyst Extension created a series of density maps.

The next method of establishing a spatial relationship is a hot spot analysis. A hot spot analysis was performed using the Hot Spot Extension, however it

appears a different algorithm was used to calculate the hot spot. The CrimeStat hot spots were different than the Hot Spot Extension. The nearest neighbor hierarchical spatial clustering routine and K-means clustering were calculated, using CrimeStat.

The Hot Spot Extension has a tolerance level from zero to one hundred, which allows an acceptable amount of property crime to be figured into the algorithm. Property crime is generally not considered to be the highest priority at many police departments. Crimes, which cause harm or injury to human being, are much more urgent than property crime. Changing the tolerance levels can show the progression of property crime from one area to another. Hot spots were calculated at tolerance intervals of ten. The higher the tolerance, the smaller the area of the hotspot.

Nearest neighbor analysis measures whether or not points are clustered or dispersed as would be expected on the basis of chance. Furthermore, this routine is a comparison between the average distance of the nearest neighbor by the expected random distance of the nearest neighbor by dividing the empirical average nearest neighbor distance by the nearest neighbor index. Ten statistics are calculated to arrive at the analytical conclusion; the sample size, mean nearest neighbor distance in meters, standard deviation of the nearest neighbor distance in meters, minimum distance in meters, maximum distance in meters, mean random distance, mean dispersed distance in meters, the nearest neighbor index, standard error of the nearest neighbor index and the z-test, a significance test of the nearest neighbor index.

This series of analysis groups the incidents with respect to spatial proximity. A significance level was set to 0.05 and the minimum number of points per cluster was set to ten. The significance level of 0.05 is a common confidence interval used in statistical analysis. This is a one-tailed test.

The minimum number of points per cluster was set to ten because it was the default setting. If too few points are selected, the number of clusters will appear inflated, because the test will result in numerous small clusters. The default value of one standard deviation from the mean was also selected. Again, this is a common statistical practice. The statistic is also hierarchical in the sense that first order clusters are treated as individual points to be clustered into second order clusters. The second order clusters are then also treated as points to be clustered into third order clusters. Put as simplistically as possible, the system searches for clusters of about ten incidents and groups them based on proximity.

The K-Means routine calculates the number of nearest neighbors. The k-nearest neighbor index compares the mean distance to the Kth nearest other point with a spatially expected random distance. K-Means partitions points into k groups. K represents the number of nearest neighbors. The default value is five, so five clusters will be identified.

It finds areas where the distance between the points within the cluster are small, but the distance between the k seeds is great. Small K will result in large cluster areas, whereas large K will result in smaller cluster areas. The clusters for 1996, were large, meaning the distance between the incidents was relatively small. In simplest terms, the incidents are divided into about five groups to create a cluster.

This method is different from the Nearest Neighbor Analysis in that it defines the number of clusters, as opposed

to Nearest Neighbor Analysis, which defines the number of incidents to create a cluster. The K-Means Clusters would probably be most effective if used when patrol beats were being redefined to combat property crime and Nearest Neighbor Analysis would be more effective to use if an area was being targeted regardless of the definition of patrol beats.

Spatial distribution statistics examine the spatial distribution of property damage. Spatial distribution statistics are classified as first order spatial statistics. The mean center and standard distance statistics define the arithmetic mean and the degree of dispersion of the distribution of incidents of property damage. Eleven statistics are calculated in this process. The sample size for each coverage was tallied. The minimum and maximum x and y coordinate values are calculated. The mean of both the x and y coordinates are computed in addition to the standard deviation of both coordinates. The standard deviation of the distance of each point from the mean center is derived from the coverage. Finally, a circular area is defined by the standard distance deviation (Levine, 1999).

The next routine of spatial distribution statistics, called standard deviation ellipses, defines the dispersion and orientation or direction of that dispersion. Again, this routine involves a number of specific calculations in order to come to a conclusion.

The final type of analysis is a distance analysis The median distance center is the point at which the distance to all other points is at a minimum. Seven statistics are computed to create the median center. The sample size, mean of both x and y coordinates, the number of iterations to derive the median center, the tolerance or degree of error for stopping the iterations and the median x and y coordinate (Levine, 1999). In theory, his point suggests either crime radiates from or moves toward this area.

Results

The data are interesting in the sense that a number of patterns, indirectly related to alcohol consumption, were discovered. Looking at data for an entire year, the mean number of incidents was two per day for both years The standard deviation of incidents per day was also two for both years. Ninety-one days experienced damage above the mean in 1998. Eighty-three days did not experience property crime. In 1996, seventy-nine days were above the mean

The number of incidents for both years decreased during the summer months and during the typical winter break or Christmas break. Considering the age groups engaging in property damage, the data suggests the number of incidents is higher, when the universities are in session. However, further research is needed to find conclusive evidence. January 12, 1998 was a bit of an anomaly. Twenty incidents of property crime were reported on that day. After discussion with local law enforcement, it is likely this anomaly correlates to a rash of vandalism by local youths. Spring had a high number of incidents for both years, which makes it the most interesting season. Property crimes for spring were examined more thoroughly, as a result.

