Spatial Patterns of Motor Vehicle Theft in Beltrami County, Minnesota

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ABSTRACT

The purpose of this thesis is to develop a profile of motor vehicle theft in a jurisdiction consisting of both urban and rural landscapes. To this end the data were mapped according to season and zoning in the jurisdiction and examined for spatial autocorrelation using geographic information systems. The information is then used to address a current legislative issue being considered by one of the municipalities in the study area. It concludes that the criminal activity in question is likely due in part to gang activity and in part to opportunism on the part of individual thieves

INTRODUCTION

Traditional policing strategy focuses on calls for services and investigation of crimes that have already been committed, or are in the progress of being committed. As the concept of a civil constabulary is a relatively recent development (only around 200 years old) this has been the approach throughout most of history (Chamard, 2006). Traditional tactics still play a large role in modern police work, but they are by nature reactive; meaning the police do not initiate incidents.

In response to civil unrest in the late '60s and '70s reformers began to standardize and professionalize police forces nationwide. One of the key points of this reform was to change the nature of police from a crime fighting to a problem-solving role. This led to the development of more involved and active strategies for crime prevention.

Following the 2001 attack on the World Trade Center local law enforcement has experienced mission creep as municipal and county agencies are expected to devote time and resources to high-level threats such as terrorism that were once solely the domain of federal agencies. Consequently, agencies have turned to technology to better utilize their increasingly stretched resources.

Crime mapping is one such method. A subset of intelligence-based policing-practices which focus on predicting crimes- Crime mapping utilizes computer databases to process police reports for spatial patterns, identifying hotspots-concentrations of crime by a variety of factors including but not limited to, victim

correlations, time of day, address, location, and zoning. Compiled data is then analyzed for the most effective deployment of officers and suggest other efforts such as awareness campaigns. The most specialized and advanced crime-mapping systems such as the CompStat (Complaint Statistics) of the New York Police Department (NYPD) or NIBRIS (National Incident-Based Reporting System) allow Commanders to monitor incidents in real time (CompStat, 2013)

This is an exploratory study applying crime mapping to Beltrami County in northern Minnesota. Specifically, this is a study of spatial patterns of motor vehicle theft in the county. Beltrami County has a population of approximately 44,400 people three quarters of which live in the county seat, Bemidji, the rest is a large primarily rural area. The county has the highest crime rate in the Minnesota in addition to being one of the poorest in the state, therefore there is a great deal of interest in vehicle theft patterns are and whether they are opportunistic or predatory in nature.

LITERATURE REVIEW

Routine activities theory underlies much of criminal justice as a field, and as a framework for the application of police resources. Routine activities theory was put forward by Lawrence Cohen and Marcus Felson in "Social Change and Crime Rate Trends: a Routine Activity Approach (1997)." Routine activities theory states that crime will occur with a "motivated offender, suitable targets, and an absence of capable guardians" (Cohen & Felson, 1979). Motivated offenders are assumed given that without a criminal there can be no crime. Suitable targets are those that a

criminal finds worthwhile to offend against. Finally capable guardians are those environmental factors that dissuade criminal activity. A capable guardian does not need to be a person, surveillance systems; such as CCTV cameras can also be guardians.

Mapping crime to observe patterns is theoretically as old as professional police forces. Throughout the nineteenth and twentieth centuries almost every large police agency experimented with some form of mapping (Chamard, 2006). Historically maps were expensive, time consuming to produce, and often suffered from poor geometric accuracy, reducing departments to inserting pins in a wall map- this method can locate clusters of incidents, but is not very useful for any in-depth analysis.

In 1986 the National Institute of Justice and Chicago Police department began an experiment to adapt personal computers to the needs of their newly adopted community policing programs. The results, published in 1991 by Michael Maltz, Andrew Gordon, and Warren Friedman and as "Mapping Crime in Its Community Setting: Event Geography Analysis" proved that effective computer analysis of crime patterns was possible. The computers were capable of generating usable information in a timely manner for police strategists to use turning crime mapping into a viable practice. Based in part on the Chicago study the New York City Transit Authority Police (NYCTP) detective Jack Maple developed "Charts of the Future" a program designed to concentrate the department's few personnel where they would be most useful. Despite the lack of computers "charts of the future" utilized basic statistical analysis of trends, becoming the first intelligence-led policing model

(COMPSTAT, 2013). When the NYCTP merged with the New York Police Department in 1994-95 "Charts of the Future" was computerized and adopted citywide as "CompStat." CompStat combines complaints, police reports, and GIS to predict crime trends as they arise.

Crime mapping software experienced an explosion following its introduction. When Thomas Rich published "The use of Computerized Mapping in Crime Control Programs" in 1995 he found that 30% of police departments were making use of some form of crime mapping software. He surveyed 280 departments, 84 respondents replied that they were using software of some form, and that most had adopted it since 1992, but that significantly less were actually making use of the data to any great degree.

However in "Repeatable and Emergent forms: Searching for Crime Spaces and Crime Places" (2002) Leslie Kennedy notes that few agencies who initially invested in these systems retained them in any complex capacity. Many agencies only used the software to create a digital version of a pin map. Officers and administrators generally lacked the expertise to interoperate data into actual patrol strategies, or preform advanced statistical analysis.

Sharon Chamard in "The Adaption and Discontinuance of Computerized Crime Mapping by Municipal Police Departments in New Jersey" observed trends amongst departments who discontinued the use of crime mapping software. Most served a small population and employed less than 100 personnel (sworn and civilian), and had low crime rates largely negating the need for advanced analysis. A few departments found the systems too technically difficult to use-or were straight

incompatible with the force's database. In contrast forces that used crime mapping regularly tended to be large (over 100 officers) or have high crime rates. Agencies that adopted crime mapping were predominantly urban.

In 1991 the Waveland Press published Environmental Criminology (Brantingham & Brantingham, 1991), which outlined the spatial elements of crime. The book emphasizes that crime mapping is concerned with four elements of criminal behavior. Location, the setting a crime occurred in, place, weather, time of day, and traffic. Offence, the crime committed. Target, victim information, this may be demographic, or the object of a theft. Offender, any known characteristics about the criminal, this too may be demographic, or the crimes they commit.

In 1999 "The spatial patterning of county homicide rates: an application of exploratory spatial data analysis" by Messner, Anselin, Baller, Hawkins, Deane, and Tolnay Became one of the first studies to examine rural crime patterns using geographic information sciences. These researchers examined homicide rates in the St. Louis Metropolitan statistical area. They found that in rural areas crimes do not follow the same patterns as urban areas due in large part to a diffuse population. They also concluded that homicide rates are spatially related. The study advanced crime-mapping techniques by demonstrating that visual inspection is insufficient to draw proper conclusions and that global measures of spatial autocorrelation such as Moran's I eliminate detail from the map. Consequently this thesis was revised to use the Getis-Ord Gi* algorithm which preserves this detail.

In the article titled "Estimating the probability of local crime clusters: the impact of immediate spatial neighbors (Andersen, 2011)" used a variant of Moran's I

to known as local Moran's I to examine and conclude that neighboring areas affect and crime and are affected by the crime rates of their neighbors (Andersen, 2011). In other words the area adjacent to a given hotspot is more likely to experience crime associated with that hotspot than areas that are farther away.

There are a few studies that have been done and are similar to this proposed study "A Spatial Analysis of Criminal Effort: Auto Theft in Newark, New Jersey" by Marissa Potchak, Jean McGloin, and Kristen Zgoba (2002) examined the distances criminals traveled from their residences to the site of their crime, as a measure of motivation and effort in deciding to commit a crime. The study showed that automobile theft is more likely the less distance a criminal had to travel, and hence less work required stealing a car. This indicates thieves are opportunistic in nature. While there is no direct equivalent in this study, certain patterns are expected if thieves are primarily opportunistic in targeting vehicles.

Similarly, "Getting Away With the stolen Vehicle: An Investigation of Journey-After-Crime" Yongmei LU (2003) focused on the behavior of thieves who have just stolen a car. This study found that most stolen vehicles are recovered close to the scene of the crime. Vehicles are often recovered within the same jurisdiction, though this may be an artifact of the difficulty of recovering stolen goods that have been transported great distances.

In 2010 Marissa Levy and Christine Tartaro published "Repeat Victimization: A Study of Auto Theft in Atlantic City Using the WALLS Variables to Measure Environmental Indicators." This is a comprehensive study that examines each factor from the WALLS model (Watchers, Activity, Location, Lighting, and Security") of

crime risk assessment. WALLS are essentially a set of features that all places share, with criminals theoretically targeting areas with few people, little activity, in a remote area, with poor lighting, and no little security. This study takes a place-oriented approach to automobile theft, asking, "What does a target look like?" This Atlantic City study found that lighting levels and the relative activity around a potential target make little impact on theft, how secure the target is, number of potential witnesses, and above all where the target is situated made the most difference.

There are a few gaps in the literature regarding automobile theft and crime mapping. There has been little work focused on mapping crime in rural communities.

