

SPATIAL DYNAMICS OF SEX TRAFFICKING IN AUSTIN, TEXAS

by

Deborah Mletzko, B.S.

A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degree of
Master of Science
with a Major in Criminal Justice
May 2017

Committee Members:

Lucia Summers, Chair

Ashley Arnio

Donna M. Vandiver

COPYRIGHT

by

Deborah Mletzko

2017

FAIR USE AND AUTHOR'S PERMISSION STATEMENT

Fair Use

This work is protected by the Copyright Laws of the United States (Public Law 94-553, section 107). Consistent with fair use as defined in the Copyright Laws, brief quotations from this material are allowed with proper acknowledgment. Use of this material for financial gain without the author's express written permission is not allowed.

Duplication Permission

As the copyright holder of this work I, Deborah Mletzko, authorize duplication of this work, in whole or in part, for educational or scholarly purposes only.

DEDICATION

To my Lord and Savior who gives my life purpose, my amazing husband, and the brave men and women in law enforcement, non-profit organizations, and other agencies who fight for the victims and survivors of sex trafficking every day.

ACKNOWLEDGEMENTS

To my husband, I am forever grateful for the love, support, and encouragement shown to me. You are my best friend and true love. None of this would be possible without you at my side.

I am honored to have the love and support of my parents. The encouragement and drive you both have given me made this possible. I am also blessed to have the support of my brothers who believed in me every step of the way.

A special thanks to my thesis committee who made this all possible. Without their help, I would not have been able to accomplish this research. Their wisdom and guidance was essential to my success. With special mention to Dr. Summers, who pushed me to achieve more than I thought was possible and prepare me for my future.

Thank you to the Austin Police Department for providing the data for this study. The efforts of the analysts in retrieving this data are greatly appreciated. Additionally, thank you to the officers and detectives involved in the Human Trafficking Unit and their dedication to this issue.

Thank you to Redeemed Ministries, Allies Against Slavery, Refuge Services of Texas, and the Texas Attorney General's Office in speaking with us and providing insight into this research and the issue of sex trafficking in Austin, Texas. Additionally, thank you all for your efforts in combating this issue and your dedicated service to this state.

Special thanks are also due to the other graduate students, friends, and professors at Texas State University who prepared me, pushed me, and helped me through countless hours of studying. It was such an honor and pleasure to be able to work beside all of you.

TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS	v
LIST OF TABLES	viii
LIST OF FIGURES	ix
ABSTRACT	xi
CHAPTER	
I. INTRODUCTION	1
II. LITERATURE REVIEW	4
III. CURRENT STUDY	21
IV. METHODS	23
V. RESULTS	34
VI. DISCUSSION	78
APPENDIX SECTION	86
REFERENCES	89

LIST OF TABLES

Table	Page
1. Number of census block groups (CBGs) separated by the number of sex trafficking related incidents they contained.....	37
2. Correlation matrix between sex trafficking-related incidents and all other variables .	69
3. Descriptive statistics for predictor variables, for census block groups with no sex trafficking-related activity and those with at least one recorded incident	71
4. Binary logistic regression results with sex trafficking-related incidents as the outcome measure (N=519).....	74
5. Poisson regression results with sex trafficking-related incidents as the outcome measure, for the census block groups containing at least one sex trafficking-related incident (N=111)	77

LIST OF FIGURES

Figure	Page
1. Census block groups (N=519) in Travis and Williamson Counties intersecting with Austin Police Department (APD) jurisdiction.	25
2. Kernel density estimation of sex trafficking in Austin, Texas.....	35
3. Sex trafficking-related incidents in Austin, Texas at the census block group level (N=519).....	36
4. Kernel density estimation of prostitution activity in Austin, Texas.	38
5. Prostitution activity in Austin, Texas at the census block group level (N=519).	39
6. Scatterplot displaying association between sex trafficking- and prostitution-related crime counts, at the census block group level (N=519).....	40
7. Kernel density estimation for drug-related offenses in Austin, Texas.....	42
8. Drug-related offenses in Austin, Texas at the census block group level (N=519).	43
9. Scatterplot displaying association between sex trafficking- and drug-related crime counts, at the census block group level (N=519).....	44
10. Scatterplot displaying association between sex trafficking-related crime counts and combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).....	45
11. Kernel density estimation of ATMs within Austin, Texas.	47
12. Scatterplot displaying association between sex trafficking-related crime counts and the number of ATMs weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).	48
13. Kernel density estimation of gas stations within Austin, Texas.	50
14. Scatterplot displaying association between sex trafficking-related crime counts and the number of gas stations weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).	51

15. Kernel density estimation of hotels in Austin, Texas.	53
16. Scatterplot displaying association between sex trafficking-related crime counts and the number of cheaper (\leq \$100) hotels weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).....	54
17. Percent of female-headed households and sex trafficking activity in Austin, Texas at the census block group level (N=519).	56
18. Percent of households on public assistance and sex trafficking activity in Austin, Texas at the census block group level (N=519).....	57
19. Percent of households in poverty status and sex trafficking activity in Austin, Texas at the census block group level (N=519).....	58
20. Scatterplot displaying association between sex trafficking-related crime counts and the percentage of female-headed households, at the census block group level (N=519).....	59
21. Scatterplot displaying association between sex trafficking-related crime counts and the percentage of households on public assistance, at the census block group level (N=519).....	60
22. Scatterplot displaying association between sex trafficking-related crime counts and the percentage of households in poverty status, at the census block group level (N=519).....	61
23. Percent of residents having moved in the previous year and sex trafficking activity in Austin, Texas at the census block group level (N=519).	63
24. Scatterplot displaying association between sex trafficking-related crime counts and the percentage of residents having moved in the previous year, at the census block group level (N=519).....	64
25. Racial/ethnic heterogeneity and sex trafficking activity in Austin, Texas at the census block group level (N=519).	66
26. Scatterplot displaying association between sex trafficking-related crime counts and racial/ethnic heterogeneity, at the census block group level (N=519).....	67

ABSTRACT

This research aimed to determine whether sex trafficking-related offenses in Austin, Texas, clustered geographically and, if so, whether such patterns could be predicted by the spatial distribution of other prostitution and drug-related crime, proximity to highways, and the presence of facilities known to be associated with the sex trade (ATMs, gas stations, and cheaper hotels), as well as neighborhood variables capturing the extent of social disorganization.

A variety of methods were employed, including nearest neighbor analyses, kernel density estimation and thematic maps, non-parametric correlations, and a hurdle regression model. Data for all sex trafficking and compelled prostitution crimes recorded by Austin Police Department (APD) during 2013-2015 were used as the outcome variable. Data for the predictor variables came from APD and several public sources. Most of the analyses employed the census block group as the unit of analysis, of which there are 519 in the research area.

Results showed sex trafficking-related offenses significantly clustered in space. Bivariate correlations revealed sex trafficking activity to be moderately correlated with prostitution and drug-related crime, and weakly associated with most of the remaining variables. In the multivariate models, however, only drug-related offenses and the percentage of households on public assistance were shown to be significant predictors of whether a census block group were affected by sex trafficking (i.e., at least one offense

recorded; binary logistic regression); in affected block groups, the actual incidence of sex trafficking was predicted by prostitution- and drug-related offenses, the combined distance from the block group to the three highways considered, and the number of ATMs and cheaper hotels (<\$100) weighted by their proximity to highways (Poisson regression).

The limitations of police-recorded sex trafficking data, and how these more likely represent the transaction stage of trafficking (when sex/victims is/are sold), may explain the weak/nil results obtained, as some of the predictors considered might be more closely associated with other stages of the trafficking process such as recruitment and harboring. In any case, the significant effects detected are consistent with existing theory and evidence, and the spatial concentrations observed call for law enforcement and other agencies to target their efforts in highly affected areas.

I. INTRODUCTION

Sex trafficking is a human rights violation often referred to as “modern day slavery” by researchers (Walker-Rodriguez & Hill, 2011). Sex trafficking is recognized as the fastest growing organized crime type and third largest criminal enterprise (Texas Department of Public Safety [TXDPS], 2014) in the world. It is also prominent within the United States (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). In the U.S., law enforcement has emphasized the danger of this criminal activity because of its effect on the exploitation of minors, the physical and sexual abuse of victims, its prominence in child pornography, as well as the gross human rights violations, health risks and trauma associated with it (Cole & Sprang, 2015; TXDPS, 2014; Walker-Rodriguez & Hill, 2011). Survivors who are fortunate enough to escape or be rescued develop post-traumatic stress disorder (Cole & Sprang, 2015; Hom & Woods, 2013). It is important to focus on this issue because TXDPS (2014) has reported sex trafficking is growing in Texas, with an increasing number of gangs engaging in this crime due to the high profits involved, and a separate trend of victims getting younger.

Sex trafficking has gained global attention from governments, media, advocates, and city officials, but there is still relatively little known about its spatial distribution, movements, and networks (Kenyon & Schanz, 2014; Latonero, 2011; Reid, 2010; Reid, 2014). Sex trafficking is largely misunderstood, mislabeled, used as a moral movement, and has large knowledge gaps and poor prevalence estimates (Cole & Sprang, 2015; Farrell & Cronin, 2015; Kenyon & Schanz, 2014; Reid, 2014; Zhang, 2009).

Identifying where sex trafficking activity concentrates is vital in creating strategic solutions to prevent future victimization and inform investigative efforts. This criminal

activity affects immigrants, runaways, the homeless, and other vulnerable individuals (TXDPS, 2014). Because of the recent involvement of gangs in sex trafficking and the increased use of the Internet to advertise sexual services, it is increasingly difficult for law enforcement to track the problem (TXDPS, 2014; Latonero, 2011).

Although substantial efforts have been made to increase our knowledge in this field, much of the extant research focuses on either sexually trafficked minors or international victims (Cole & Sprang, 2015; Estes & Weiner, 2001; Kenyon & Schanz, 2014; Reid, 2010; Reid, 2014). Little research has been conducted in Texas despite its high trafficking prevalence rates, and even less is known about the spatial dynamics of sex trafficking at the meso-level. The little that is known about sex trafficking-related activity is analyzed through statistics from the National Human Trafficking Hotline, which gathers the number of reports for each state.

Although not focused on sex trafficking, previous studies relating to meso-spatial correlations and hot spot analyses regarding massage parlors and commercial sex trade environments have found that illicit massage parlors concentrate in space and that commercial ads for escorts correlate with the locations of banks, hotels, and adult shops (Chin, Kim, Takahashi, & Wiebe, 2015; Voloshin, Derevitskiy, Mukhina, & Karbovskii, 2016). These studies have found that illicit massage parlors concentrate in space and that commercial ads for escorts do correlate with the locations of banks, hotels, and other relevant facilities (Chin et al., 2015; Voloshin et al., 2016).

The present study examines sex trafficking cases within the city of Austin, Texas, to determine whether such cases spatially cluster and whether their geographic distribution can be correlated to prostitution activity, drug activity, relevant facilities, and

the social demographics of neighborhoods. Using geocoded results obtained from police reports, spatial analyses were performed to answer these questions. Examples of relevant facilities include truck stops, highways, and certain types of hotels, which are examined within the framework of the routine activity perspective (Cohen & Felson, 1979). The neighborhood variables considered relate to social disorganization (Sampson & Groves, 1989), and focus on levels of deprivation, residential mobility, and ethnic heterogeneity. By examining sex trafficking from a meso-spatial perspective, it is posed that relevant environmental factors can be identified.

II. LITERATURE REVIEW

Defining Sex Trafficking

For the purpose of this study, sex trafficking is defined as “the recruitment, harboring, transportation, provision, or obtaining of a person for the purpose of a commercial sex act...” which must be induced by “force, fraud, or coercion...” (18 U.S.C. § 1591). A commercial sex act is defined as “any sexual act for which something of value is given or received” (Trafficking Victim Protection Act, 2000). Examples of commercial sex trade outlets where sex trafficking is reported include strip clubs, brothels, massage parlors, escort websites, and any location where prostitution is exercised (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). In Texas, sex trafficking crimes are usually recorded by police as “trafficking of persons.” By the very definition, sex trafficking is divided into several key stages: namely recruitment, harboring, transporting, provision of services or person, and obtaining of services of person. A person may be arrested for trafficking of persons if involved in any of these stages, no matter the extent of their role. Examples of roles include a driver transporting a victim, a trafficker or third party recruiting a victim, and/or the purchase of sexual services.

Law enforcement agencies also use a more specific offense code to describe instances of sex trafficking that involve prostitution: “compelling prostitution.” To be categorized as a trafficking of persons incident (instead of compelling prostitution), it must involve compelling prostitution and at least one other element such as recruitment, harboring, and transportation. Compelling prostitution is committed when “a person...causes another by force, threat, or fraud to commit prostitution” or when the

victim is under the age of 18, in which case force, threat, or fraud need not to be proven (Texas Penal Code Title 9.43.05).

Compelling prostitution has obvious similarities to the definition of sex trafficking, but it is more specific to the inducement of prostitution (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). It can also involve the client being arrested after soliciting services. In these cases, the pimp, or trafficker, is typically a third party which receives the money from the purchase. Alternatively, trafficking of persons may involve people being sold onto other agents who force the victim to engage in commercial sex acts. Not all sex trafficking incidents involve compelling prostitution and vice versa. This distinction is critical because law enforcement may use either offense code when addressing such incidents. Traffickers and pimps are usually charged under compelling prostitution, while buyers and traffickers who are selling a victim onto another agent tend to be charged with trafficking of persons. As with trafficking of persons, an individual may be charged with compelling prostitution at any phase of the process, whether involved with transportation to the hotel, handling the money for the transaction, or partaking in the commercial sex act. The Texas Penal Code also specifies other forms of prostitution, such as promotion of prostitution and purchasing of prostitution, but these incidents have not been analyzed because they would detract from the focus of sex trafficking. These incidents relate more so to pimps and purchasers of commercial sex.

Sex trafficking and compelling prostitution cases were combined in sex trafficking reports to describe the problem in the state of Texas because neither penal code captured all of the forms of sex trafficking (TXDPS, 2014). In their 2014 report, TXDPS also makes reference to some cases where the victim initially agreed to engage in

the sexual activity, but that eventually involved elements of force. This too is considered sex trafficking. Whenever an element of force, fraud, or coercion exists, at any stage of the process, or whenever the victim is under the age of 18, sex trafficking has occurred. Compelling prostitution was also considered together with the trafficking of persons incidents to account for law enforcement's varying definition of sex trafficking incidents. This allows the research to have a more inclusive dataset to capture sex trafficking.

Because of the complex nature of this crime, sex trafficking is often confused with human smuggling, prostitution, drug trafficking, and/or kidnapping. Although sex trafficking can involve any of these criminal activities, it does not necessarily require any of them. Human smuggling involves internationals being smuggled into the country with the consent of the foreign national (TXDPS, 2014). Cases of human smuggling sometimes become sex trafficking cases when foreign nationals are eventually forced into committing commercial sex acts, sold onto other agents involved in sex trafficking or the illicit sex trade, or sexually abused by the smuggler and refused freedom (TXDPS, 2014).