Density Analysis

Winona State University (WSU) is used as a landmark in the following figures. It is located in the central part of the city. The downtown area, which is north of WSU appears to have the highest

density of property crimes for both years. The direction changed from an east-west pattern in 1996 (Figure 1) to a north-south pattern in 1998 (Figure 2). The size of the density polygon increased on the east-side the city, along Mankato Avenue, in 1998. More areas of density appeared on the west-side of the city in 1998. A small area of density was located just east and just west of WSU occurred both years.

Hot Spot Analysis

The Hot Spot Extension was used to identify crime hotspots. After hotspots are identified, a community oriented policing strategy can be applied. If WPD were to allow crime to exist at the 90% tolerance level, very tolerant, based on the 1996 data, they would be using their resources most wisely by implementing community policing strategies on Market Street between Third and Fourth Streets. If a tolerance level of 80% it would be wise to implement a strategy between Third and Fourth Streets and between Franklin Street and Walnut Street, in addition, to implementing strategies between Johnson Street and Washington Street and between Third Street and Fourth Street (Figure 3). Looking at the bars in the vicinity of the 90% tolerance level, WPD might want to contact Gabby's Bar and Grill for input on how they can work together to decrease the amount of property crime in the area.

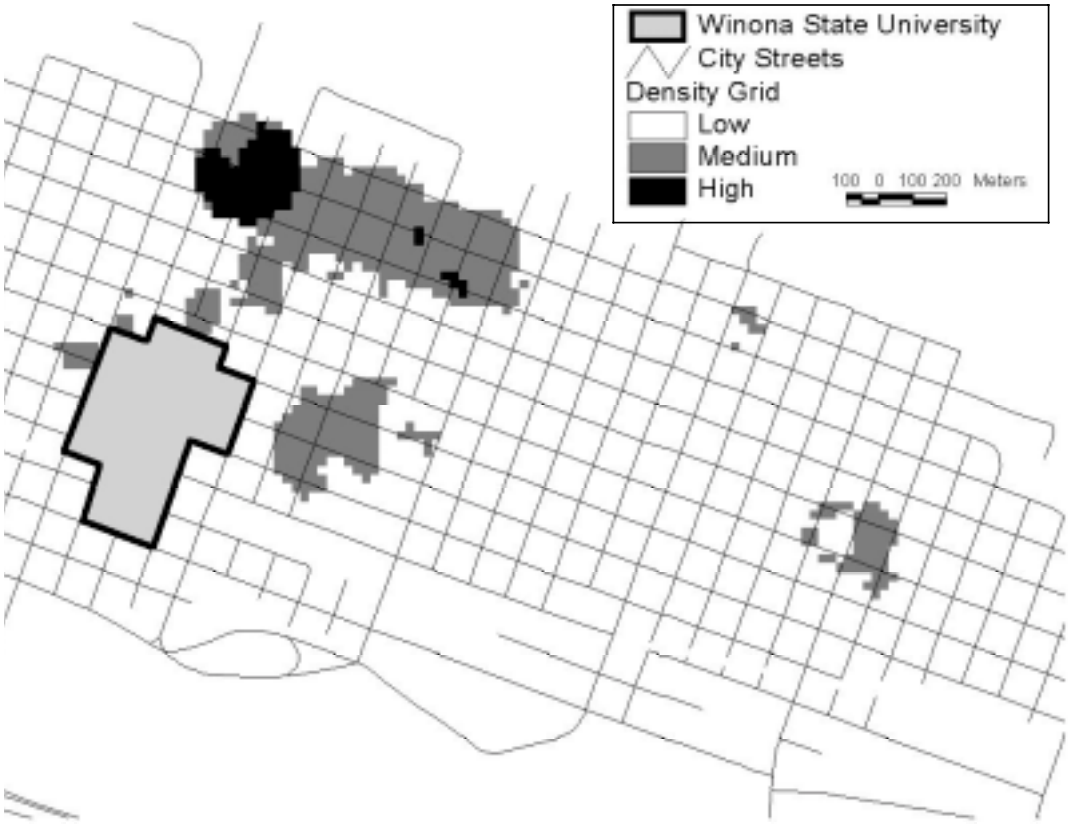

Figure 1. Property Crime Density for 1996

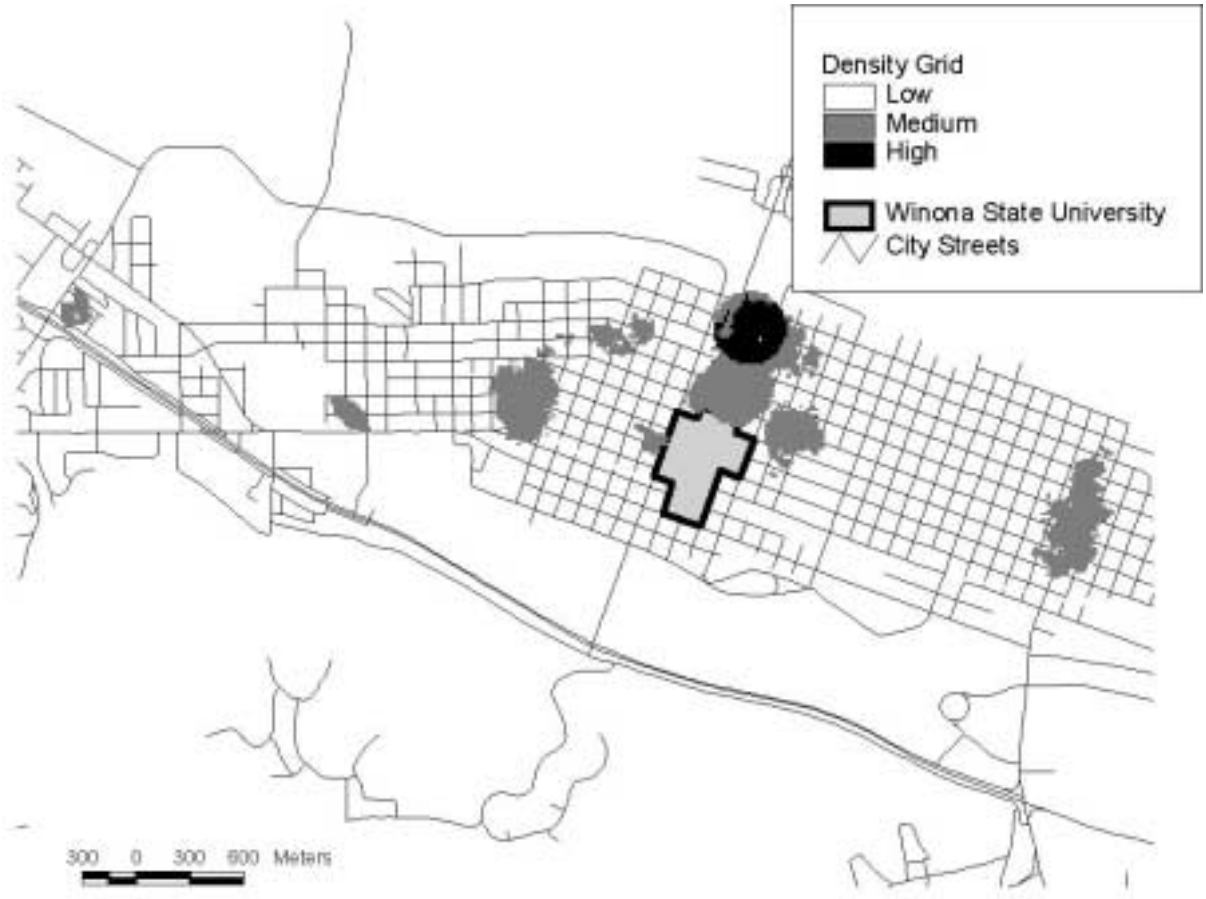

Figure 2. Property Crime Density for 1998

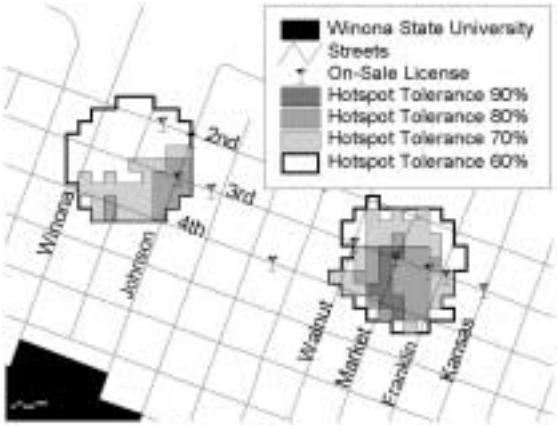

Figure 3. Property crime hot spots set to tolerances of sixty through ninety using Department of Justice Hot Spot Analysis Extension for Spring 1996.

The Hot Spot Analysis Extension polygons for Spring of 1998 were very interesting. The 90% tolerance level for spring of 1998 shows a hot spot between 2nd Street and Fourth Street and Johnson Street and Winona Street. The 80% tolerance level for that area does not change. The area of the 70% tolerance level changes the shape and size of the polygon, and the 60% tolerance level is the same size and shape. I believe this indicates numerous incidents at the same addresses, rather than numerous incidents in the same area. In other words, such a pattern is probably caused by multiple incidents at the same address, as opposed to multiple addresses of incidents. When the number of incidents per address were tallied, it validated my assumption (Figure 4).