RESEARCH QUESTION

This is an exploratory study of the patterns of motor vehicle theft in Beltrami County, Minnesota. The jurisdiction in question consists of the county seat, Bemidji, with a population of around 13,400 and several small towns with populations ranging from around 700 to Funkley with a population of five. The goal of this study is to create a spatial profile of motor vehicle thefts in Beltrami County. Specifically of interest is determining the areas of the county that are hotspots for this sort of criminal activity, and determining what sorts of neighborhoods are more vulnerable. Additionally this study sought to determine if the patterns change at different times of the year. The relationship between loss and recovery locations

was a subject of interest, however that information was unavailable due to inconsistent recording practices.

CLASSIFICATION

Ambient Population the year-round residents of an area

Car Cars are "passenger vehicles designed to carry 15 persons or less." This class includes all sedans, coupes, compact cars, subcompact cars, hatchbacks, etc. a car generally does not stand as tall as the armpits of an average person (Minn.Stat.168.002.Subd.24.(a).

Coldspot Cold spots are areas of unusually little activity. The base threshold for considering a coldspot was a p score of 0.05, meaning a 95% certainty that the absence of a cluster was not random.

Global A global measure or Process is one that applies to the entire study area. Global measures are calculated for the entire information set or study area.

Hotspot A hotspot is an area of unusually high concentration of events. The base threshold for considering a hotspot was a p score of 0.05, meaning a 95% certainty that the cluster was not random

Local A local measure or process applies to each location of interest. Local measures are useful when different processes may be at work in different regions of a study area.

Luxury Vehicle Luxury Vehicles are those that serve primarily as a status symbol. A luxury vehicle was defined as one that cost $75,000 new, and is generally

recognized as such. A Cadillac, Rolls Royce, or Bentley would all classify as luxury vehicles, but a stolen bulldozer would not.

Minivan A minivan is a vehicle shaped like a van but designed primarily for carrying passengers.

Motorcycle A motorcycle is a two wheeled motorized vehicle. This class includes the vehicles colloquially known as mopeds even though no mopeds were present in the study population.

Motor Home Any vehicle permanently modified to provide temporary living accommodations (Minn.Stat.168.002.Subd.17.(a)).

Motor Vehicle Theft Taking a Motor Vehicle (i.e. self-propelled ground transport) without the owner's permission (Minn. Stat. 609.52. Subd. 2. (17)).

Neighborhood for the purposes of this study 'Neighborhood' means any generally recognized area where people reside and/or do business. It is possible to have both

Opportunistic Crime Opportunistic crime occurs with little or no prior planning, an opportunity for crime presents itself and the offender(s) takes it.

Pickup A Pickup is a light truck consisting of a cab and box bed, rated for less than one ton (Minn. Stat. 168.002. Subd. 26.).

Predatory Crime Predatory crime occurs when offenders plan and seek out victims. Predatory crime often manifests as a certain good, location or group being disproportionately victimized.

Rural an area with less than 16 residences and/or businesses per square mile

Sport Utility Vehicle (SUV) A sedan built on a light truck frame, it can be either two or four-wheel drive.

Transient Population The population who are not year-round residents of an area, but frequent it from time to time.

Truck A truck is a vehicle used to transport goods of at least one ton. This class includes tractor-trailers and emergency vehicles. One emergency vehicle in the study population, it was built on a truck chassis.

Urban An area with 16 or more residences and/or businesses per square mile

Van A van is a light cargo-carrying vehicle, rated for three quarters of a ton, with an interior cargo carrying area integral to the cab (Minn. Stat. 168.002. Subd. 40)

All zoned areas were defined by the Greater Bemidji Area Joint Planning Board and cross-referenced with both air photography and site visits where practical. Zoning definitions comply with industry standards.

METHODOLOGY

For this study data were obtained from the Beltrami County Sheriff's office and Bemidji Police Department. The data in question were selected from the past 2009 through 2015, which are the most recent years for which it does not suffer from large numbers of incomplete records. The data in question included information about the date a vehicle was stolen, the location from which it was stolen, and the make and model. The number of adults and juveniles arrested in relation to each incident were also included, but not used for this study.

After aggregating the records from both agencies duplicate records were eliminated, this affected three records. Civil cases were eliminated. The databases used different means of recording the location of crimes, including postal code, by

distance from the nearest intersection, and place names. The data were corrected to use Postal addresses, which are the same as 911 service addresses in Beltrami County. The points were mapped, achieving 97% confidence in their placement. This placement is well within the acceptable placement rate of 85% (Ratcliff, 2004). The unplaced points were vehicles that were stolen from other jurisdictions and recovered in Beltrami County. Recovery locations were only available for the county that a vehicle was found in, and not consistently locatable to an address.

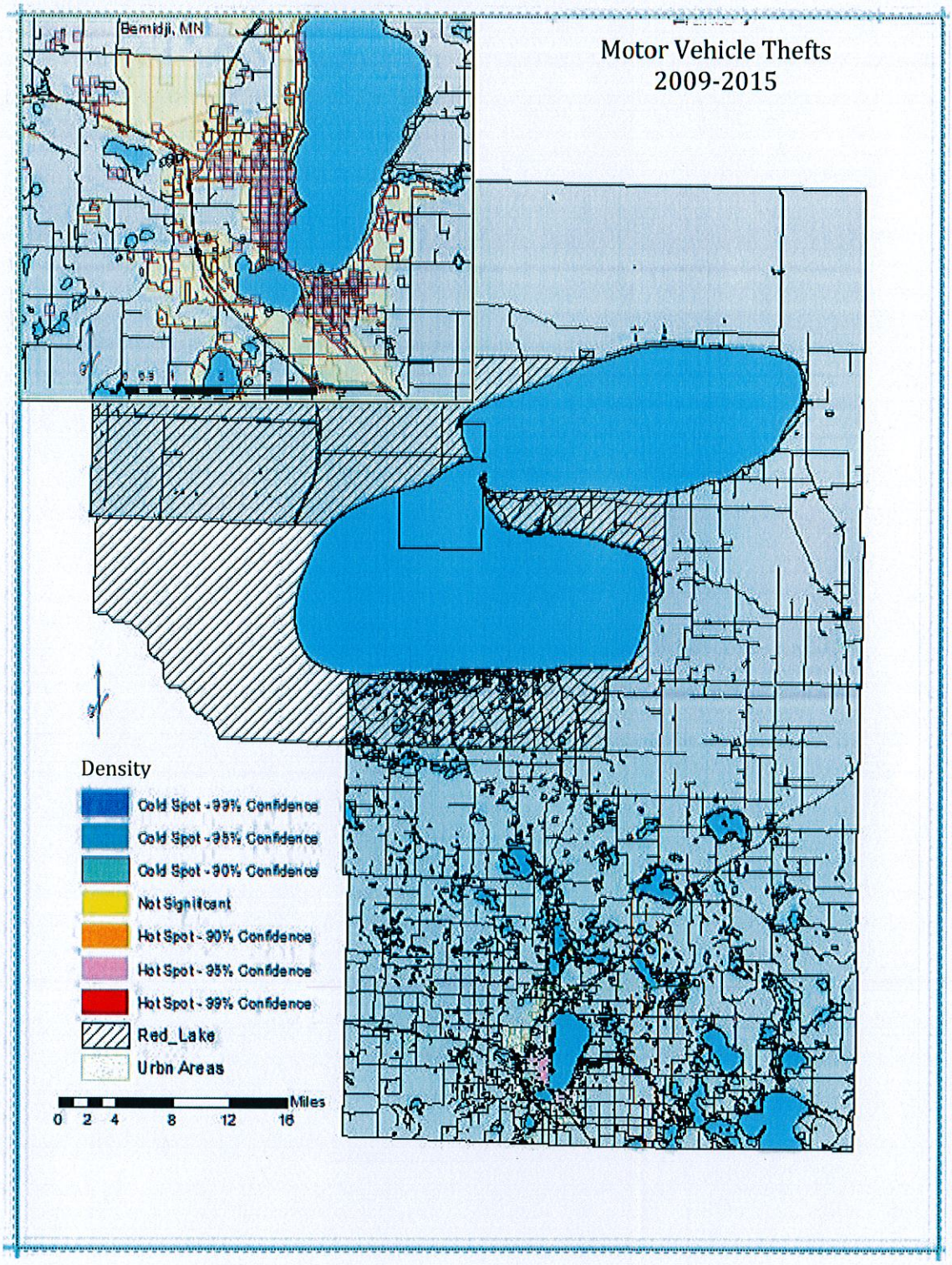
The points representing thefts were then consolidated into a grid of 300m x 300m overlay (approximately a two block area). Each grid cell was assigned a value of the number of theft locations that fell inside of it. The Getis-Ord Gi* algorithm was applied to the consolidated cells. Getis-Ord Gi* was chosen because it is a local measure, unlike Moran's I which measures an average statistic for the whole study area. Getis-Ord Gi* is therefor more appropriate to assess spatially disparate groupings for significance. Z scores represent standard deviations from the norm. P values are the probability that a given pattern could be produced randomly. A p score of 0.05 represents 95% probability that the cell is not random and therefore a hotspot. This is displayed in figure 1 as percent confidence. The software was set up to automatically apply p and z scores to each point in order to correct to eliminate false positives.

After inputting the addresses and applying a grid to the map computer software handled the calculations for each grid cell due to the large number of cells. The software utilized for this study was ARCgis 10.3. it is the industry standard for

Geographic information systems. Cells without any data have been hidden from view to facilitate map legibility.