The Stages of Sex Trafficking

Sex trafficking is a complex phenomenon involving multiple stages, namely recruitment, harboring, transportation, and transaction. In regard to *recruitment*, most research suggests traffickers recruit victims by acting as a boyfriend or admirer, through family members, gang involvement, and even through social media (Cole & Sprang, 2015; TXDPS, 2014; Latonero, 2011). The most vulnerable populations are those who are isolated from others and/or normalize sex (e.g., a pimp acting as a boyfriend asks the victim to have sex with other men as a favor to him), runaways, drug addicts, those with a history of sexual abuse and/or foster care, the homeless, and illegal immigrants (Cole &

Sprang, 2015; TXDPS, 2014; Reid, 2014). With minor victims, discerning between a sex trafficking case and a prostitution case is simpler, because the minor is always treated as a victim (and the case, therefore, treated as trafficking). With adults, determining whether they are a consenting sex worker or a victim is more difficult. According to Cole and Sprang (2015), most police departments in their study did not have the resources or training required to distinguish between a victim of sex trafficking and a consenting prostitute.

Making this assessment is difficult, because there are often moments in the recruitment stage where victims realize years later they were coerced into committing commercial sex acts; in other cases, they may feel loyalty to the pimp or trafficker despite wanting to refuse involvement (Brayley et al., 2011; Cole & Sprang, 2015; TXDPS, 2014; Reid, 2014). Sometimes, willing adults make decisions not to work in strip clubs or as prostitutes anymore, at which point they become victims if the trafficker or pimp threatens or manipulates them into continuing their involvement. Often, traffickers are family members or boyfriends, which also blurs the situation (Cole & Sprang, 2015). It is sometimes difficult to help survivors and prosecute traffickers, as establishing the presence of force, fraud, or coercion can often be challenging (Cole & Sprang, 2015; Estes & Weiner, 2001; Farrell & Cronin, 2015; Hom & Woods, 2013; Kenyon & Schanz, 2014; Reid, 2014).

Harboring involves holding the victim at a specific location, such as a residence, or a hotel where the trafficker or pimp is staying for a short period of time (TXDPS, 2014). Media accounts of law enforcement busts involving trafficking incidents typically depict investigators and officers rescuing dozens of victims crammed into a tiny room,

sleeping on top of each other, caged like animals, chained to the floor, and living in refuse and abysmal health conditions. Most sex trafficking instances of harboring, however, do not include cages or chains or even mass numbers of people (TXDPS, 2014). It may simply be the victim's own family home where their parents are selling them for sex, or someone posing as a boyfriend with a single victim being trafficked (Cole & Sprang, 2015; TXDPS, 2014). Victims are often retained by the trafficker by methods of pregnancy, drug addiction, provision of resources and sense of family, shame, and threats (Reid, 2014).

Transportation is a stage of sex trafficking that involves the movement of the victim. This could be across national, state, or city borders (TXDPS, 2014; Estes & Weiner, 2001). Not all sex trafficking cases require transporting victims over such long distances. In some cases, traffickers, pimps, or drivers may be transporting the victim from a residence (or wherever the victim is being harbored) to a nearby location where the transaction takes place (e.g., hotel, parking lot, strip club, massage parlor, etc.; TXDPS, 2014; Walker-Rodriguez & Hill, 2011).

As for the provision, or obtaining, of services or persons, this is known as the *transaction* stage. This involves the purchaser buying the person from the trafficker or pimp (to exploit and profit from), or, more often, buying commercial sex services. In instances of compelling prostitution, the victim may be the one taking the money from the purchaser to later give it to the trafficker.

Estimated Prevalence of Sex Trafficking

Sex trafficking is more narrowly focused than human trafficking in that victims are used for sex, and not labor. Many non-profit organizations attempting to raise awareness about the issue estimating there to be 27 million people enslaved in human trafficking today (A21, 2016). Conservative estimates for the number of people trafficked into the U.S. for any purpose, labor or sex, are proposed to be between 14,500 and 17,500 each year (Clawson, Dutch, Salomon, & Grace, 2009; United States Department of State, 2010). Of the 2,515 human trafficking investigations conducted by federal task forces between 2008 and 2010, 82% were sex trafficking cases (Bureau of Justice Statistics [BJS], 2011).

There is a large knowledge gap in this area. It is clear the estimated numbers of international trafficking victims are inconsistent, and this may be explained, at least in part, by differences in recording practices across nations. Accurate estimates for the number of domestically trafficked individuals, however, are also unreliable. Many advocates and rescued victims have stated in interviews and conferences that they believe only one percent of all sex trafficking victims are ever rescued (A21, 2016). In contrast, researchers propose that the number of trafficked persons into the U.S. is only in the tens of thousands (Clawson et al., 2009; United States Department of State, 2010). Most victims are thought to be domestic by some agencies (BJS, 2011), but foreign by others (e.g., the Federal Bureau of Investigation; Walker-Rodriguez & Hill, 2011).

In Texas alone, there were 709 known human trafficking-related incidents between January 2007 and January 2014, involving 609 victims and 176 suspects (TXDPS, 2014). When including federal taskforces on human trafficking, during the

same time period, the figure increases to 957 reported victims and 1,057 reported incidents in Texas, and the rates are increasing year to year. These reported incidents include both domestic victims (juvenile runaways, vulnerable adult U.S. citizens, etc.) and international victims (undocumented persons and illegal aliens involved with smugglers). Sex trafficking is the fastest growing industry in organized crime and the third most profitable criminal enterprise in the world (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). Although the numbers can be disputed, the importance and urgency expressed by law enforcement on the issue should not be disregarded.

Domestic and international victims of sex trafficking can range in age from pre-pubescent to adult (TXDPS, 2014; Walker-Rodriguez & Hill, 2011), but some agencies believe most to be under the age of 17 and female (BJS, 2011). In contrast, traffickers within the U.S. are mostly male, between the ages of 18 and 24, and U.S. citizens (BJS, 2011). Rescued victims are likely to experience a lifetime of trauma and require intensive treatment just to teach them basic life skills (Hom & Woods, 2013; Kenyon & Schanz, 2014).

Theoretical Framework: The Geography of Sex Trafficking

Most sex trafficking-related incidents are located spatially (online advertisements are exceptions) and it is reasonable to assume that, just like for other crime types, the physical and social environment can facilitate or hinder their occurrence. For instance, the spatial distribution of sex trafficking-related incidents may be associated with those of prostitution activity and illicit massage parlors, as suggested by TXDPS (2014) and Walker-Rodriguez and Hill (2011). Prostitution and illicit massage parlors are spatially related to a number of environmental factors, which suggests similar relationships may be identified for sex trafficking (Chin et al., 2015; Levitt & Venkatesh, 2007).

Felson and Clarke (1998) propose such patterns can be explained by the fact that crime is based on opportunity. Crime opportunities are concentrated in time and space, and they depend on the routine movements of people (Felson & Clarke, 1998). It was Cohen and Felson (1979) who first suggested the important role of routine and convenience in criminal activity. They developed the routine activity perspective to describe how crime takes place when a motivated offender, a lack of a capable guardian, and a suitable target intersect in time and space (Cohen & Felson, 1979). The theory can be successfully applied to sex trafficking (Kenyon & Schanz, 2014). Traffickers and pimps are motivated to victimize because it is of financial benefit to them and most of these victims lack any family or friends to act as a capable guardian (Kenyon & Schanz, 2014). Where such individuals encounter vulnerable individuals, who are manipulated and exploited, without a capable guardian interfering, the opportunity for sex trafficking arises. Suitable targets, motivated offenders, or capable guardians are not randomly distributed in space nor time, which gives rise to the spatial and temporal crime patterns

observed (Cohen & Felson, 1979). Based on this premise and the fact that most sex trafficking-related activities involve the *actual physical* contact of a motivated offender and a suitable victim in the absence of a capable guardian, it is hypothesized that:

Hypothesis 1: Sex trafficking-related offenses will cluster geographically.

Due to its emphasis on place, the routine activity perspective is often related to social disorganization theory, which states that one of the most telling predictors of high crime rates is community structure (Sampson & Wooldredge, 1987). Several proxies have been used in the past to estimate social disorganization, including unemployment rates, rates of female-headed households, education levels, minority populations, measures of poverty, and residential turn-over (Bursik, 1988; Gottfredson, McNeil, & Gottfredson, 1991; Shaw & McKay, 1942) There are three main community structure variables relevant to crime occurrence, namely racial and ethnic heterogeneity, economic concentrated disadvantage, and residential instability (Bursik, 1988; Gottfredson, McNeil, & Gottfredson, 1991; Sampson & Groves, 1989; Sampson & Wooldredge, 1987; Shaw & McKay, 1942).

Finally, Brantingham and Brantingham's (1995) concept of crime attractors also provides some insight as to why sex trafficking would be concentrated in particular places. Crime attractors are places known to motivated offenders for the crime opportunities they offer. For sex trafficking, crime attractors include locations such as certain hotels, gas stations, strip clubs, massage parlors, and red light districts. Crime attractors that are easily accessible, such as those in close to proximity to highways, may display the highest concentration of criminal activity.

Other Crime Types and Sex Trafficking

Just like red light districts, drug markets are a typical crime attractor. This may relate to the spatial distribution of sex trafficking because drugs are often involved in this activity (Cole & Sprang, 2015; TXDPS, 2014). To control their victims, traffickers often use drugs, which keeps them dependent on the trafficker for their drug supply (Cole & Sprang, 2015; TXDPS, 2014). Independent of this, traffickers and pimps are often involved in selling illicit drugs, especially if they are involved with a gang. Traffickers may get their trafficking or compelled prostitution victim to offer drugs to the clients before servicing them; in such cases, traffickers could supply the victim with drugs either at the place where the trafficker harbors the victim, on the way to the transaction location, or at the transaction location itself. This implies a spatial overlap may exist between narcotics violations, trafficking of persons, prostitution activity, and compelling prostitution incidents. Based on this, two related hypotheses are formulated:

Hypothesis 2a: There will be a significant association between the spatial distributions of sex trafficking-related offenses (i.e., sexual trafficking of persons and compelling prostitution) and those of prostitution and drug-related offenses.

Hypothesis 2b: At the census block group level, the number of both prostitution- and drug-related offenses will be positively associated with the number of sex trafficking-related offenses, all else being equal.

Meso-Spatial Patterns of Sex Trafficking

Although sex trafficking victims can be found on the streets, in red light districts and near drug activity, it is becoming increasingly common for prostitutes to revert to the Internet to advertise their services and arrange to meet clients, and for traffickers to recruit potential victims (Hadjiyanni, Povlitzki, & Preble, 2014; Latonero, 2011). Many ads contain vague addresses, such as highway intersections, and images of the girls and women scantily clad in hotel rooms. The suite in the picture may or may not be the actual location where the transaction will take place. Due to the privacy required for the completion of the sexual act, the “placeness” of sex trafficking is vital in understanding the issue (Hadjiyanni et al., 2014).

Spatially analyzing sex trafficking and other aspects of the sex trade is not a new concept. For instance, research has been conducted on concentrations of illicit massage parlors in Los Angeles census tracts (Chin et al., 2015), which are often used by traffickers to sell victims into a brothel-like setting (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). In Austin, certain massage parlors are believed to be brothels where women are rotated through every few weeks along a trafficking route from Houston to California (Redeemed Ministries, personal communication, October 2015).

Another study examined the locations indicated in online advertisements in relation to facilities associated with the adult industry, police stations, metro stations, hotels, bars, banks, parking lots, salons, industrial sites, banks shops, and long-term rentals (Voloshin et al., 2016). They found that the locations of banks, pharmacy shops, and long-term apartment rentals had the strongest correlation to the location of sex trade venues. Banks are highly correlated to illicit sex trade activity because of ATMs and their

easy access to cash withdrawals and deposits, both for the trafficker and the purchaser (Voloshin et al., 2016).

Walker-Rodriguez and Hill (2011) and TXDPS (2014) refer to incidents of sex trafficking taking place at different types of facilities. There are numerous news articles and law enforcement cases detailing cases of sex trafficking at locations such as truck stops, strip clubs, and massage parlors (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). Banks and long-term room rentals have also been found to be associated with prostitution and sex trafficking (Voloshin et al., 2016). Banks may be relevant because they make it more convenient for customers to make withdrawals and for traffickers to make deposits; having a bank close to the transaction site is efficient for their “business.”

Another characteristic of the physical environment that is thought to be relevant is easy access to major highways as transportation routes for traffickers between cities and across state lines. Access to highways can be correlated to criminal activity and is important for personal routine activities (Brantingham & Brantingham, 1995; Cohen & Felson, 1979). Highways may be related to criminal activity for various reasons, depending on the crime type. Correlating factors may include ease of access and escape routes, criminals being unfamiliar with the city being forced to find opportunities from a central location, the anonymity afforded by the activity density, and, in the case of sex trafficking, central locations for purchasers or transaction sites. Highway proximity has been shown to be associated both with narcotic violations and prostitution, so it follows the association may also exist for sex trafficking (TXDPS, 2014; Walker-Rodriguez & Hill, 2011).

In Texas specifically, there exists something known as the Texas Triangle where traffickers travel between Austin, San Antonio, Houston, and Dallas (Neuman & Bright, 2008). The Texas Triangle is one of 11 mega-regions in the U.S. that contains the majority of the Texas population and is highly connected (Neuman & Bright, 2008). The Texas Triangle utilizes IH-35, IH-45 and IH-10 as major trafficking routes that allow traffickers to move between highly populated cities to rotate their business. When business slows down, usually within a few days, they move to the next city. Purchasers of commercial sex often desire new products and services, so traffickers constantly move to remain profitable. This information has not been documented in public reports, but rather in meetings and discussions between entities involved in combating sex trafficking. A review of escort ads on Backpage.com, suggests that the sex trade does seem to be spatially associated with highways, possibly due to the ease of access for sex trade workers, traffickers, and customers.

By studying the spatial distribution of facilities such as cheaper hotels and hostels, truck stops, and ATMs, especially those located near a highway, patterns may emerge around these locations believed to be optimal for sex trafficking activity. Obviously, not all facilities of this type will be linked to sex trafficking. Prior research and anecdotal evidence, however, appear to indicate that these facility types, when positioned in near proximity to highways, may pose an increased risk. This is justified by the knowledge that traffickers use highways to travel between cities, as they provide a central location for purchasers to find the transaction facility, and highways having frequent and dense use by potential customers. Consequently, the following hypotheses are formulated:

Hypothesis 3a: At the census block group level, distance from the highway will be negatively associated with the number of sex trafficking-related offenses, all else being equal.

Hypothesis 3b: At the census block group level, the number of cheaper hotels, gas stations containing truck stops, and ATMs, after weighting these by how far they are from the highway, will be positively associated with the number of sex trafficking-related incidents, all else being equal.

Community Characteristics

Sex trafficking is also likely to be concentrated in locations of high social disorganization. Researchers have used spatial analysis to assess different types of crime and relevant aspects of the sex trade to understand the concentration of these incidents and their relationship to facilities and community characteristics. Examples of community characteristics considered include unemployment rates, percent foreign born, percent of female-headed households, level of education, percent single males, percent of vacant households, and median age of the population (Chin et al., 2015; Levitt & Venkatesh, 2007; Lipton et al., 2013; McCord & Ratcliffe, 2007; Siregar, 2013; Voloshin et al., 2016).