The nearest neighbor clusters are a representation of another type of hotspot analysis. The Nearest Neighbor Analysis created with CrimeStat looks similar to the Hot Spot Analysis Extension hotspot at a tolerance of between forty and fifty. The

Figure 4. Hotspots with the same area at different tolerances are the result of multiple incidents at the same address.

Hotspot A is located near the Law Enforcement Center. Hotspot B is located between 3rd and 4th Streets. Hotspot C is east of WSU (Figure 5). Hotspot D is located between Mankato Avenue and Wall Street and between 6th and 9th Streets (Figure 6).

Figure 5. Nearest Neighbor Hierarchy for Downtown and East-central Property Crimes in 1996.

During 1998, the nearest neighbor analysis identified a hotspot near the Law Enforcement Center, on 3rd Street and Washington Street (Figure 7). Lincoln Street, between 9th Street and 10th Street was the location of a second hotspot, using the nearest neighbor analysis (Figure 8).

The overlay analysis of the nearest neighbor hierarchical clusters illustrates a

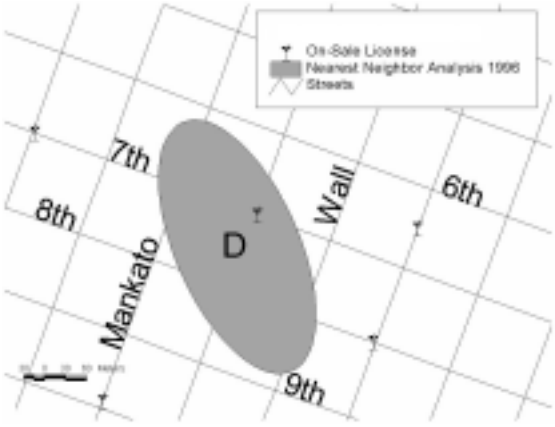

Figure 6. Nearest Neighbor Hierarchy for East-side Property Crimes in 1996.

far greater area where the cluster overlaps the bar neighborhoods. The bar neighborhood overlaps 82% of the 1996 clustered area, while the bar neighborhoods only overlap 22% of the

Figure 7. Nearest Neighbor Hierarchy for Downtown Property Crimes in 1998.

1998 clustered area (Figure 9).

K-Means Clustering resulted in five clusters of crime (Figure 10). Starting with the spring of 1996, the first cluster was on the west-side of the city. It was approximately 2,900 meters wide in a west-east direction and 850 meters in a north-south direction. It contained three businesses with on-sale liquor licenses, all

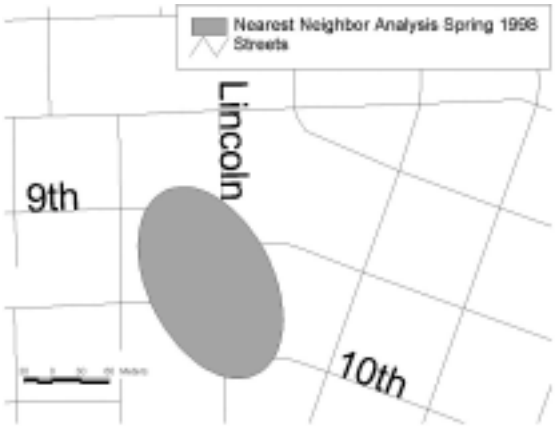

Figure 8. Nearest Neighbor Hierarchy for West-side Property Crimes in 1998.

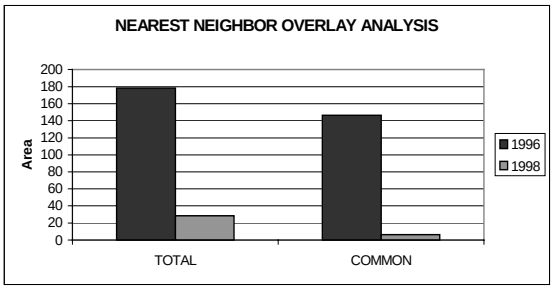

Figure 9. Nearest Neighbor Overlay Analysis Comparison. Common refers to the area in square meters the bar neighborhood overlaps the nearest neighbor cluster polygon.

of which were located on the eastern section of the cluster.

The second cluster was near Winona State University. It was about 1000 meters long running from northwest to southeast towards Winona State University. Interestingly enough, no businesses with on-sale liquor licenses were located in this cluster.

The third cluster is parallel to the second cluster and is northeast of the second cluster. It is similar in size to the second cluster. It contained ten on-sale liquor license holders.

The forth cluster is similar in size and shape to the second and third clusters. It is located on the east-side of the city. The forth cluster contains seven bars.

The fifth cluster was almost circular in shape. It was about 2,000 meters by about 2,700 meters. It only contained one on-sale liquor license. This cluster has the greatest area.