FINDINGS

Fig. 1. Vehicle Theft Hotspots



As Figure 1 Indicates most hotspots (97) occur inside Bemidji or along the US highway 2 corridor. This is not particularly surprising as around three-quarters of the county's population lives in and around Bemidji itself. US highway 2 is the main thoroughfare through the county east-west. North of Upper and Lower Red Lake (the two large lakes in the north of the county) there has been no thefts, the area is a largely uninhabited nature preserve.

Hotspots are concentrated in the population dense area of the county seat, Bemidji. Particularly in the primarily residential area in the middle of town, although to a lesser extent the commercial district that composes downtown and retail along Paul Bunyan drive NW are also hotspots. Nymore, the urban area immediately south of Bemidji, and annexed into the city, houses a secondary concentration of hotspots. Nymore is overall more impoverished than Bemidji, and there is far less definition between commercial and residential areas.

Fig. 2 Thefts March-May

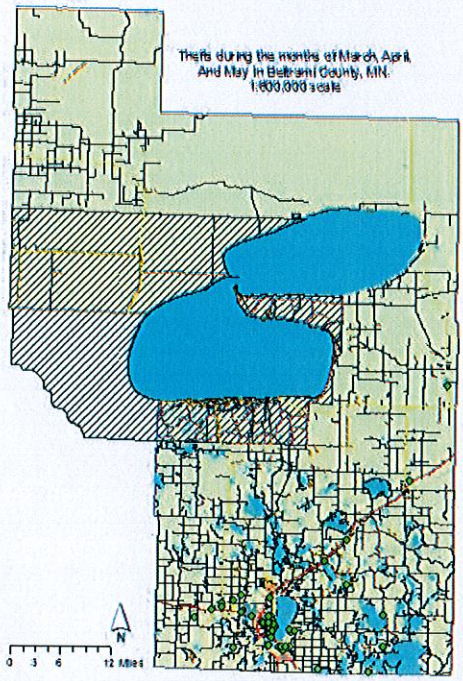
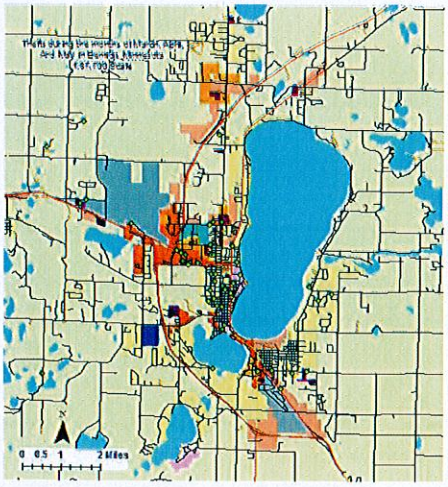


Fig. 3 Bemidji Thefts March-May



Interestingly, the areas north of Bemidji along the lake have no significant hotspots, excepting the intersection of Lake Avenue and Bemidji Avenue North, which is the location of a public fishing access. This is in contrast to the waterfront access, which is the noticeable absence of a hotspot in downtown Bemidji.

During the spring months of March, April, and May thefts tend to concentrate along US Highways 2 and 71, which run from Bemidji west, and north east respectively and for the major thoroughfares through Beltrami County. A lesser concentration can be found between Minnesota Highway 89 and US-71 north of Bemidji. Most Rural thefts occur along these three roads.

There were 11 thefts from light commercial areas and 30 from residential locations- residential meaning a single household per building, and 19 thefts from rural areas downtown experienced (see Appendix 1). Overall there were no significant changes in theft location or numbers from the rest of the year.

Fig. 4 Thefts, June-August

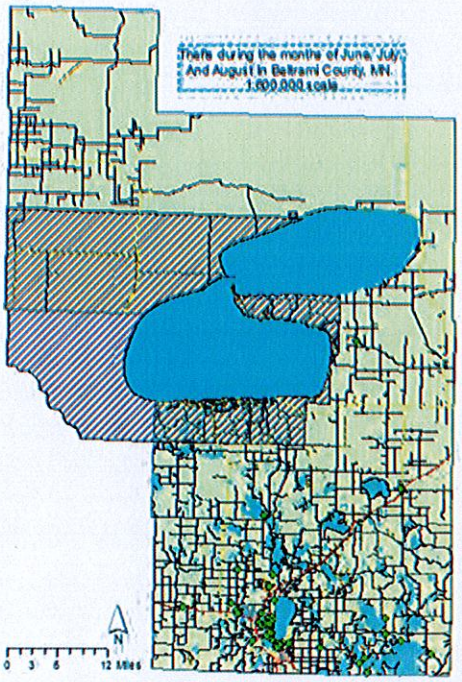
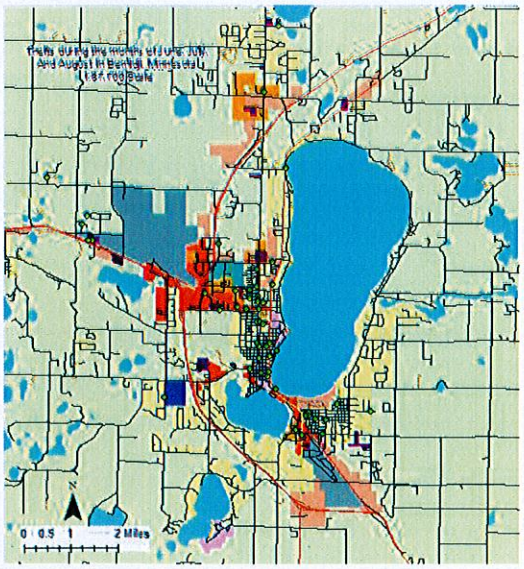


Fig. 5 Bemidji Thefts, June- August



During summer months (June through August) we see a significant shift in rural crime patterns (fig.4) but little in urban patterns (fig.5). The numbers of thefts in each zoning area change little. Light commercial areas do experience a small spike (Appendix 1) but given the small numbers involved the spike is likely not significant.

Rural crime patterns shift south from along US-71 to the lakes in the southeast corner of the County, this area is north of Cass Lake and there are a number of vacation homes in this area. These communities are satellites of Cass Lake, which is just south of the Beltrami County line; the town and surrounding area have a large transient population of tourists during summer months.

Fig. 6. Thefts, September-November

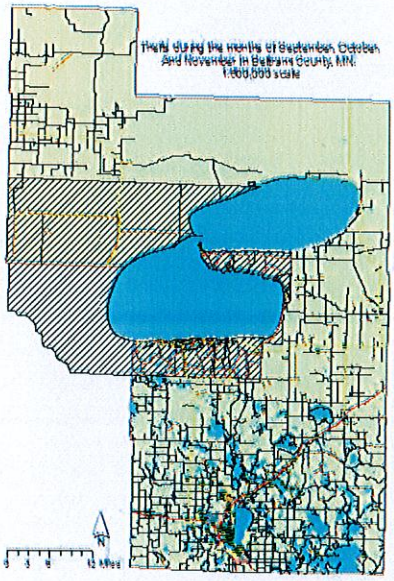
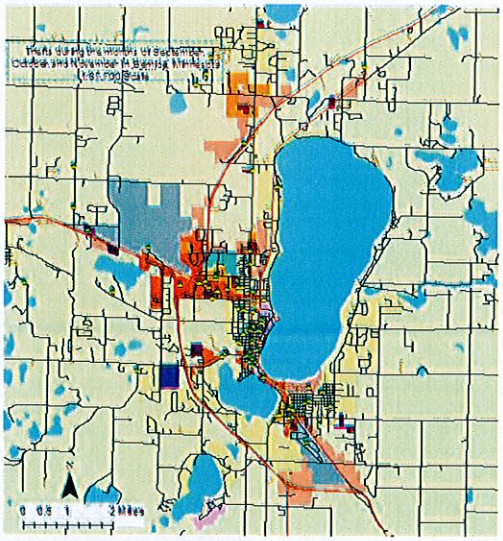


Fig. 7. Bemidji Thefts, September-November



The months of September through November see a significant spike in both the overall number of thefts, from around 72 to 92. And a shift in theft patterns in Bemidji downtown thefts spike, and those in apartment blocks rise from around one a month to about three, and remain that way throughout the winter. Rural thefts are rise significantly to 29 and are far more spread out, with occurrences both in the

Cass Lake area, and along US-71 and MN-89. Autumn theft patterns appear to be a combination of patterns observed during spring and summer, possibly indicating changing patterns with the weather.