For instance, McCord and Ratcliffe (2007) proposed that land use variables and characteristics associated with social disorganization could predict the concentration and magnitude of drug markets. They defined social disorganization by: the percent of female-headed households with children under five years; household income; the number of households occupied by renters; the number of vacant residences; the number of unemployed males between the ages of 16 and 24; the number of residents under 25 years

old without a high school education; and the percent of minority residents. The variables that were positively associated with higher drug arrest rates were the percent of female-headed households, unemployed males, residents over 25 years old without a high school diploma, and minority residents.

One study reported significant relationships between the spatial distribution of massage parlors and neighborhood socio-demographic characteristics (Chin et al., 2015). Positive associations were detected with; the percent of male residents (especially for those aged 20-64); the percent Asian or biracial residents; vacant households; unemployed residents; residents who walked to work; and households below the federal poverty level. A different study of geocoded commercial sex work online advertisements also reported significant associations with: property taxation rates; self-employed to working population ratio; percent of residents with higher education; and percent of residents holding scientific degrees (Voloshin et al., 2016). Although these studies are not specific to sex trafficking, the results are still relevant because they relate to criminal activity involved in various aspects of sex trafficking, such as the online advertisement of victims, and victims being sold or held at illicit massage parlors.

In the only study to specifically examine a relationship between community characteristics and human trafficking, set in West Java, Siregar (2013) reported positive associations for the number of divorced residents and of those with local migrant status. A negative correlation between trafficking and adult levels of education was also observed.

In the current study, it is also predicted that areas of higher social disorganization will be more affected by sex trafficking activity. Measures of social disorganization, as

mentioned previously, include economic concentrated disadvantage, racial and ethnic heterogeneity, and residential instability (Bursik, 1988; Gottfredson, McNeil, & Gottfredson, 1991; Sampson & Groves, 1989; Sampson & Wooldredge, 1987; Shaw & McKay, 1942). Economic concentrated disadvantage has been examined in many studies as a predictor of crime and will be estimated in the proposed study by three different U.S. Census variables, namely: the percent of households on public assistance income; the percent of female-headed households; and the percent of households with an income below the federal poverty line. The percent of female-headed households is often a variable used because it captures households where a male presence may be lacking, and the head of the house is working multiple jobs while taking care of a family (McCord & Ratcliffe, 2007; Sampson & Groves, 1989). In this way, it is hypothesized that:

Hypothesis 4a: At the census block group level, higher levels of concentrated disadvantage (as estimated by the percent of households on public assistance income, the percent of female-headed households, and the percent of households below the poverty line) will be positively associated with the number of sex trafficking-related offenses, all else being equal.

Guided by social disorganization theory, both racial/ethnic heterogeneity and residential mobility are thought to impede community cohesion, which can in turn, affect informal control (Sampson & Groves, 1989). For this reason, predictions are made that:

Hypothesis 4b: At the census block group level, levels of racial/ethnic heterogeneity will be positively associated with the number of sex trafficking-related offenses, all else being equal.

Hypothesis 4c: At the census block group level, levels of residential mobility will be positively associated with the number of sex trafficking-related offenses, all else being equal.

III. CURRENT STUDY

The hypotheses stated above were tested using data for Austin, Texas. Austin is a prime location due to its proximity to the Mexican border and its positioning within the Texas Triangle known for being a human trafficking and smuggling route (TXDPS, 2014; Neuman & Bright, 2008; Personal communication with Traffick911, December 10th, 2015). The aim of this study was to identify the spatial patterns associated with sex trafficking, along with the environmental and socio-demographic variables that may explain its presence.

Sex trafficking is a global problem that requires the attention of the scientific research community. Researchers have a duty to provide governments, law enforcement, and the public with the necessary empirical evidence. Sex trafficking involves many underage international female victims, but they are not the only ones affected. Researchers should broaden their scope to incorporate domestic and international victims of all ages, both male and female (TXDPS, 2014). This study did not focus on one group in particular, but rather on the problem, as a whole, as it exists in Austin.

Relying on facilities such as gas stations operating as truck stops, hotels, and ATMs as measures of potential facilitators of sex trafficking, and considering their proximity to highways, spatial analyses were conducted to determine their possible influence on the spatial distribution of sex trafficking-related offenses. The studies reviewed above paved the way for this research in providing relevant variables and facility types. If reliable patterns can be identified for where sex trafficking might be enabled, this might guide police and other agencies' proactive efforts to disrupt and reduce the activity, in their efforts to prevent sex trafficking in the city. A better

understanding of the spatial relationships between sex trafficking and various situational and neighborhood variables would enhance our understanding of the problem and provide guidance for prevention and detection.

IV. METHODS

Data Sources

All the data in the current study relate to the city of Austin, Texas. Austin is the state capital and a complex location for a research study because the “greater Austin area” that encompasses many smaller cities along its city limits. According to the U.S. Census,¹ Austin has a population of 931,830 that is majority white (68.3%) with 19% of its population living in poverty. Census block groups (CBGs) are the unit of analysis for most of the analyses in this study. Because crime data were only sourced from the Austin Police Department, the CBGs considered are limited to those from Travis and Williamson counties that fall within APD’s jurisdiction. (Travis and Williamson are the only two counties within APD’s jurisdiction, with Travis County accounting for the majority of the APD area.)

The CBGs intersecting with the APD’s jurisdiction were selected using ArcMap “Select by location” tool. This yielded 558 CBGs, but some of these barely overlapped with the APD area, so a decision was made to only consider those CBGs with 10% or more of their surface area within APD’s jurisdiction. This resulted in 519 CBGs to which crime, facility, and census data were spatially joined (see Figure 1).

Police-recorded crime data relating to sex trafficking (including both trafficking of persons and compelling prostitution offenses), prostitution, and narcotics violations reported during 2013-2015 were obtained. It is unknown whether these incidents came to the attention of the police due to anonymous tips, previous law enforcement

¹ <http://www.census.gov/quickfacts/table/PST045215/4805000>

investigations, or special operations. An assumption may be made that the majority of the sex trafficking-related incidents considered fall into the transaction phase due to the type of location where they mostly occurred (i.e., strip clubs, hotels, etc.). Overall, there were 234 sex trafficking-related, 825 prostitution, and 18,928 drug-related offenses over the three-year period considered.

Additional data were gathered from publicly available sources on the location of gas stations, ATMs, and hotels. Only facilities within the boundaries of APD's jurisdiction were included in the analysis. Data for the ATMs were manually compiled from national bank and credit union websites by another Texas State University researcher for an unrelated project. The same researcher also shared a database of gas stations she had obtained through a public information request to the Texas Department of Agriculture.² Hotel data were obtained from the City of Austin website and the

² Thanks are owed to Monica Caballero, currently a PhD student in the School of Criminal Justice at Texas State University, for sharing these data.

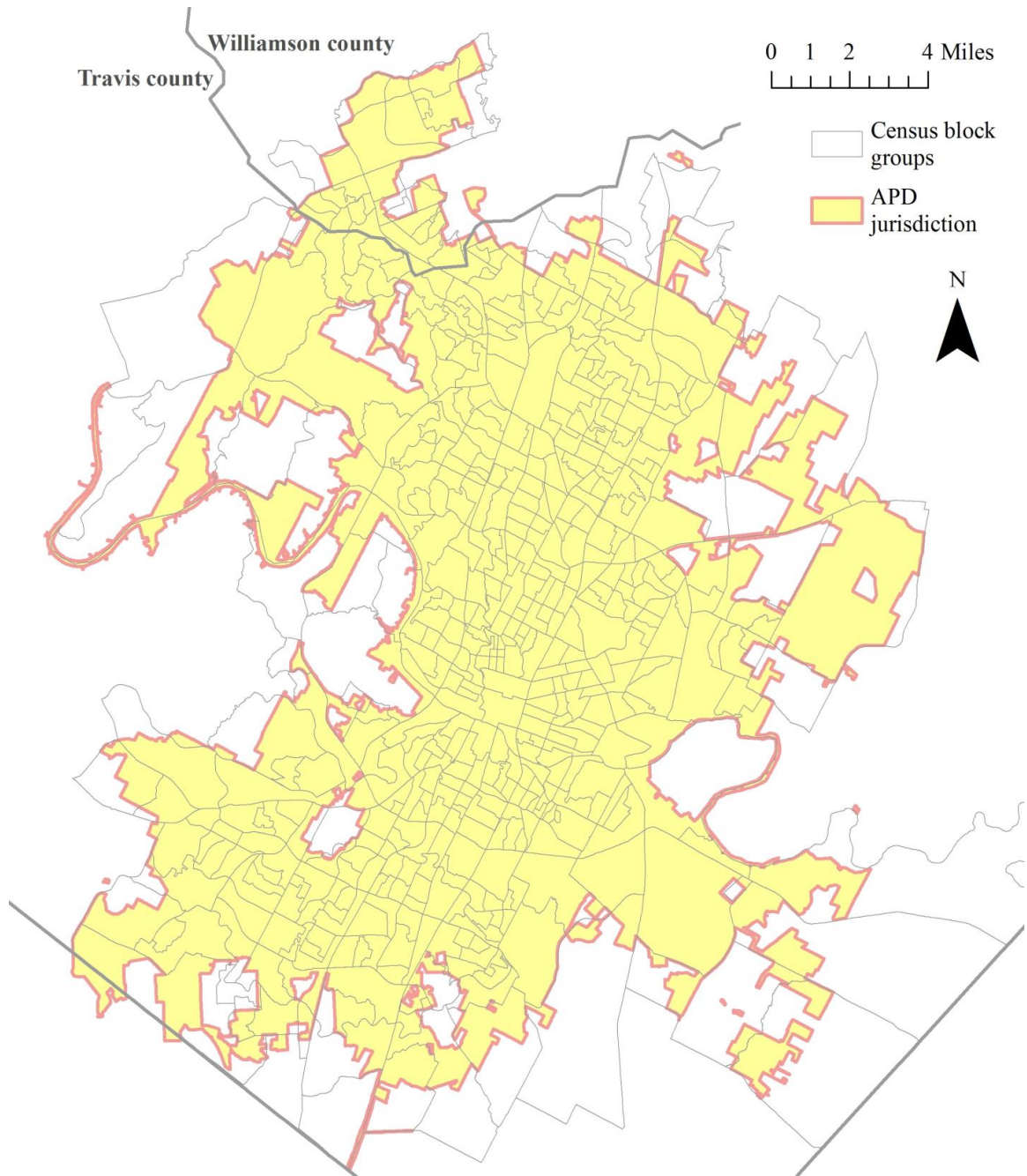


Figure 1: Census block groups (N=519) in Travis and Williamson Counties intersecting with Austin Police Department's (APD) jurisdiction.

addresses geocoded using Google Maps Geocoding API. After searching multiple website and other public data sources, it was established there was only one truck stop in the research area, so a decision was made to consider all 346 gas stations (rather than only those including a single truck stop). There were also 411 ATMs and 156 hotels in the research area. Because the hypothesis was formulated based on “cheaper” hotels, only hotels with an average room rate of \$100 or less were included. This left 74 hotels (the median room rate was \$99).

To measure social disorganization, data from the 2010-2014 American Community Survey (ACS) was used to construct measures of concentrated disadvantage, racial and ethnic heterogeneity, and residential instability at the census block group level. In the first instance, data were downloaded for both Travis and Williamson Counties using American Fact Finder.³ As explained earlier, although the data were downloaded for all the block groups in both counties, only the block groups overlapping APD’s jurisdiction were considered.

The variables used as proxies for economic concentrated disadvantage were the percent of female-headed households (B11001: HD01_VD06), percent of households on public assistance (B19057: HD01_VD02), and the percent of households in poverty status (B17017: HD01_VD02). Residential instability was measured by residential mobility, that is, the percent of residents in the CBG that had moved in the past year (B07201: HD01_VD01). To measure racial and ethnic heterogeneity, an index was created using Agresti and Agresti’s (1978) index of qualitative variation. From the relevant ACS table (B02001), five specific combinations of races and ethnicities were

³ http://factfinder.census.gov/bkmk/navigation/1.0/en/d_program:ACS

included in the index: White non-Hispanic; Black non-Hispanic; other non-Hispanic; white Hispanic; and other Hispanic. The index was calculated as follows:

$$EH = 1 - \sum_{i=1}^k \left(\frac{n_i}{N}\right)^2$$

where n_i = the sample size (residents) for each (ethnic/racial) subgroup;
 k = the number of subgroups in the sample (in this case, $k=5$); and
 N = the total sample size (residents).

Analytical Strategy

To test hypothesis 1, that sex trafficking-related crime would cluster geographically, a kernel density estimation (KDE) map was created to visually depict the spatial distribution of these offenses. Nearest neighbor analysis was then employed to determine whether any clustering observed was statistically significant.

To test hypothesis 2a, that the spatial distributions of sex trafficking-related activity, prostitution, and drug-related offenses would spatially overlap, a series of Spearman's correlation tests were implemented. An acknowledgement is made that this may not be the most appropriate test as the data points may not be independent from each other, due to the spatial nature of the data. For this reason, the Spearman correlation test results are to be interpreted with caution.⁴ To control for the risk of inflated type I error, correlation p values were adjusted using a Bonferroni correction. These tests were complemented with KDE and thematic maps describing the spatial distributions of the different crime types considered. Hypothesis 2b, which predicts those same relationships

⁴ A more appropriate strategy might have been to implement Monte Carlo simulations to test for the spatial association of the two sets of spatial points, but this was beyond the scope of the current research.

would exist when using the CBG as the unit of analysis, and all else being equal, was tested by examining the coefficients for these two variables (i.e., number of prostitution offenses and number of drug-related offenses) in a regression model which used the number of sex trafficking-related offenses as the dependent variable.

Within the same regression model, hypotheses 3a and 3b were tested by including the following predictors: distance to the highway; and number of crime attractors (i.e., hotels, gas stations, ATMs) weighted by their distance to the highway. To calculate these distances, the only interstate highway (IH-35) and two US highways (US-183 and US-290) in the research area were considered (but state highways and other road types were excluded from the analyses). It was thought these three highways would capture travel between large metropolitan areas. Rather than measuring the distance to the nearest highway, an attempt was made to prioritize those facilities that were close to *multiple* highways by employing the *combined* distance (i.e., sum of all three distances).

For the main distance variable, distances were calculated from the centroid of the CBG to the nearest access ramp for each of the three highways;⁵ the three minimum distances were then summed to arrive at the combined distance measure. The distance-weighted number of facilities was obtained by calculating the inverse combined distance for each individual facility, then aggregating these to the CBG level. For instance, a hotel that was 0.5 mile from IH-35, 2 miles from US-183, and 4 miles from US-290 would receive a score of 2.75 (i.e., $1/0.5 + 1/2 + 1/4 = 2 + 0.5 + 0.25$); it is these scores that

⁵ To calculate such distances, exit/access highway ramps had to be exported as point data from the original road network shapefile downloaded from the U.S. Census Bureau TIGER website. This allowed for an OD Cost Matrix to be performed where all the facilities were combined into an origin attribute table and the highway exit/access points were placed into a destination attribute table.

were then summed within each CBG to calculate the number of distance-weighted facilities. All distances were road distances (e.g., rather than Euclidean or Manhattan distances), and calculated using ArcMap Network Analyst and a street network line shapefile downloaded from the U.S. Census TIGER products website.