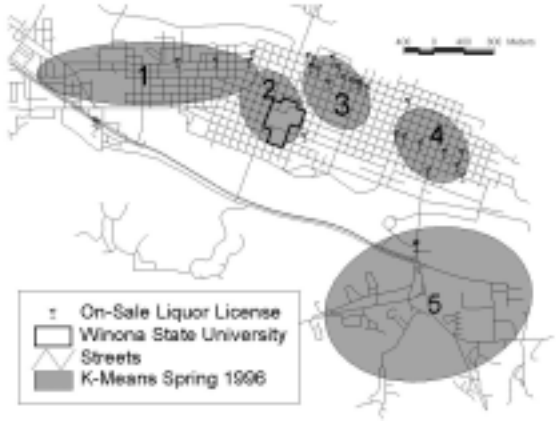

Figure 10. K-Means 1996

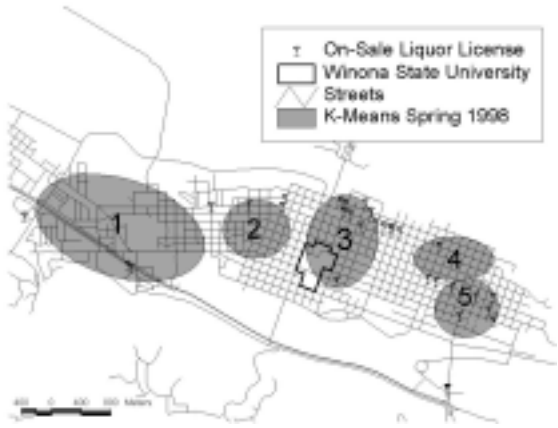

Figure 11. K-Means 1998

Overall the clusters for spring of 1998 are smaller than the clusters for spring of 1996 (Figure 11). The largest cluster is on the west-side of the city. It contained two bars.

The second cluster had one on-sale liquor license. It had three bars less than 300 meters away. It was the third largest cluster for 1998.

The third cluster occupied the area from downtown towards the eastern section of Winona State University. It contained six bars; three bars were on the border of the cluster and four bars less than 350 meters away from the cluster.

The forth cluster was the smallest cluster in the data set. It contained one bar. It was about 1050 meters from west to east and roughly 550 meters from northwest to southeast.

The fifth cluster for spring of 1998 contained six bars and two bars were less than 300 meters from the cluster. The shape was similar to a circle. The diameter was between 750 meters and 870 meters of the ellipse.

Spatial Distribution Analysis

The distribution changed from 1996 to 1998. Three possible explanations can be noted. First, the Winona Police Department began community oriented policing in 1995. It may have taken time before the strategies had an impact on crime. The second explanation is that a large number of crimes were attributed to Winona State University's Springfest celebration in 1996 and Springfest was not held in 1998. The final explanation, is that if college students cause most of the property damage, as an externality of alcohol use, then a cultural shift in the attitudes about alcohol use could have altered the distribution. In addition, Winona State University has been increasing standards, with respect to grade point average and admissions throughout the 1990's. Students with higher grade point averages usually consume less alcohol verses students with lower grade point averages. Therefore, a change in grade point average standards can have a positive externality on property crime, because the cost of alcohol consumption is increased.

The mean center for both years was located on the Winona State University campus. In 1998, the mean center was near the corner of Main Street and Sanborn (8^{th}) (Figure12). The mean center for 1996 was near the corner of Winona Street and Sanborn (8^{th}) (Figure 13).

The area the ellipses covered contained a number of bars. The 1996 ellipse (Figure 14) contained eighteen bars, with three additional bars near the border of the ellipse, while the1998 standard deviation ellipse contained sixteen bars (Figure 15). The ellipses cover slightly different areas.

The standard deviation ellipse for 1996 overlapped the neighborhoods by 27%, while 1998 was overlapped by 26%. In other words, about 26% of the area in the standard deviation ellipses were also part of bar neighborhoods (Figure 16).

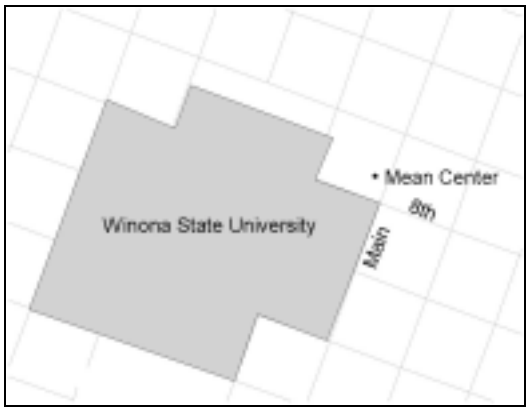

Figure 12. Mean Center 1998.

Figure 13. Mean Center 1996.