Fig. 8 Thefts, December- February

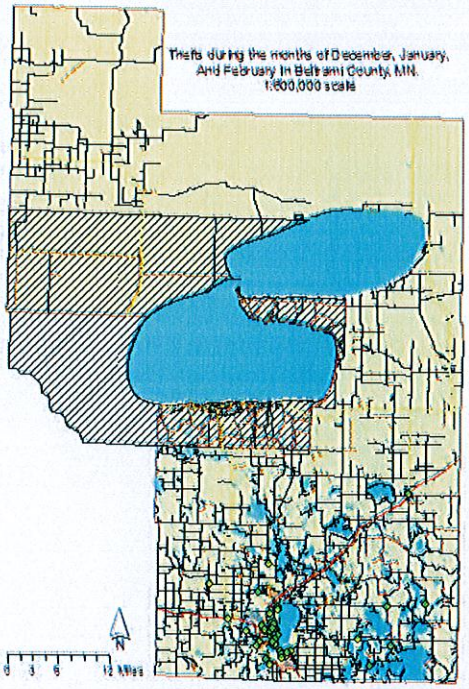
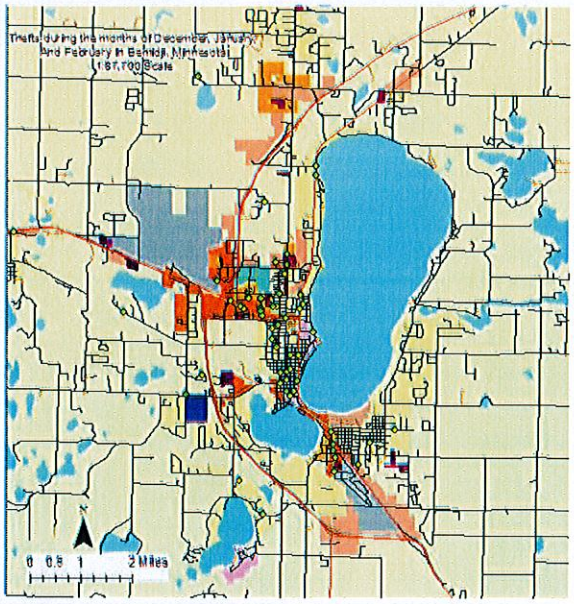


Fig. 9 Bemidji Thefts, December- February



During winter months (December through February) there is a slight decrease in rural thefts below the norm of summer months at around 14 incidents, commercial thefts are slightly elevated, as are those from apartments (see appendix 1). Rural thefts are diffuse, probably indicating that the crime sites are residences.

Residential thefts are closer to the downtown area and near to Paul Bunyan drive. Apartment thefts are primarily concentrated in the buildings north of Paul Bunyan drive. This area is made up of the larger multi-dwelling apartment complexes in town; these areas are collage students are known to use extensively.

Fig. 10 Vehicles by Classification

Type	Number Stolen
Car	149
Pickup	81
SUV	29
Truck	3
Van	6
MiniVan	22
Motor Hom	2
Motorcycle	4
Luxury	12

Fig. 11 Vehicles Recovered By County

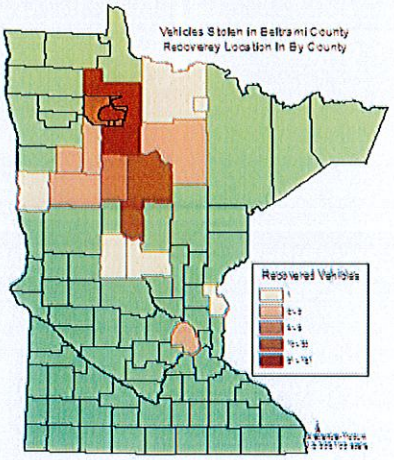


Figure 10 shows the breakdown of vehicles stolen by their classification. As discussed earlier the class of a vehicle is largely independent of what manufacturers market the vehicle as due to mixed classifications over time, and pluralistic badging practices.

Luxury vehicles made up a small percentage of those stolen, however further analysis showed nine of the 12 vehicles were Cadillac de Villes, primarily sixth generation. This indicates a predatory crime pattern with regards to luxury vehicles.

Figure 11 shows how many stolen vehicles were recovered from surrounding jurisdictions. In all 276 of those vehicles stolen were recovered, most of them within one month. When plotting the Location of vehicles recovered by county a radiating pattern emerged. The farthest recovery was in Chicago, Illinois but most were found in the Beltrami County. Beltrami County has had the most stolen vehicles found at 181, which is consistent with prior research findings. After Beltrami County, the next highest was Red Lake Reservation with 30, followed by Cass County with 28.

DISCUSSION

While traditional hotspot crime mapping is aimed at primarily identifying high-crime neighborhoods or locations and targeting response, this study is focused on exploring spatial patterns of vehicle theft.

Cars are the most commonly stolen class of vehicle. Followed by pickup trucks. In comparison SUVs and Minivans are taken one quarter as often as Pickup trucks and around one seventh of the time cars are. Vans and Trucks, which are commercial vehicles, appear to be very unpopular, as are motorcycles and motor homes. The most commonly stolen vehicles were as follows: Chevrolet Silverado (26), the Ford F-150 and its variants (11), and the Cadillac de Ville (9). The vast majority of stolen vehicles were models from between 1990 and 2005

Routine activity theory predicts that the areas that have higher concentrations of thefts would be those with more offenders, more targets, and fewer guardians per target. Beltrami County has four large transient populations, tourists in summer, College students, hunters, and visitors from the several surrounding Native American reservations who frequent Bemidji, which is the closest city. While licking exact numbers latter is presumed to be relatively constant throughout the year. Transient populations represent an increase in both motivated offenders and targets, and a comparative decrease in capable guardians. Additionally individual guardianship both tourists and hunters likely decreases as both perceive their relaxation environment to be less threatening.

The Spatial Patterns of Interest for this study are the shift in rural theft locations during the summer and large spike in autumn. There are few possible

underlying causative factors at work here including the Transient populations of tourists during summer months and of college students during the academic year. Consequently an explanation of the increased number of incidents may include the increased availability of victims. Alternatively residents, tourists, and students behave in different ways. Collage Students come back in late august and early September, which is roughly the same time we see a spike in vehicle thefts. Another possible explanation for the increase in thefts during colder months is that people may be running their cars and letting them warm up unsupervised, during which time the thieves come and take the vehicle.

Every autumn northern Minnesota receives a transient population of hunters from all over this and surrounding states. Beltrami County is no exception. Hunters often do not take vehicles deep into the wood but rather leave them a cabins or camps where they remain unattended during the day. Routine activities theory predicts this increase in unguarded targets would lead to an increase in thefts. This is the only likely major change rural areas undergo that could account for the large increase in vehicle theft. It seems highly unlikely that the vehicles of field hands would be stolen given they are often driven onto the work site and watched over by the workers.

During summer months the Cass Lake area has a large influx of tourists. There are consequently a number of vacation homes in southeastern Beltrami County. The increase in thefts in this area indicates that thieves are taking advantage of the easy target a relaxed tourist makes. This opportunism is further supported by the fact that Cass County has a high number of recovered vehicles in

relation to Beltrami County's other neighbors. This population increases is not accompanied by a proportional increase in police personnel, the result is a net decrease in capable guardians per suitable target. This shift in theft locations to areas where individuals are less on guard and

Spring and autumn theft patterns along main roads suggest opportunistic crime based upon first available targets. Large variety in the makes and models of stolen vehicles is also consistent with opportunistic crime. This indicates that no specific type is being targeted overall; rather anything that moves is stolen.

On the other hand there is a predatory crime pattern with regards to Luxury vehicles. Although only 12 luxury vehicles were stolen, 9 of them were sixth generation Cadillac de Villes. This strongly indicates this model is being targeted in an organized manner.

CONCLUSION

In conclusion, the spatial analysis of motor vehicle suggests largely opportunistic crime patterns, however the data suggest some predatory offending may be occurring. Beltrami County does not show indicators of organized vehicle theft crime, with the exception of luxury vehicles.

There is no singular profile of a typical theft, apart from the fact that the vehicle selected is very likely to be from the mid 1990s to late or early 2000s and a car of some description. The Chevrolet Silverado and Cadillac de Ville appear more likely to be stolen than other vehicles.

The comparatively high number of thefts from residential areas is likely due to the higher concentration of targets in these areas. Where there are more targets, one would expect to find more offences against these targets. The question then becomes how to make the targets less suitable. Conventional means of dissuading personal crimes such as streetlights have been shown to be ineffective of vehicle theft (Levy & Tartaro, 2010).

Enforcement efforts should focus on Residential parts areas year-round because these areas have the most thefts consistently. Seasonally in spring and winter thieves stick close to main roads. Summer enforcement resources should be focused in the southeast corner of the county north of Cass Lake, thefts in this area appear to be targeting tourists. In autumn, hunting season there is an increased presence of thieves in rural areas, which corresponds to the large population of visiting hunters; offenders are targeting their vehicles. In Bemidji during the cold weather months vehicles are more likely to be stolen downtown and from apartments then they are in summer months. Vehicles are slightly more likely to be taken from commercial areas. It is probable that these changes are due to the increased presence of suitable targets during these months.

These findings are consistent with the predictions of routine activities theory. There are more targets and possible offenders when transient populations are present.

The most important finding of this study may be the predatory thefts of Cadillac de Villes. Despite Luxury vehicles only being 12 out of 307 thefts the

prevalence of de Villes inside this class may indicate the presence of organized offending, either for direct resale, or for parts. This requires further investigation.

LIMITATIONS

The major issue with this research was the quality of the data available. The recording agencies' computer systems could not interface with one another, or neighboring jurisdictions. To compound the matter officers were inconsistent in their formatting. Point data, distances from the nearest intersection, place name, and surveying lots were used to record the location of offences requiring considerable effort to standardize addresses. Certain officers and even investigators would omit perceived non-vital information from their stolen property reports. Information on the time of day vehicles were stolen was unavailable due to poor recording practices.