Hypotheses 4a, 4b, and 4c were also tested within the same regression model, by means of including separate predictors for each of the five census variables considered. Thematic maps were also created to illustrate how economic disadvantage, residential mobility, and ethnic/racial heterogeneity varied across the research area. Further maps combining each of the census variables and the number of sex trafficking-related offenses were produced to visualize bivariate relationships.

Due to the spatial nature of the data, it was important to incorporate a spatial lag term in the regression to account for any spatial autocorrelation. This can be done using several methods. We chose to incorporate the spatial lag as an operator, or an explanatory variable, in the regression. This was calculated using the equation (Anselin & Berra, 1998):

$$SLag_i = \sum_{j=1}^N \frac{c_j}{d_{ij}}$$

where i = CBG for which the spatial lag is being calculated;

j = all other CBGs;

N = the total number of other CBGs (519);

c_j = the number of sex trafficking-related incidents in CBG j ;

d_{ij} = the distance in miles between the centroids of CBGs i and j .

Finally, the model included the resident population of the CBGs as a control variable. Where the CBG was not totally contained within the APD area, the population was calculated pro rata (e.g., a CBG with 2,217 residents that overlapped 89.3% with the APD area was assigned a pro rata population of 1,980). It is acknowledged pro rata populations are just estimates, and that the assumption that population density would be homogeneous across the CBG will not always hold. In any case, pro rata population estimates were thought to be better than the original population figures, especially for those areas where the spatial overlap was small. Overall, 101 of the CBGs (19%) did not fully overlap with the APD area and, of these, 41 (7.9% of all CBGs) had an overlap between 11% and 49%.

Ethical Considerations

Ethical standards have been established for conducting research on human subjects. Before research even begins, these standards must be considered in regard to the research methods. In general, researchers are required to avoid harm to participants and themselves, obtain informed consent from participants, avoid deception, and maintain privacy and confidentiality (Bachman & Schutt, 2013). For quantitative analysis of secondary data such as this, ethical considerations tend to be simpler.

Harm to the subject and the researcher are not an issue because all of the data are secondary and are either publicly available or accessible through a freedom of information request. In retrieving the data and information from APD and other organizations, the intentions and use of the data were made obvious to the entities (where these were inquired about), while taking every precaution to respect their concerns.

Because APD already anonymized the crime data, there was no issue of violating the

privacy of the victims or other individuals associated with sex trafficking activity in Austin. However, actual incident locations were included, and this may be used as indirect identifiers when such locations relate to private property; for this reason, all data were kept securely on an encrypted external drive. Data relating to the location and characteristics of facilities (e.g., ATMs, gas stations, hotels, highways) were retrieved from publicly available websites and/or data sources. Overall, the risk associated with the present study was very low. On November 4, 2016, the Texas State University Institutional Review Board (IRB) confirmed the proposed research would be exempt under Category 4 (Existing Data) and provided official approval (application number 2017240).

Data Quality

These data come from secondary sources, and thus, limitations exist. The crime data were gathered by APD for their purposes of reporting and investigating crime; which lack detail optimal for a study on sex trafficking. For example, no information on how law enforcement encountered these incidents of sex trafficking, what constituted the difference between classifying it as compelling prostitution or trafficking of persons, how the victim was recruited, transported, or harbored, or the characteristics of victims, purchasers, and/or traffickers involved were readily available.

Additionally, there is believed to be a large “dark figure of crime” regarding sex trafficking. Victims are heavily manipulated, abused, and live with many freedom restrictions, so they may not get the chance to report the crimes committed against them (Hom & Woods, 2013). In other cases, they may never want to report their victimization because they do not believe they could live without their trafficker who provides

everything for them. Further, some victims have serviced law enforcement and developed a deep distrust for their protectors (Della Giusta, Di Tommaso, & Strom, 2008). This leaves individuals in their everyday lives to detect suspicious activity and report it, but the highest percentage of cases in which victims escape show that victims rescue themselves (Della Giusta et al., 2008). In short, law enforcement is only thought to catch a small glimpse into the sex trafficking activity that exists within their jurisdiction.

Using only APD data also restricts the study to cases that fall within APD's jurisdiction. Cases of sex trafficking handled by the Department of Public Safety, Sheriff's Offices, the FBI, or Homeland Security are not accounted for. Data from these agencies are increasingly difficult to attain and efforts to secure these proved unfruitful. In any case, there could be many more cases of sex trafficking in the area and excluding such cases could have potentially affected the findings. Having said this, police department data have been used in countless studies and are often the best data available for studies of crime. This is one of those cases.

Facilities data were gathered from city websites and other secondary datasets, and are subject to error, but every effort was made to ensure the data gathering was as comprehensive as possible. The census variables selected have been used in previous studies to measure social disorganization, so the assumption is made that they will be suitable proxies. Definitions and clarification were sought through law enforcement contacts to ensure the sex trafficking data were analyzed and interpreted accurately. All these efforts are expected to increase the measurement validity of the study.

Because the study is restricted to data from APD, cross-population generalization may be an issue, but external validity may be achieved if the study were replicated in

other large cities in Texas, such as San Antonio or Dallas. Other variables would have to be considered in generalizing the results to El Paso because of its proximity to the border, or Houston because of its harbors.

V. RESULTS

Sex Trafficking

As can be seen from Figure 2, sex trafficking in Austin does, in fact, cluster in specific geographic spaces. Clusters of activity are notable along the IH-35 in the South Congress-Riverside area (where IH-35 intersects with US-290 south of the river), downtown, and the Rutherford Lane area (where IH-35, US-290, and US-183 converge). The latter is a short distance from Rundberg Lane, a street known for prostitution activity in the city.

A nearest-neighbor index (NNI; using Manhattan distances) was calculated to determine whether the spatial clusters observed were statistically significant. Nearest-neighbor analysis examines the distance between each sex trafficking point and the closest point to it, and it compares such distances to the corresponding distances from a random distribution. If the empirically observed distances are smaller than those from the random distribution ($NNI < 1$), this is indicative of spatial clustering; if they're larger ($NNI > 1$), then the points are deemed to be dispersed. The analysis showed sex trafficking-related incidents clustered geographically to a significant level ($NNI = 0.77$, $p < 0.001$, $Z = -12.48$).

At the CBG level, concentrations could also be observed, but these were not as striking (see Figure 3). Despite the clustering appearing in only a few CBGs, spatial autocorrelation is believed to exist and was accounted for the regression. Most CBGs (408; 78.6%) contained no sex trafficking-related incidents, and the remainder contained either one or two incidents over the three-year period (see Table 1).

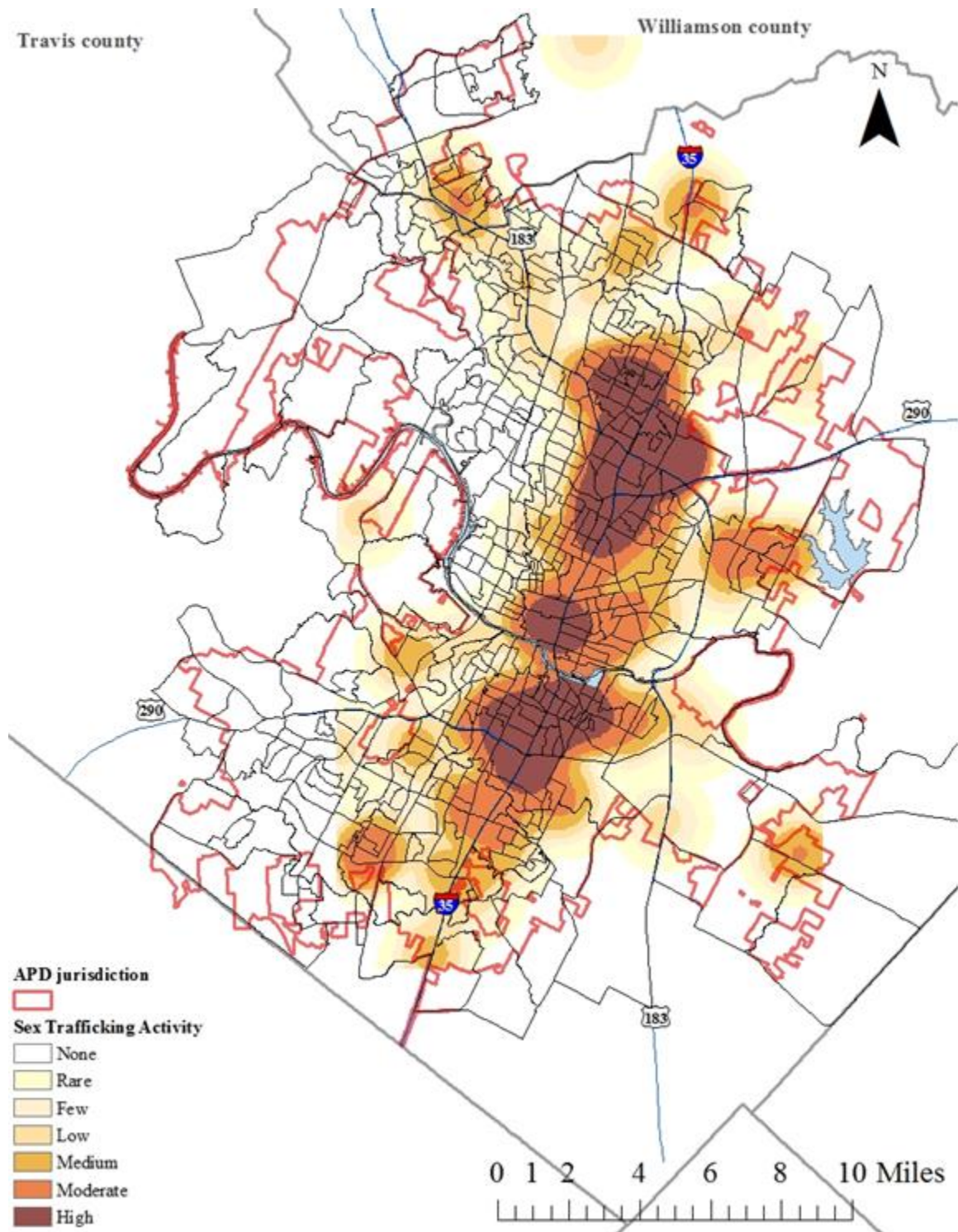


Figure 2: Kernel density estimation of sex trafficking in Austin, Texas.

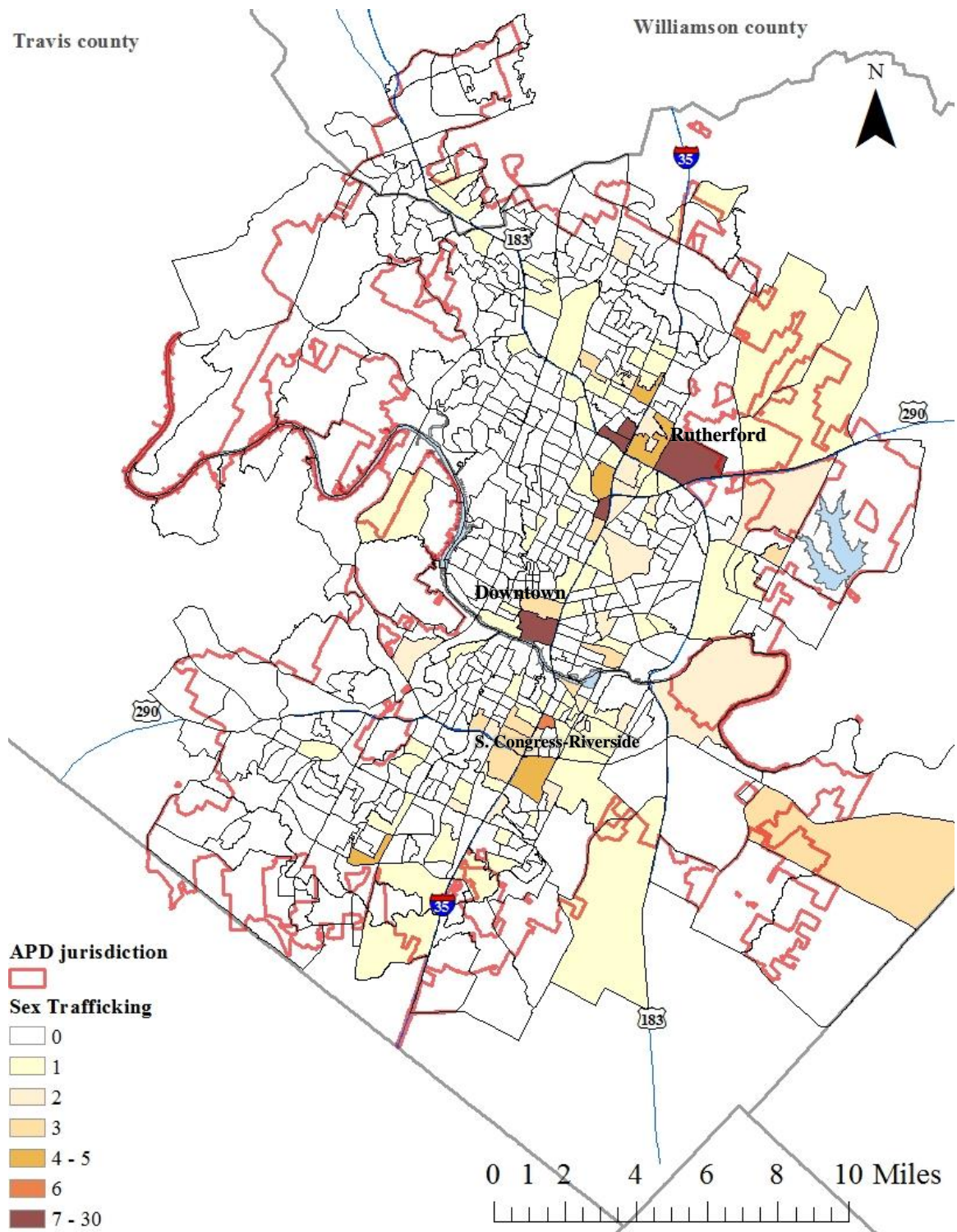


Figure 3: Sex trafficking-related incidents in Austin, Texas at the census block group level (N=519).

Table 1: Number of census block groups (CBGs) separated by the number of sex trafficking-related incidents they contained.

	Number of offenses per CBG									
	0	1	2	3	4	5	6	7	12	30
Number of CBGs	408	69	20	11	2	3	1	3	1	1
Percentage of CBGs	78.61	13.29	3.85	0.39	0.58	0.58	0.19	0.58	0.19	0.19

Other Crime Types and their Spatial Association with Sex Trafficking

Figure 4 represents the kernel density estimation for prostitution in Austin, Texas, and reveals a similar spatial distribution to sex trafficking-related incidents. Both distributions follow the length of IH-35 through Austin and concentrate in the same three main areas. Such similarities are also obvious when the prostitution thematic map (using the CBG as the unit of analysis; see Figure 5) is compared to the one for sex trafficking presented above. A Spearman's rho test using the CBG as the unit of analysis confirmed there was a significant, positive, moderate association between both variables ($\rho=.432$, $p<.001$; also see Figure 6 for a scatterplot). Nearest neighbor analyses revealed the observed prostitution spatial clusters were, as was the case for sex trafficking, statistically significant (NNI=0.48, $p<0.001$, $Z=-28.69$).