Distance Analysis

A number of general statistics were

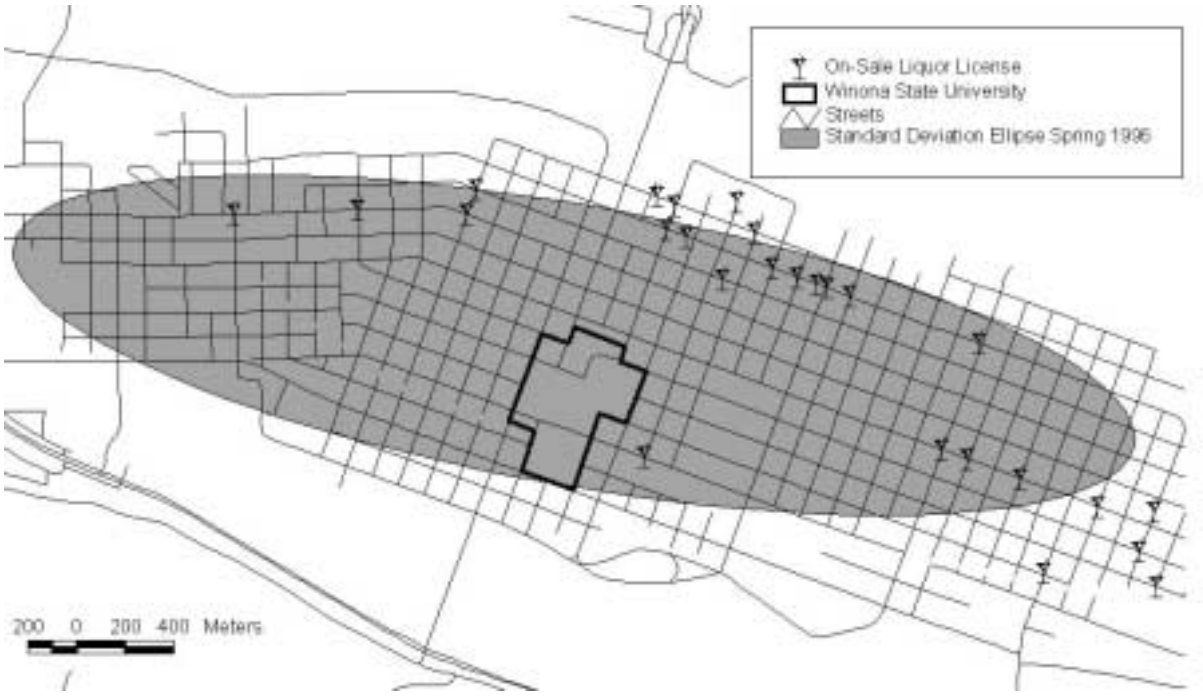

Figure 14 Standard Deviation Ellipse for Property Crime in 1996 for Winona, Minnesota.

Table 1 Distance Analysis Statistics. Statistics created from shape files using CrimeStat. All numbers in the table represent meters except sample size, which indicates the number of incidents included in the sample and Standard Distance Deviation, which is measured in square meters.

Statistic	1996	1998
Sample Size	199	171
Minimum X Coordinate	603136	604740
Minimum Y Coordinate	4874370	4876504
Maximum X Coordinate	611846	611312
Maximum Y Coordinate	4879151	4879190
Mean X Coordinate	608907	608620
Mean Y Coordinate	487132	4879190
Standard Deviation X Coordinate	1416	1620
Standard Deviation Y Coordinate	4878132	4878195
Standard Distance Deviation	1566	1699
Standard Deviation Circle	7711158 sq m	9069199 sq m

calculated with respect to distance. A minimum and maximum, mean and standard deviation were calculated for spring of both years (Table 1).
The median center distance, is the minimum distance to all other points. In 1996, it was located near 7th and Main Street (Figure 17). The median distance for 1998 was located on the Winona State University campus near, 7th and Winona Streets (Figure 18).

The standard deviation of the X,Y coordinates for 1996 , which was also part of a bar neighborhood was 982 square kilometers or 26% of the standard deviation of the X,Y coordinates for 1996 was also located in a bar neighborhood (Figure 19).

Figure 15. Standard Deviation Ellipse for Property Crime in 1998 for Winona, Minnesota.

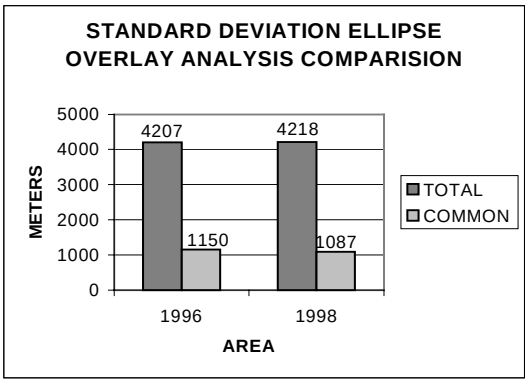

Figure 16. Standard Deviation Ellipse Overlay Analysis . Common refers to the area in both the bar neighborhood and the ellipse.

In 1998, 22% or 712 square kilometers of the standard deviation of the X,Y coordinates were located in a bar neighborhood.