One issue with this study is using hotspot algorithms on rural areas. Because in rural areas crimes are necessarily spread out, algorithms have difficulty picking up on larger patterns. Clusters become too big to be useful directing response efforts; the smallest regular rural unit area, the township, covers 36 square miles. Alternatively lose larger patterns to the fine details. A study area with both urban and rural suffers from an inability to find an all around useful cell size for both urban and rural areas, this study used two cities blocks as a compromise.

To improve data quality for future researchers I recommend a checklist. The airline industry has been using checklists for decades, and more recently medical practitioners have adopted the procedure. The result has been a noted decrease in

surgical complications (Gawande, 2010). Police departments, who are under similar pressure to avoid mistakes, should look at adopting the measure. Checklists help standardize the information and help avoid mistakes and forgetfulness.

Future research should focus on the time of day that vehicle thefts occur. Other possible areas of interest include rural thefts during hunting seasons Law enforcement data collection techniques. The predatory behavior on the sixth generation Cadillac de Ville requires Law enforcement follow up.

Data Sources

The data used for the study were retrieved from the databases of the Clearwater County Sheriff's Office and Bemidji Police Department Records. Zoning information courtesy of the Greater Bemidji Area Joint Planning Board and is available to the public upon request, or at their website http://www.jpbgba.org/.

Map base layers were created from publicly available road and political maps of the United States for use in GIS Applications. These layers are available from the United States Census Bureau and USGS.

References

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APPENDIX 1: SESONAL THEFTS BY ZONE

Location Stolen	Total	March-May	June-August	September-November	December-February
Apartment Block	19	0	3	7	9
Commercial	45	11	12	9	13
Downtown	20	3	3	9	5
Bemidji High Sch	0	0	0	0	0
Hospital	0	0	0	0	0
Light Commercial	8	1	4	1	2
Mobile Home Par	0	0	0	0	0
Trailer Park	17	5	3	5	2
Residential	116	30	28	30	28
University	3	1	1	0	1
University Land	0	0	0	0	0
Industrial	4	2	0	2	0
Rural	75	19	19	29	14
Total	307	72	70	92	74