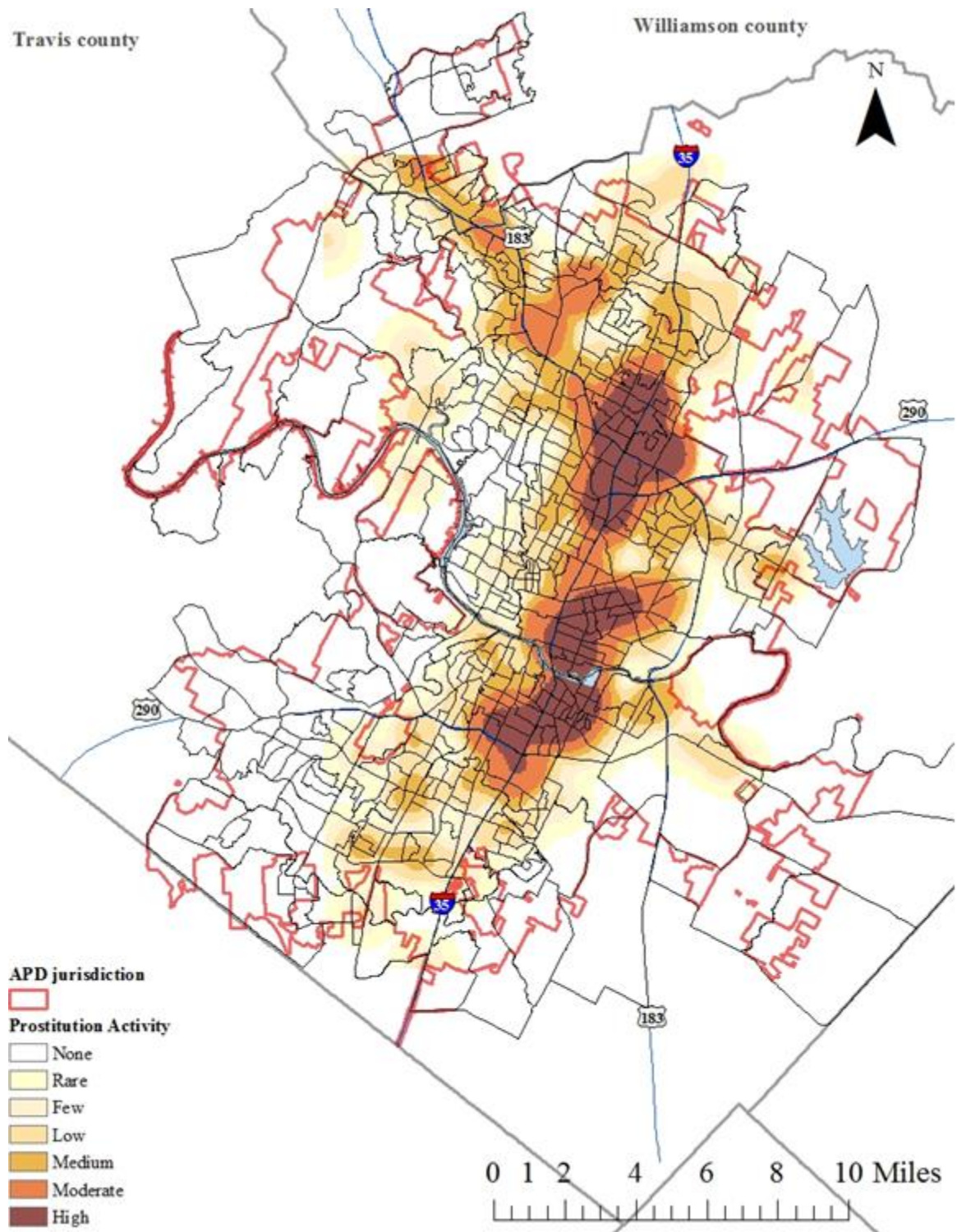


Figure 4: Kernel density estimation of prostitution activity in Austin, Texas.

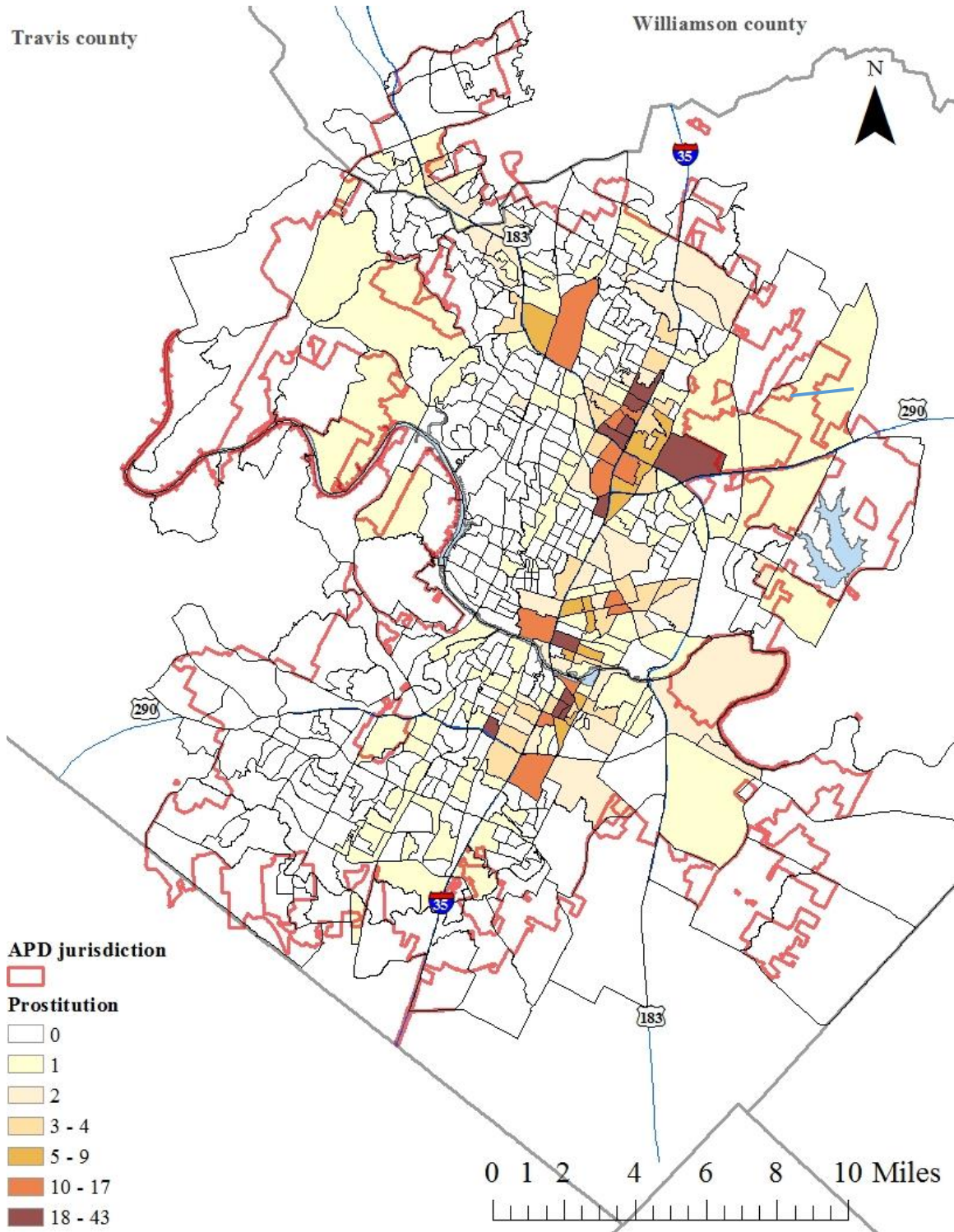


Figure 5: Prostitution activity in Austin, Texas at the census block group level (N=519).

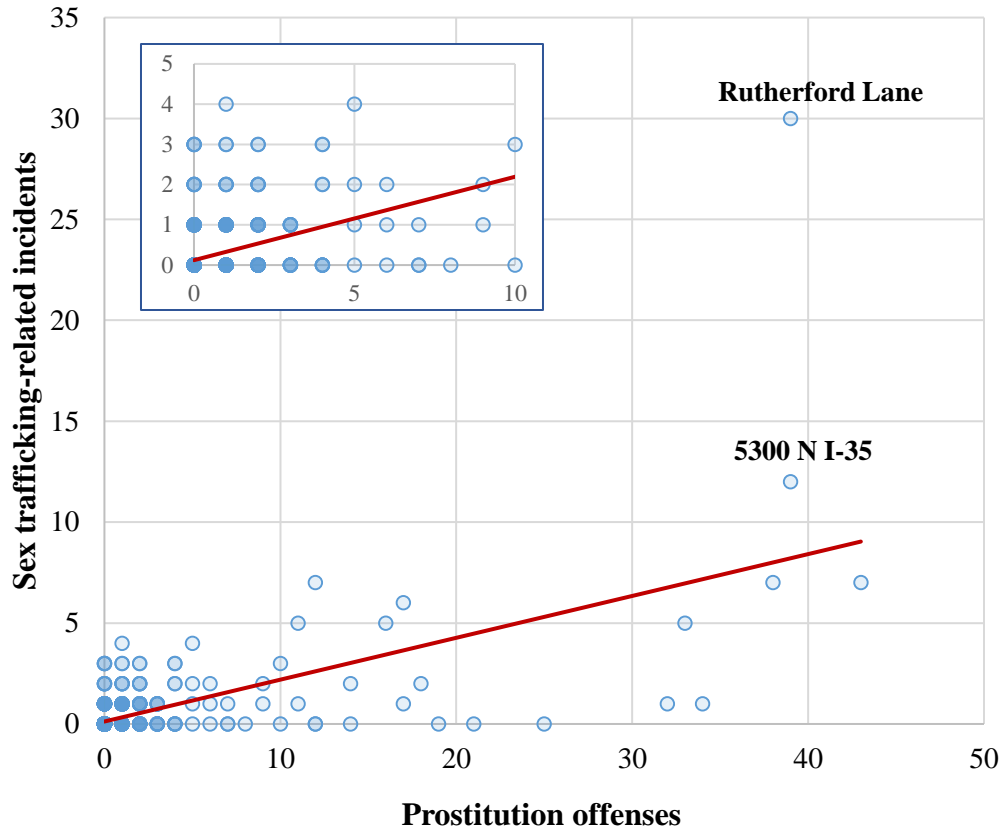


Figure 6: Scatterplot displaying association between sex trafficking- and prostitution-related crime counts, at the census block group level (N=519).

Drug-related offenses also appeared to cluster to a significant extent (NNI=0.30, $p < 0.001$, $Z = -184.97$) but the distribution portrays a different spatial pattern from the distributions of sex trafficking and prostitution (see Figures 7 and 8). To better understand how the spatial distributions of drug- and sex trafficking-related incidents relate to one another, a scatterplot is also presented in Figure 12. Instead of clustering in the three specific hotspots previously identified, there are many more, smaller areas of concentrated activity. Nevertheless, a Spearman correlation test still revealed a significant, positive, moderate relationship between sex trafficking- and drug-related offenses ($\rho = .454$, $p < .001$) similar in strength to the one for prostitution. This indicates the visual difference may be due, at least to some extent, to scaling differences between the variables. Further, drug-related offenses are concentrated in many CBGs that contain few to no sex trafficking-related incidents, such as along the river, the section of IH-35 south of the river, and certain economically deprived neighborhoods (as shown in the maps displaying data related to social disorganization variables).

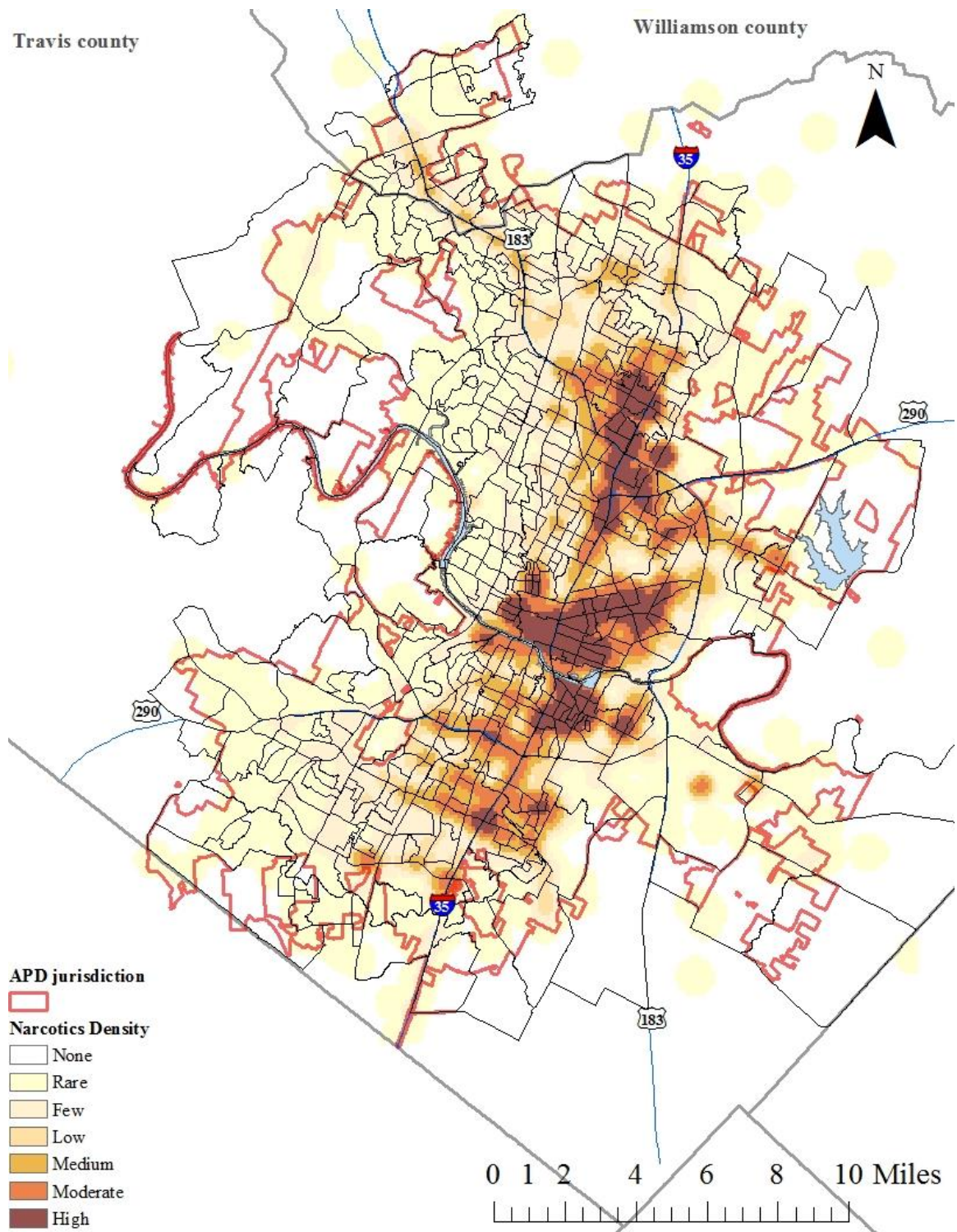


Figure 7: Kernel density estimation for drug-related offenses in Austin, Texas.