The standard distance deviation overlay analysis shows and increase in total area between 1996 and 1998, however the increase between the area where the standard distance deviation ellipses for both years was very slight, with respect to raw numbers. Overall, however, the area percentage for 1998 decreased by 2% (Figure 20).

In 1996, the median center was one block from Winona State University, near 7th and Main. The median center for 1998 was on the Winona State University Campus, itself.

Figure 17. Median Distance of Property Crime in Winona, Minnesota for 1996. It is a method of measuring the center of incidents.

Figure 18. Median Distance of Property Crime for Spring 1998.

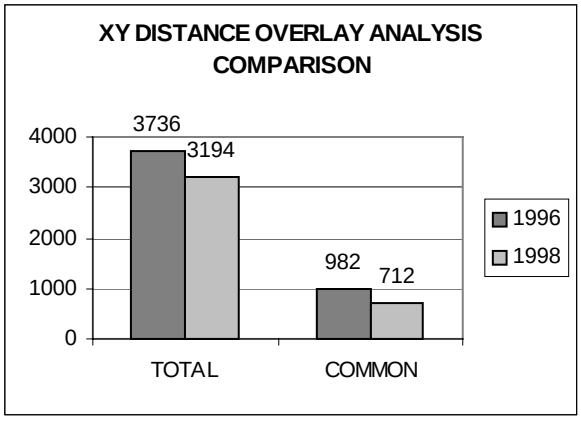

Figure 19. XY Distance Overlay Analysis. Common refers to the area in both the bar neighborhood and the ellipse.

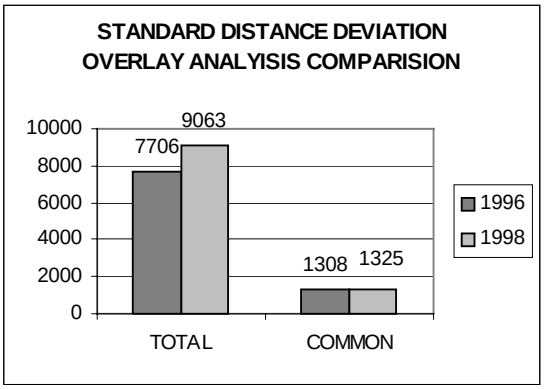

Figure 20. Standard Distance Deviation Overlay Analysis. Common refers to the area in both the bar neighborhood and the ellipse.

The data, which suggests Winona State University's relationship to property crime was far more interesting. Springfest, a Winona State University sanctioned event, had a reputation for students engaging in obnoxious behavior. The last several years the event was held, rumors circled that it would be the last year the party was held. In 1996, that rumor became reality. After years of disruptive behavior, the university stopped sanctioning the event. 1996 was the last year the party was held at Lake Winona.

On April 27, 1996, six incidents were reported and the following day, twelve incidents were reported. Judging from the number of incidents that weekend, it is very likely, the damage was caused by students (Figure 21).

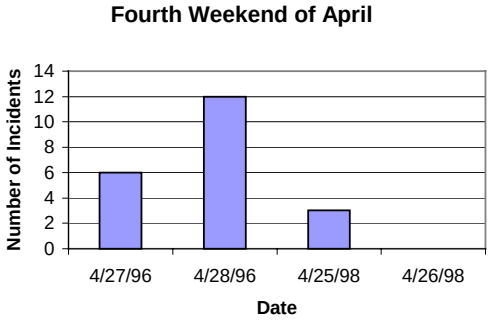

Figure 21. Reported Property Crime. Springfest was held the same weekend every year. It was held in 1996, but not in 1998.

The statistical center of a number of the coverages is on or near the Winona State University campus. It is probable that these are valid statistics, since a number of property crimes were actually reported on campus. These incidents were left out of the data set, because the addresses were not precise enough to geocode. The hotspot analysis seems to suggest a link between the bars and property crime. A great deal of property crime takes place downtown near the bars, however it also appears an evident amount of property crime takes place near the Winona State

University campus. Evidence suggests at least part of the property crime between Winona State University and the Downtown area could potentially be attributed to students. In 1996, when the hot spot extension tolerance is decreased to twenty-one, a pattern develops along Huff Street and along Main Street between Third and the Winona State University campus (Figure 22). The same cannot be said of the data for 1998. The point count data also displays an interesting phenomenon. Nine out of nineteen addresses, which displayed multiple property crimes were located in the bar neighborhoods, during 1996. Three of those locations were reported at bars or in bar parking lots.

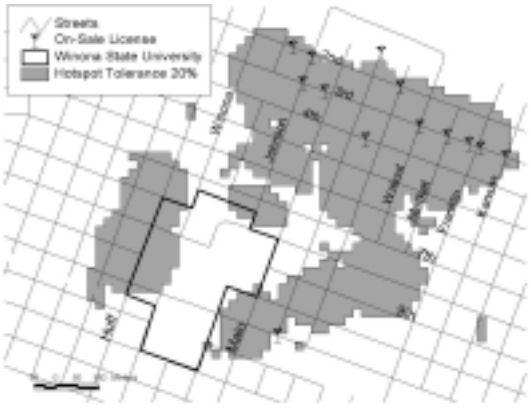

Figure 22. Hotspot at Tolerance of 21%.