APPENDIX 2: SESONAL MAP LEGEND

APPENDIX 3: MAPS

Figure 1. Vehicle Theft Hotspots

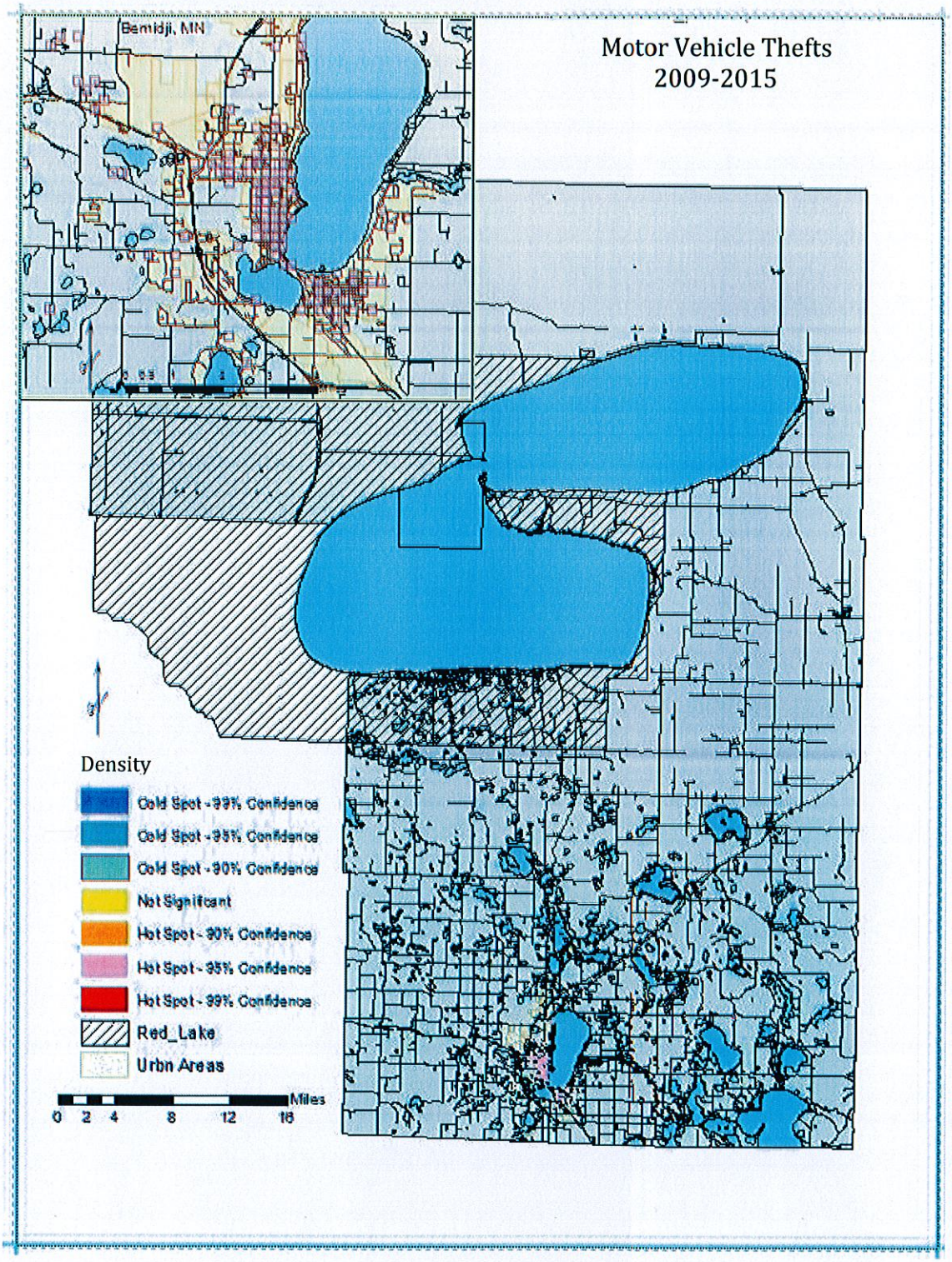

Figure 2. Thefts March-May

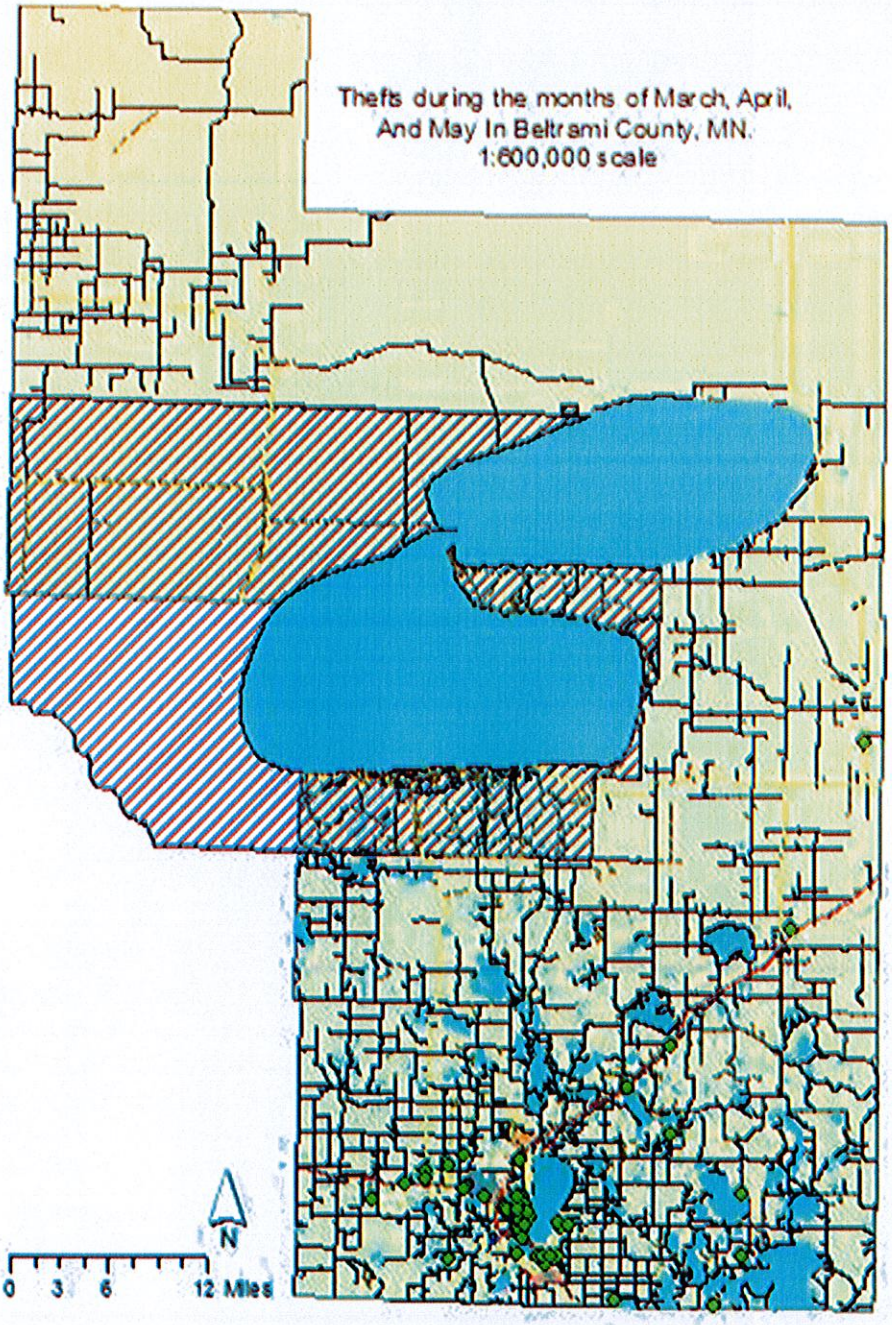

Figure 3. Bemidji Thefts March-May

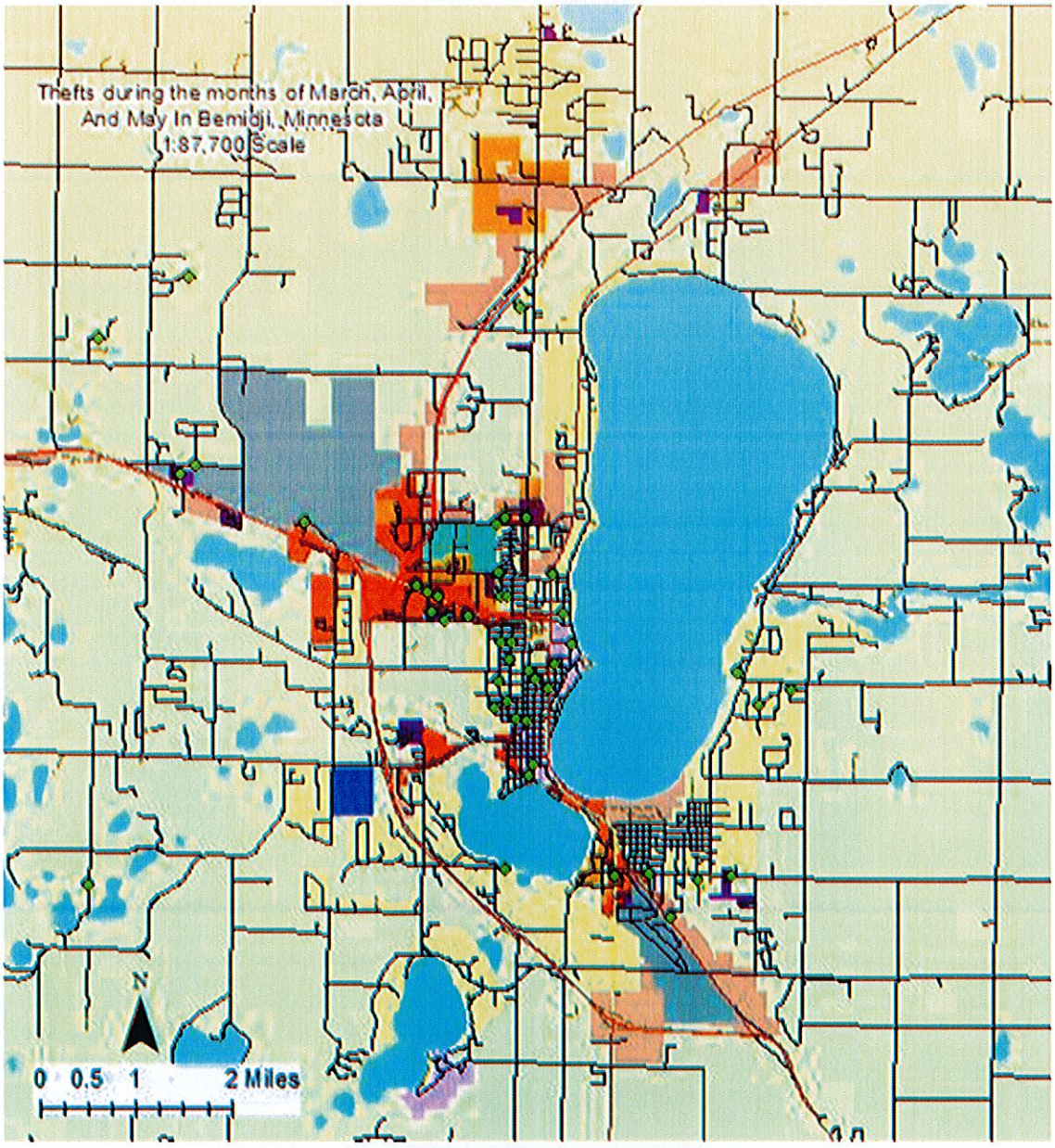