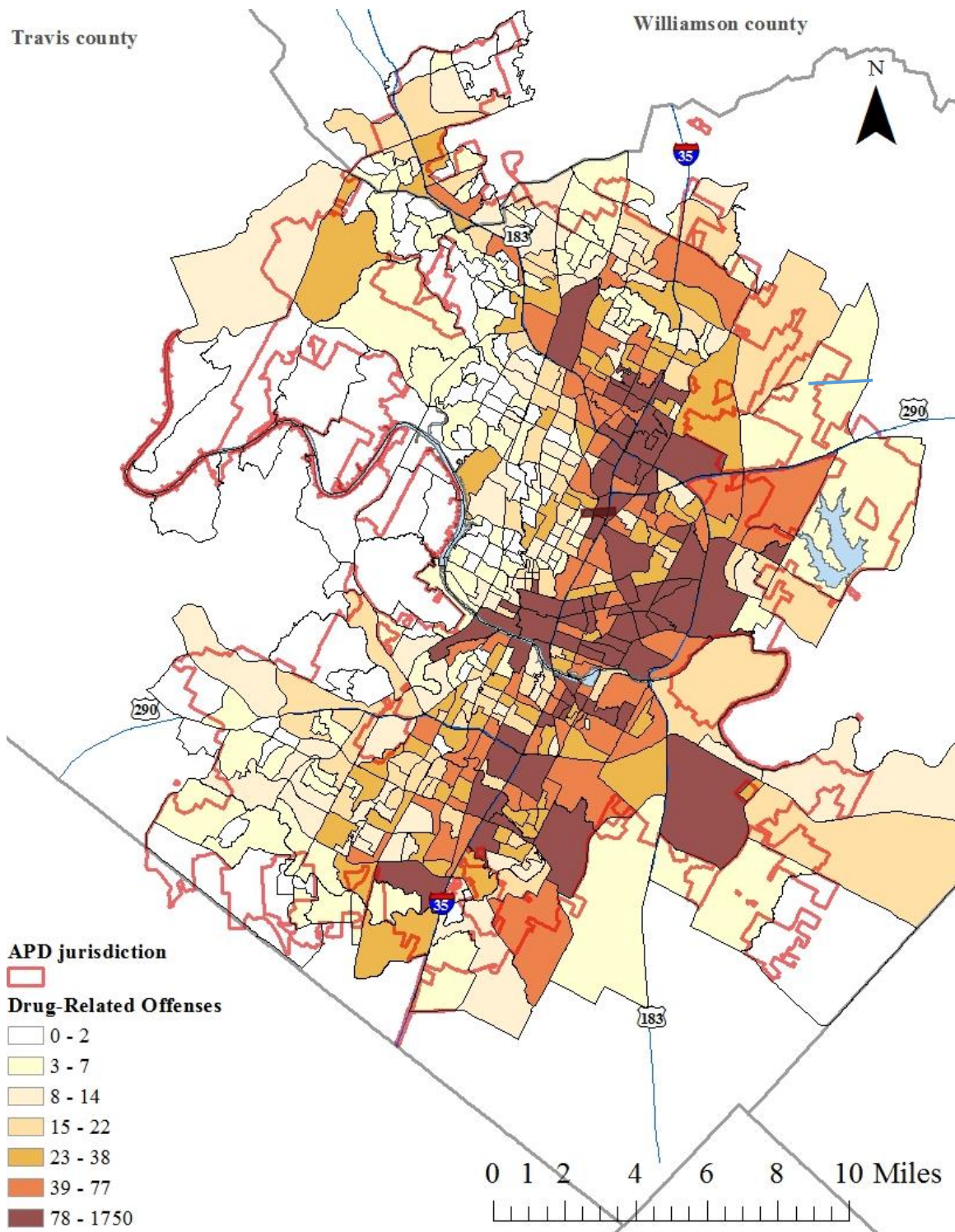


Figure 8: Drug-related offenses in Austin, Texas at the census block group level (N=519).

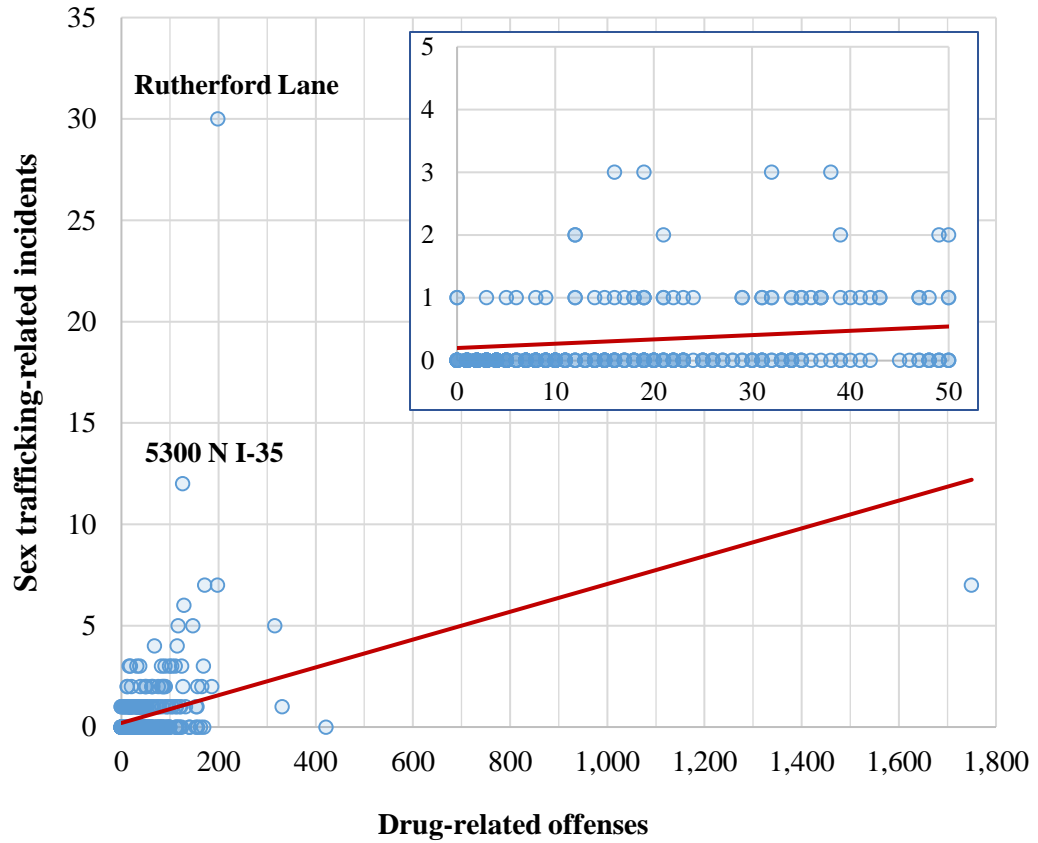


Figure 9: Scatterplot displaying association between sex trafficking- and drug-related crime counts, at the census block group level (N=519).

Combined Distance to Highways

As shown in Figure 10, the combined distance to the highways (calculated as the summed up distances from the CBG centroid to each of the three highways considered) appeared to be negatively correlated with the number of sex trafficking-related incidents, although this relationship was weak (Spearman's $\rho = -.275$, $p < .001$). It is worth noting, however, the CBGs with the highest number of incidents (12 and 30 incidents) were each a combined approximate five miles from the three highways considered.

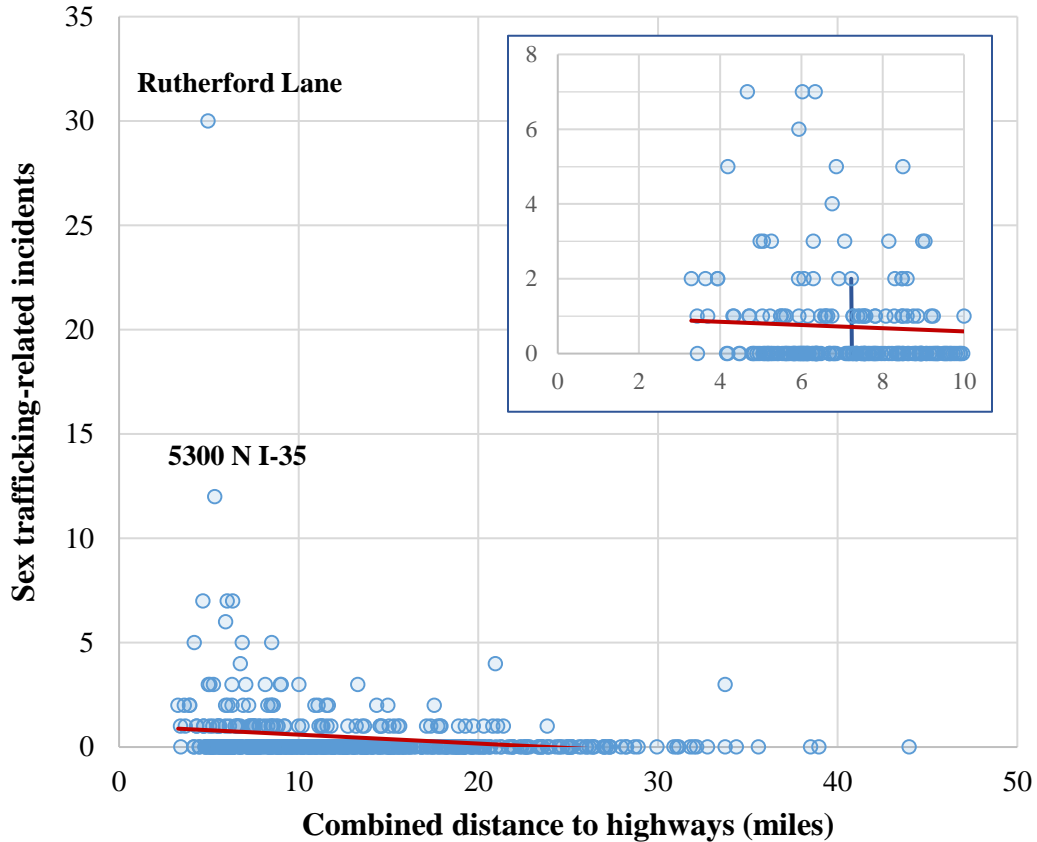


Figure 10: Scatterplot displaying association between sex trafficking-related crime counts and combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).

Facilities and their Spatial Association with Sex Trafficking

The spatial distribution of weighted facilities was too concentrated to provide thematic maps at the CBG level based on the number of gas stations, hotels, and ATMs. KDE maps were still created, and the one for ATM density is presented in Figure 11. This demonstrates an obvious concentration around multiple highways and activity centers throughout the city. As described earlier, the ATMs were weighted by their combined distance to the three highways and aggregated to the CBG level. This weighted ATM count variable was then correlated to the count of sex trafficking-related offenses, but a Spearman test did reveal only a marginally significant relationship ($\rho=.150$, $p=.058$; see Figure 12 for a scatterplot). An additional scatterplot representing the number of unweighted ATMs in relation to the number of sex trafficking-related incidents within CBGs is presented in Appendix Section.

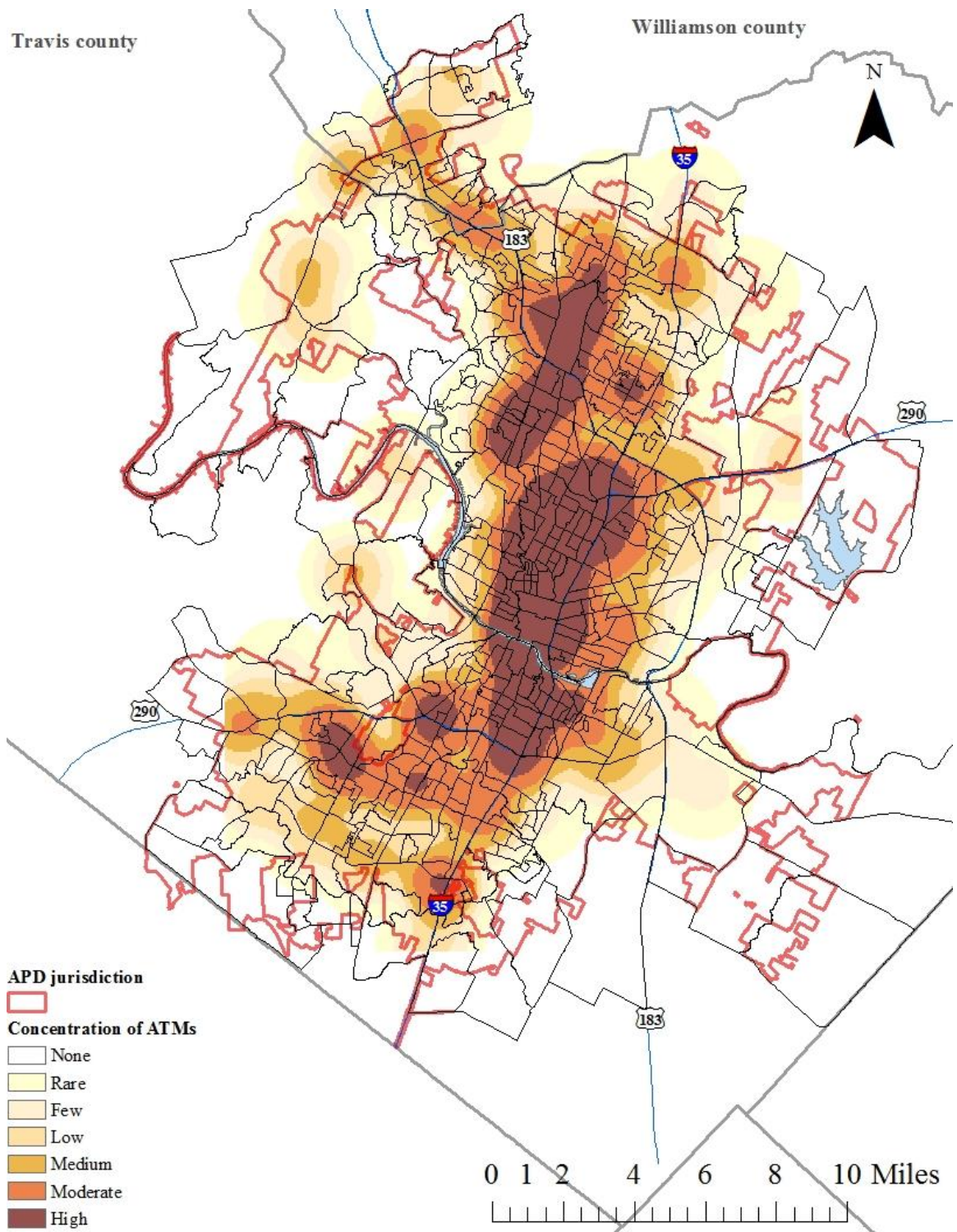


Figure 11: Kernel density estimation of ATMs within Austin, Texas.