During 1998, however, only one address, the Law Enforcement Center, out of six experienced multiple property crime reports. The Law Enforcement Center reported the greatest number of incidents for both years. This poses a significant error as a result of incident practices, because the address where the incident was reported is recorded, rather than recording the address of where the incident occurred (Williams, 2000). Four multiple incident locations were with in one block of Winona State University. Densities seem to appear on the far east and far west sides of the city.

Overall, it appears property crimes seem to be more clustered in 1996 and more dispersed in 1998. Property crimes increased between 1996 and 1998. In 1996, property crime appears to be less of an externality of alcohol and more of an externality of other factors. Winona State University has more than four times the number of students as Saint Mary's University. Therefore, the impact Winona State's students have on the community is going to appear greater than the impact than Saint Mary's students. It would be unfair to assume more property crime can be attributed to Winona State University students than to Saint Mary's University students, because the geocoding process fails to include Saint Mary's University, as well as the neighborhoods surrounding Saint Mary's University.

Winona State University is located in the central part of the city and the location of the mean center and the mean distance center may be more of a factor of location that student activities. In addition, the population density is probably greater in that section of the city, which would increase the likelihood of crime. Population density directly correlates with crime. Areas, which experience high levels of residential mobility, also have a tendency for higher rates of crime. Studies also suggest there is not a significant enough relationship between high concentrations of people between the teens and twenties and crime in general, however, property crime is the exception (Ellis: 2000).

Discussion and Issues of Error

A number of problems were encountered during the course of this study. A significant problem was related

to software conflicts. For a reason as yet unknown, the Windows 98 operating system created inevitable corruption of index files. This posed a serious problem. The index files are created during the geocoding process. Any shape file or point coverage, which uses the index files will become corrupt. The index files needed to be deleted or the work would need to be performed on a computer using the Windows 95 operating system. In deleting the index files, I would need to use the x,y coordinates to recreate the shapefiles or coverages. I was a bit apprehensive about the deletion of the index files, so I opted for working with the Windows 95 operating system. Trouble with software conflicts was not the only challenge encountered.

The data proved also to be troublesome. Although I did not expect to get perfect data from WPD, I did not think it would need so much work. A number of records were missing addresses or dates. Many of the addresses could not be geocoded because they were vague or unintelligible. A few examples include, listing intersections that do not exist because the streets run parallel, listing a street with no address or landmark, listings like "Franklin between 2nd and 3rd" and in one instance the address was listed as "w/m 10-15".

The base geocoding coverage was incomplete. Addresses were missing on entire blocks. Some blocks started with the same address the previous block ended with. Many blocks had addresses for one side of the road and not the other. The average street begins with 00 or 50, however some blocks began with other numbers. Subdivisions in the bluffs, which police reports were filed for, were totally missing from the base coverage.

Conclusion

In general it could be said that there is enough evidence to suggest on-sale liquor license businesses contribute to the property crime problem, however it appears some contribute more than others. Property crime may be more of an externality of the characteristics and attitudes of the bar patrons, than to the actual sale of alcohol. The large number of part time residents, the density of population, the age of residents and their occupation may be more telling of why property crime occurs where it does.

It appears the community policing measures, like foot patrols of Downtown have been relatively effective, judging by the decrease in crime Downtown. If WPD wants to reduce the number of property crimes in Winona, they should continue to target the Downtown Winona area and begin to more aggressively police the area between Winona State University and the area surrounding WSU. The east-side of Winona in the area just west of Mankato Avenue is another area worth targeting. In addition, WPD may wish to contact city hall for their perspective on how to further reduce property crime through more regulation of businesses with on-sale licenses. Ontario has a series of laws, which prohibit sales like happy hour or special discount nights (Cusenza, 1998). Prohibiting sales could result in a number of solutions. First, it would increase the cost of property damage according to Parker's model. Second, people may consume less alcohol, which would change their propensity for poor behavior. Third, it is possible that higher prices will mean

fewer customers and few bars. Businesses with On-sale licenses should also be contacted for input, as well.

Suggestions for Future Research

Over 300 coverages were created for this project, most of the data went unused. Themes for each month were created and hotspots in increments of ten were created with the Hot Spot Extension, making a hot spot analysis by month quite simple to analyze. Many more could have been created using the CrimeStat software. It would be interesting to look at more temporal patterns and find out the extent of the role university related events plays in property crime. It would be interesting to examine the calendars of Winona State University and Saint Mary's University in an attempt to correlate school events and property crime. A buffer of 200 meters around the Winona State University campus might, also, show some interesting results. In addition, examining data for other years would offer greater insight to the data presented in this paper.

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