Figure 4. Thefts, June-August

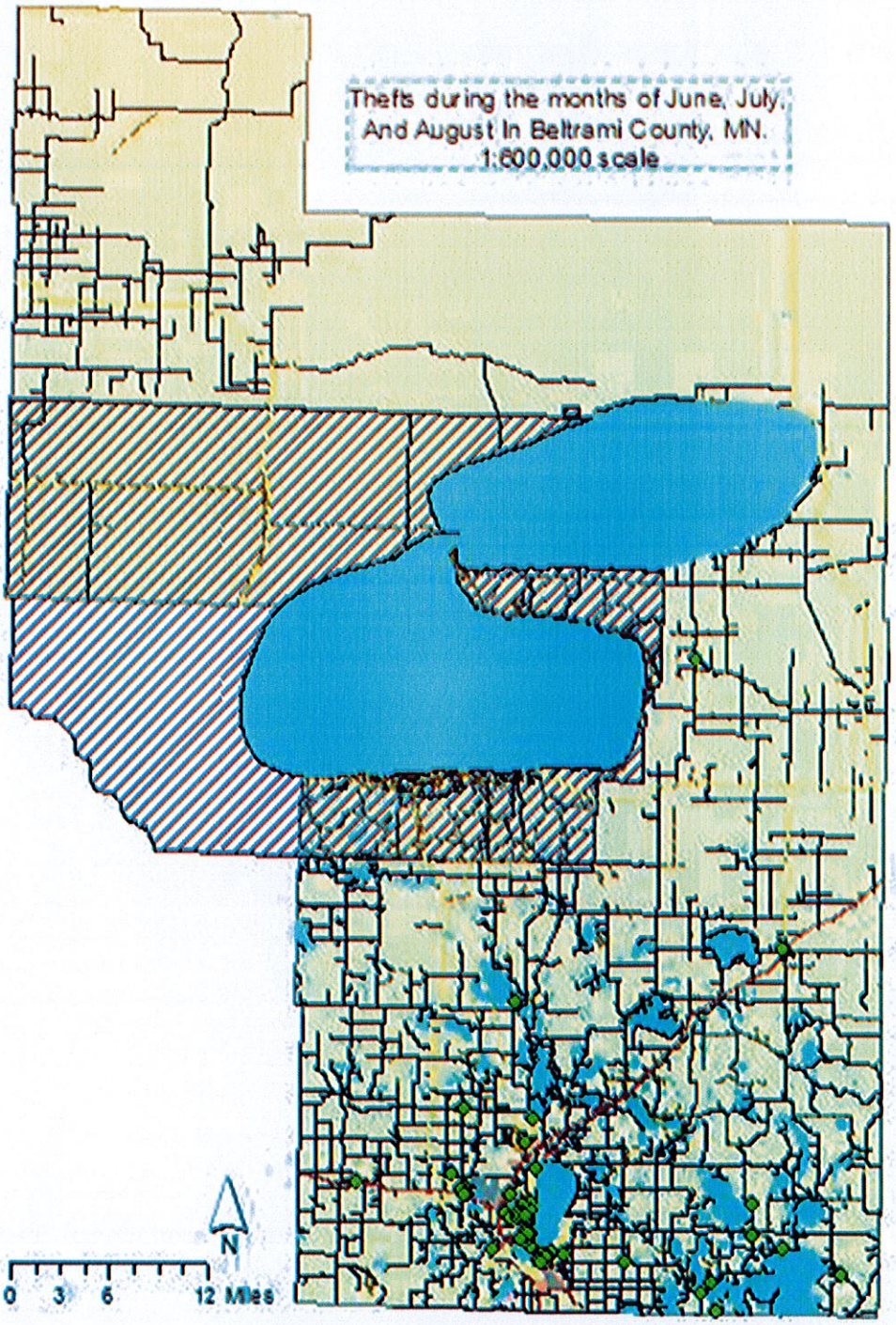

Figure 5. Bemidji Thefts, June-August

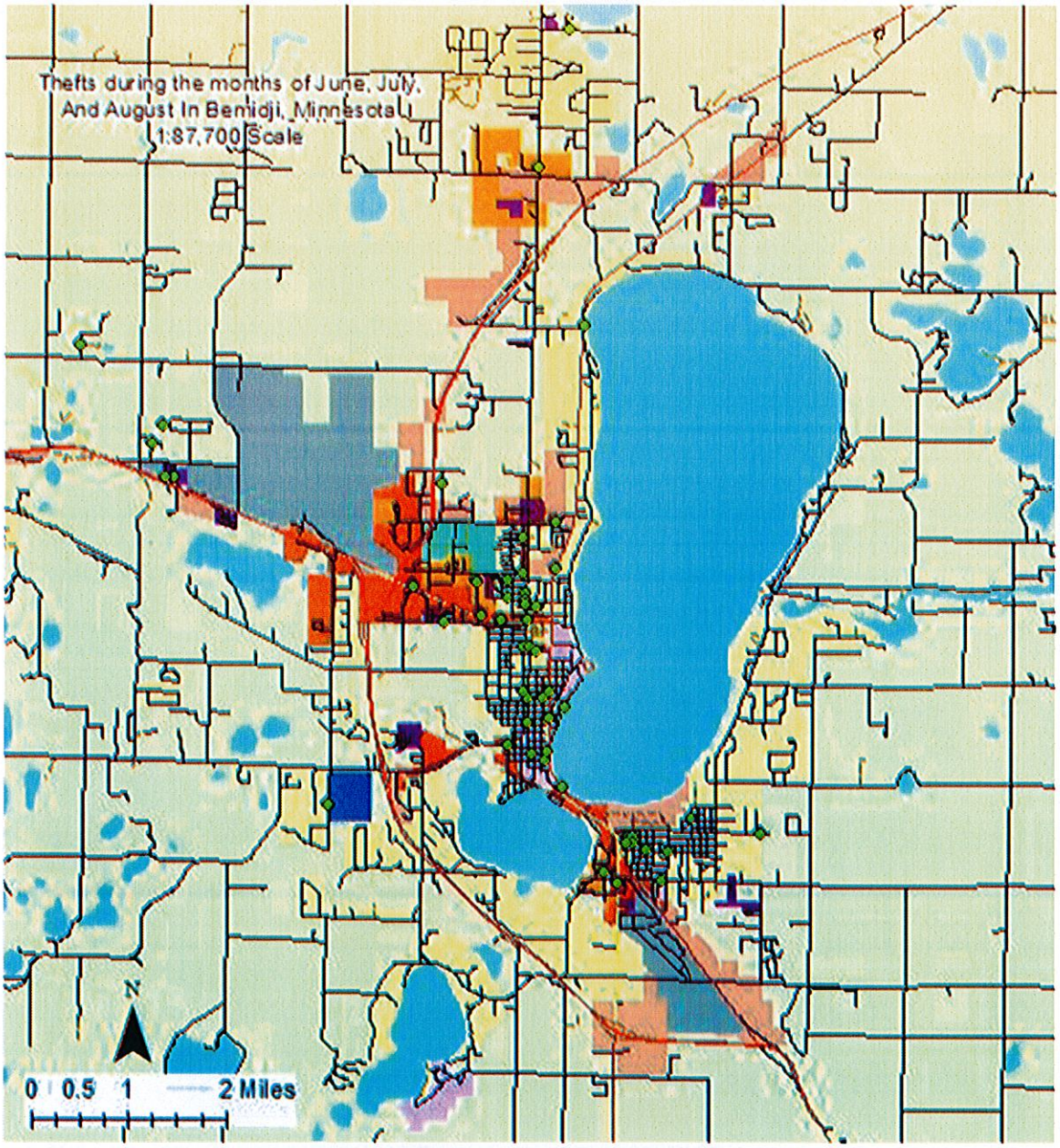

Figure 6. Thefts, September- November

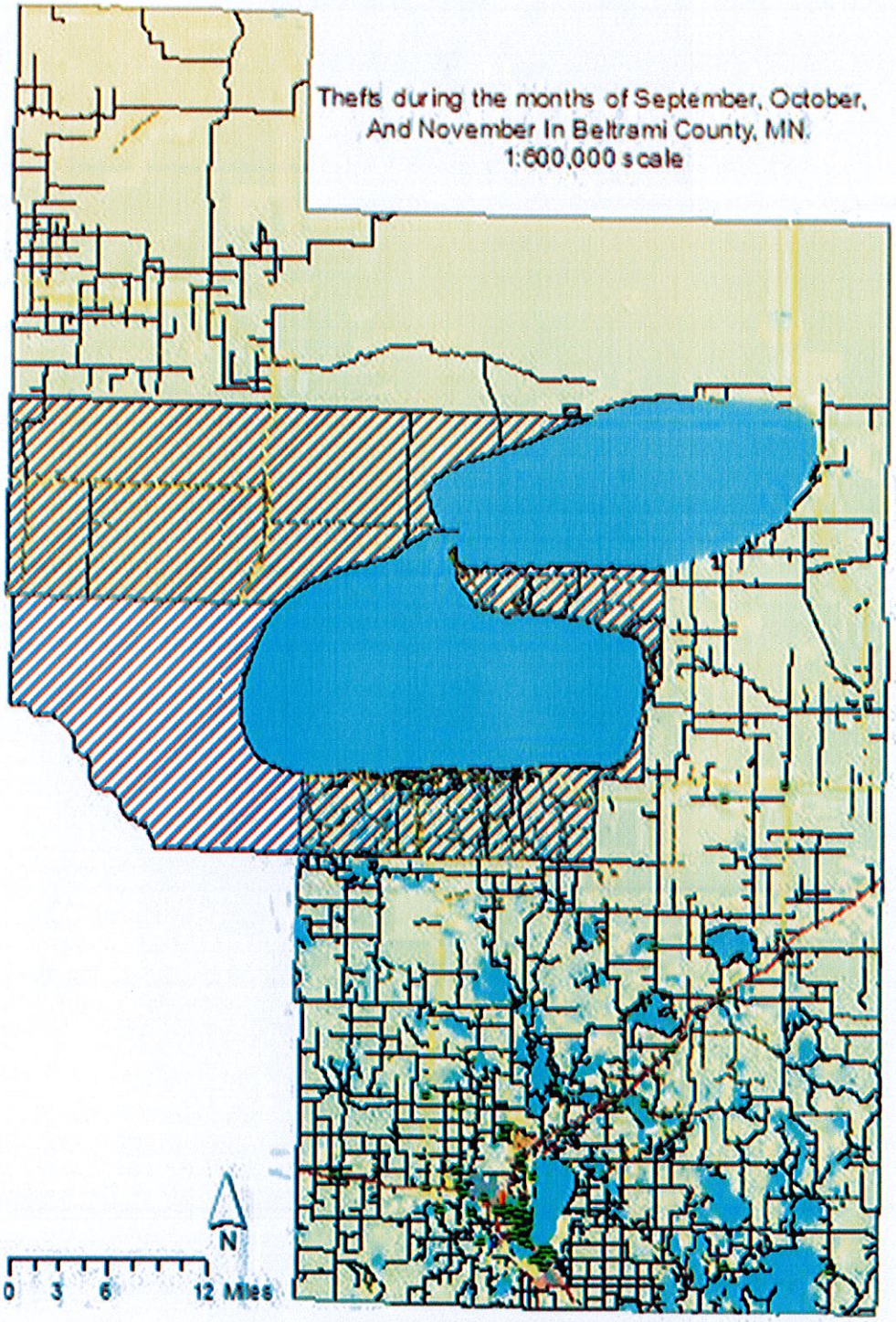

Figure 7. Bemidji Thefts, September- November