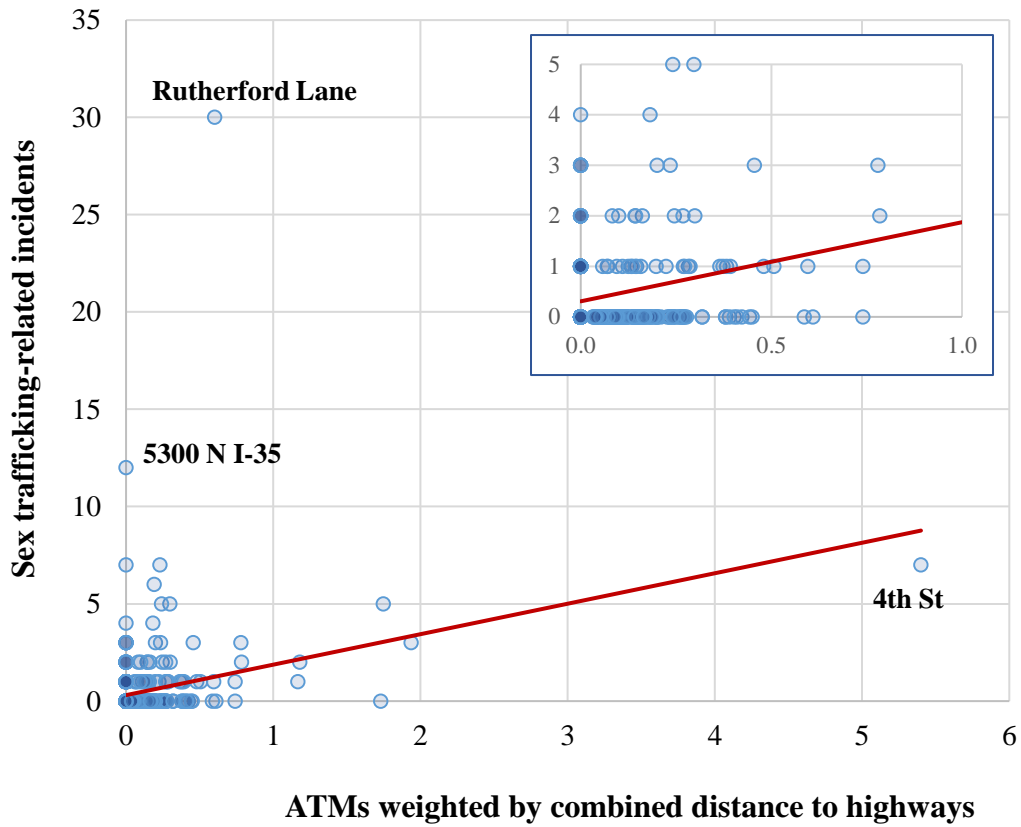


Figure 12: Scatterplot displaying association between sex trafficking-related crime counts and the number of ATMs weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).

Figure 13 represents the KDE of gas stations within the research area. Not surprisingly, these cluster around the three highways and other major arteries in the city. A Spearman's correlation revealed a significant, weak, positive relationship between the number of distance-weighted gas stations and sex trafficking-related crime counts ($\rho=.244$, $p< .001$; see Figure 14 for scatterplot). An additional scatterplot displaying the relationship between the number of unweighted gas stations and trafficking activity is presented in Appendix Section.

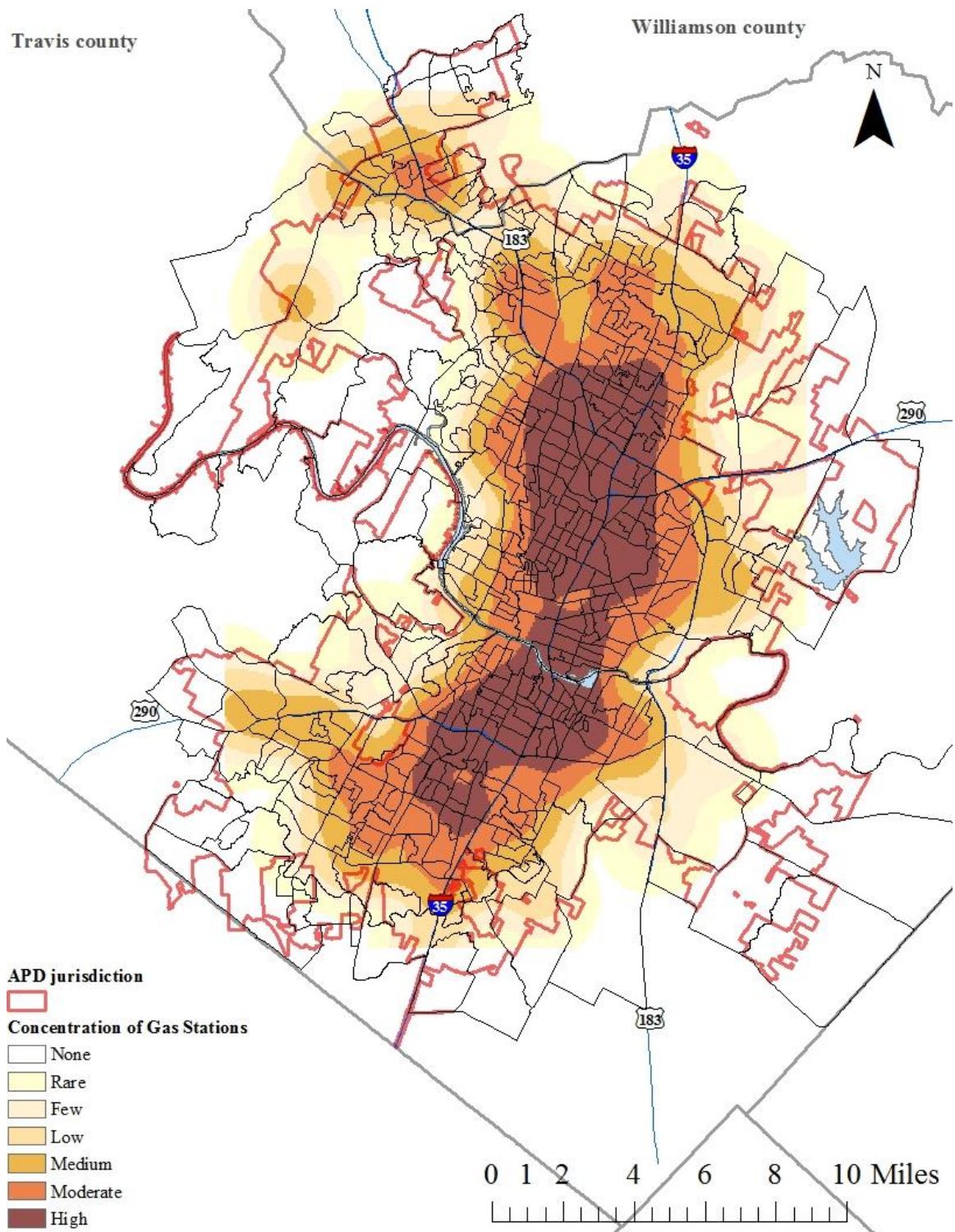


Figure 13: Kernel density estimation of gas stations within Austin, Texas.

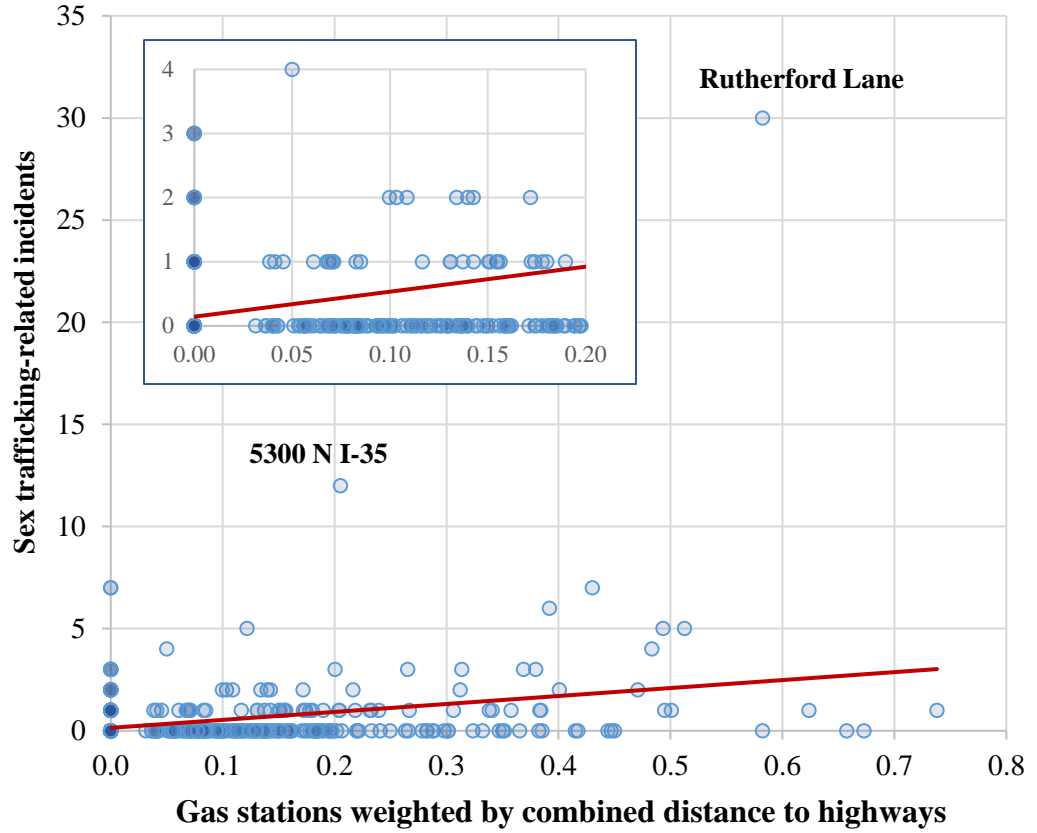


Figure 14: Scatterplot displaying association between sex trafficking-related crime counts and the number of gas stations weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).

Finally, a KDE map of cheaper hotels is provided in Figure 15. Compared to the other facilities, there are much fewer hotels in the area (74 cheaper hotels vs. 411 ATMs and 346 gas stations), and this is reflected in the density scores. The spatial distribution of cheaper hotels appeared to somewhat overlap that of sex trafficking-related incidents, and this was confirmed by a significant, positive, weak relationship found between sex trafficking-related crime counts and the number of distance-weighted cheaper hotels, at the CBG level ($\rho=.256$, $p<.001$; see Figure 16 for scatterplot). An additional scatterplot with the count of unweighted hotels is presented in the Appendix Section.

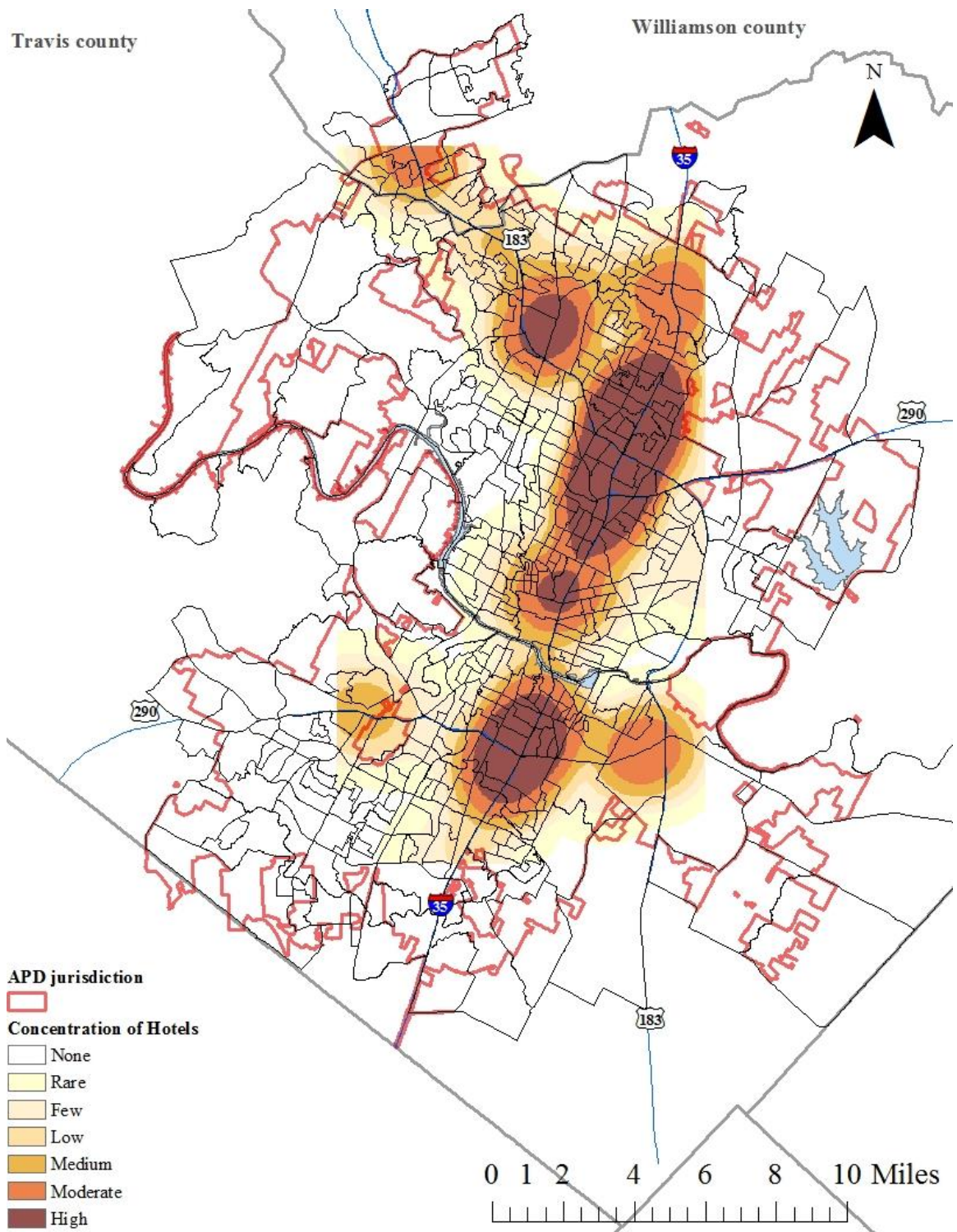


Figure 15: Kernel density estimation of hotels in Austin, Texas.