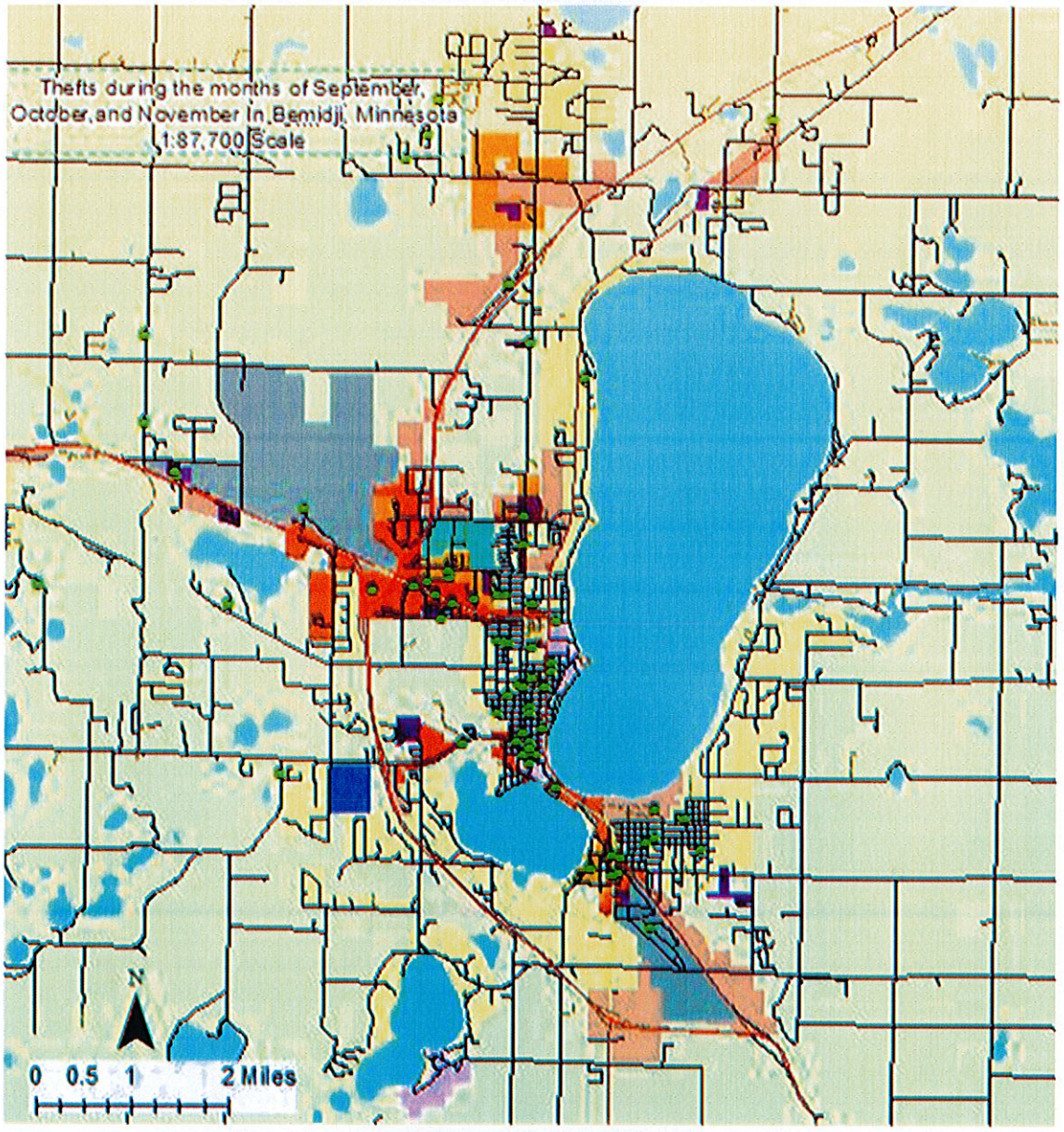

Figure 8. Thefts, December- February

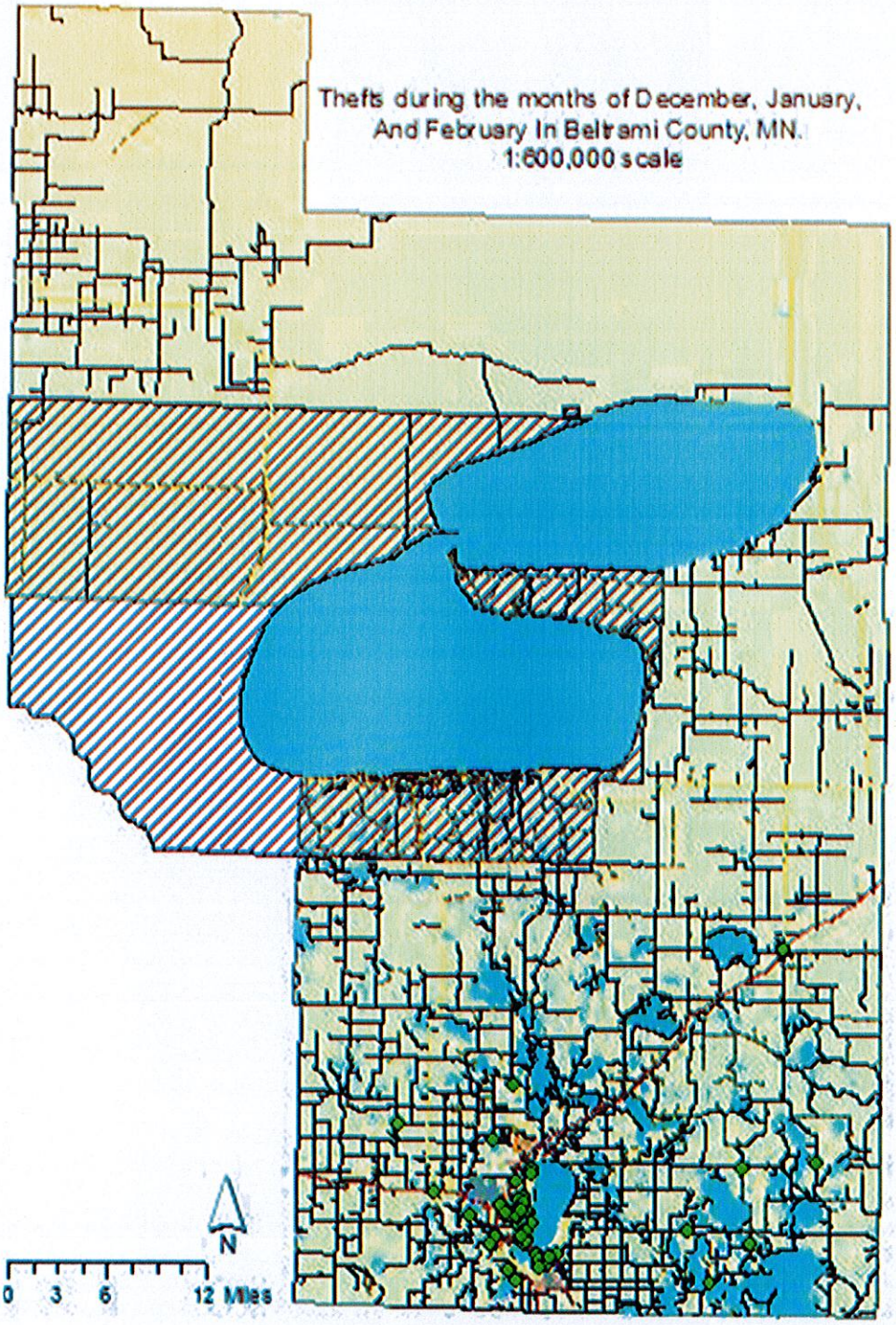

Figure 9. Bemidji Thefts, December- February

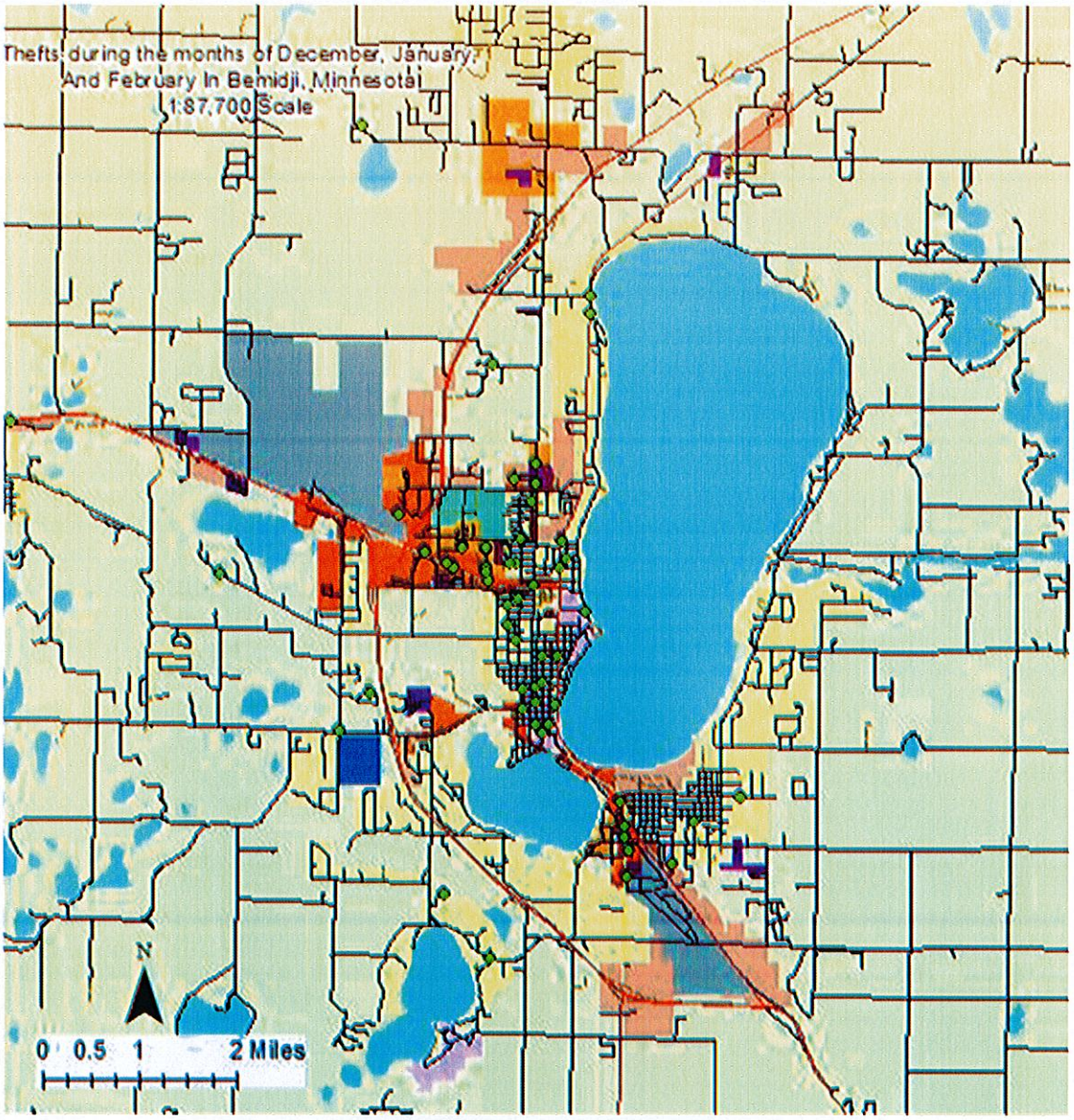

Figure 11. vehicles Recovered by County