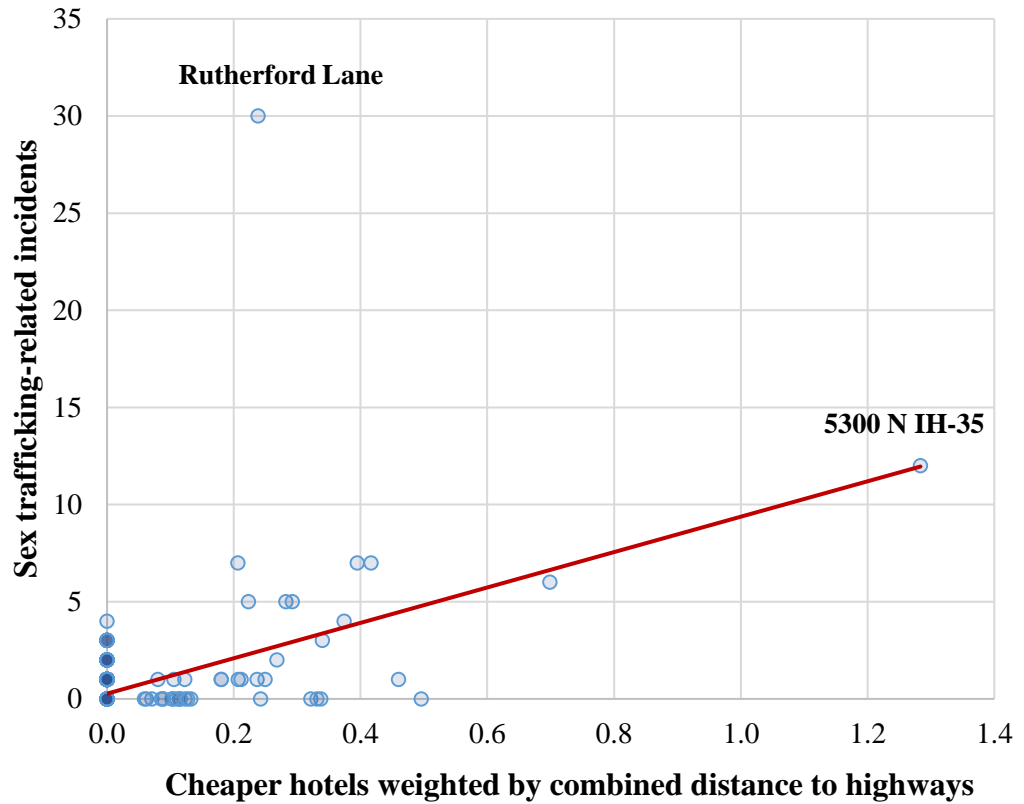


Figure 16: Scatterplot displaying association between sex trafficking-related crime counts and the number of cheaper (\leq \$100) hotels weighted by their combined distance to the IH-35, US-183, and US-290 highways, at the census block group level (N=519).

Social Disorganization and its Spatial Association with Sex Trafficking

Three concepts of social disorganization theory were operationalized in the current research, namely levels of concentrated disadvantage, racial/ethnic heterogeneity, and residential mobility.

Concentrated disadvantage

Concentrated disadvantage was estimated using three ACS variables: the percentage of female-headed households; the percentage of households on public assistance; and the percentage of households with poverty status. The spatial distribution of these three variables are presented in Figures 17-19. These thematic maps also include green graduated symbols representing the spatial distribution of sex trafficking-related incidents. Additionally, scatterplots displaying the association between sex trafficking activity and each of the mentioned census variables are presented in Figures 20-22.

It appears from Figures 17 and 20 that sex trafficking activity is more intense in CBGs where the percentage of female-headed households is high. The relationship between these two variables was found to be significant and positive, but weak (Spearman's $\rho = .188$, $p < .01$). As the percentage of female-headed households increases in a CBG, so does the number of sex trafficking incidents. However, the CBGs with the highest number of sex trafficking-related incidents do not seem to be those with the highest percentage of female-headed households.

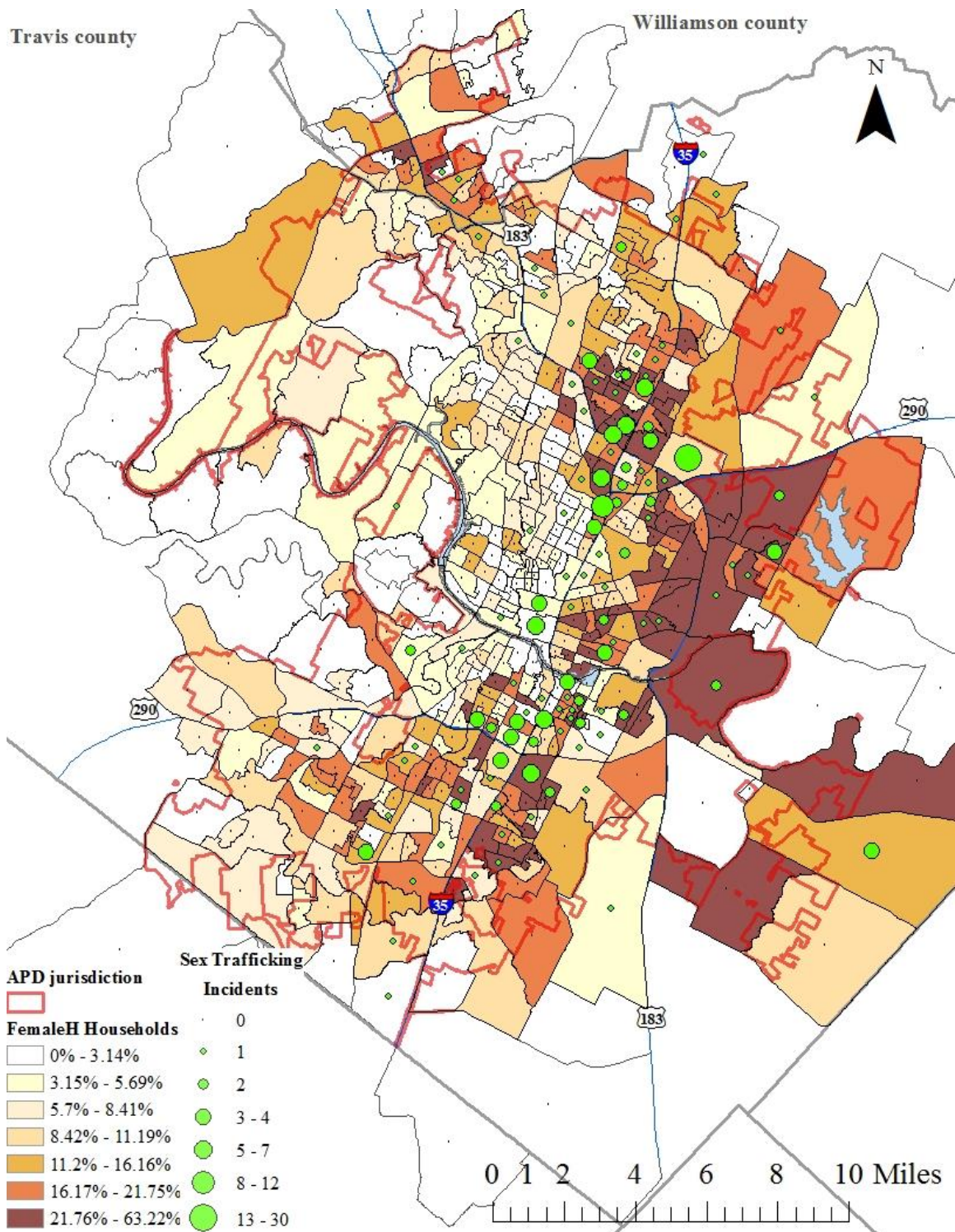


Figure 17: Percent of female-headed households and sex trafficking activity in Austin, Texas at the census block group level (N=519).

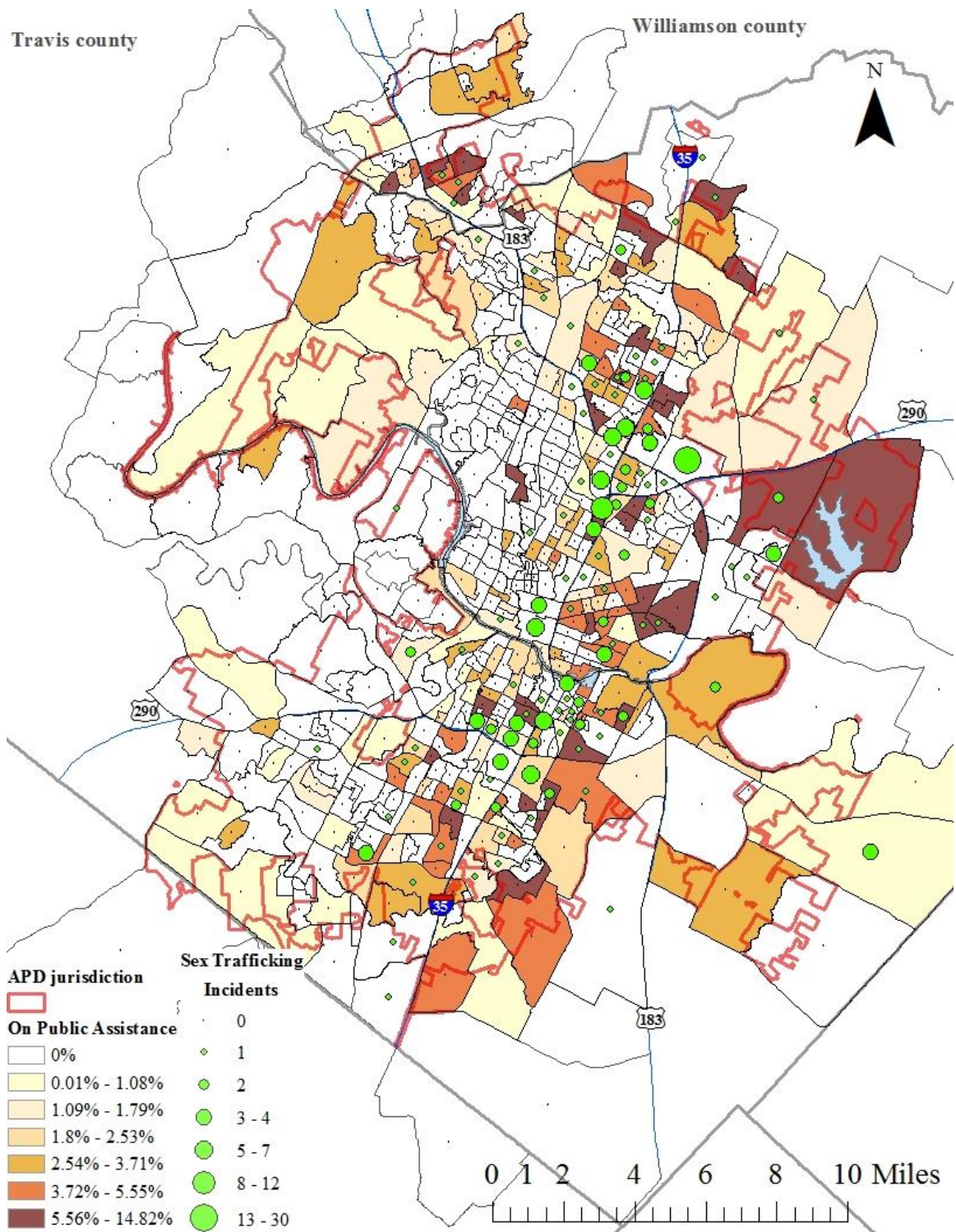


Figure 18: Percent of households on public assistance and sex trafficking activity in Austin, Texas at the census block group level (N=519).

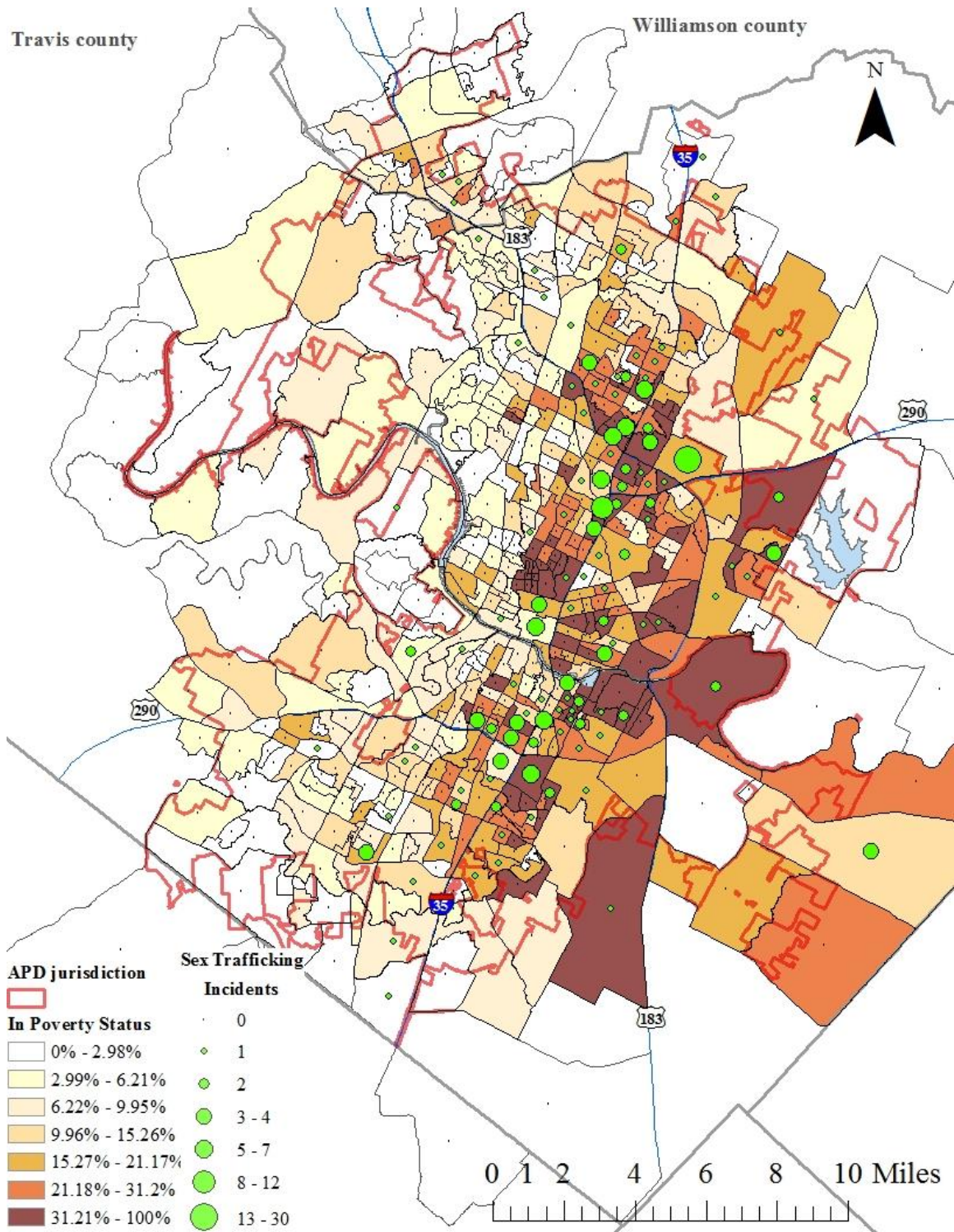


Figure 19: Percent of households in poverty status and sex trafficking activity in Austin, Texas at the census block group level (N=519).

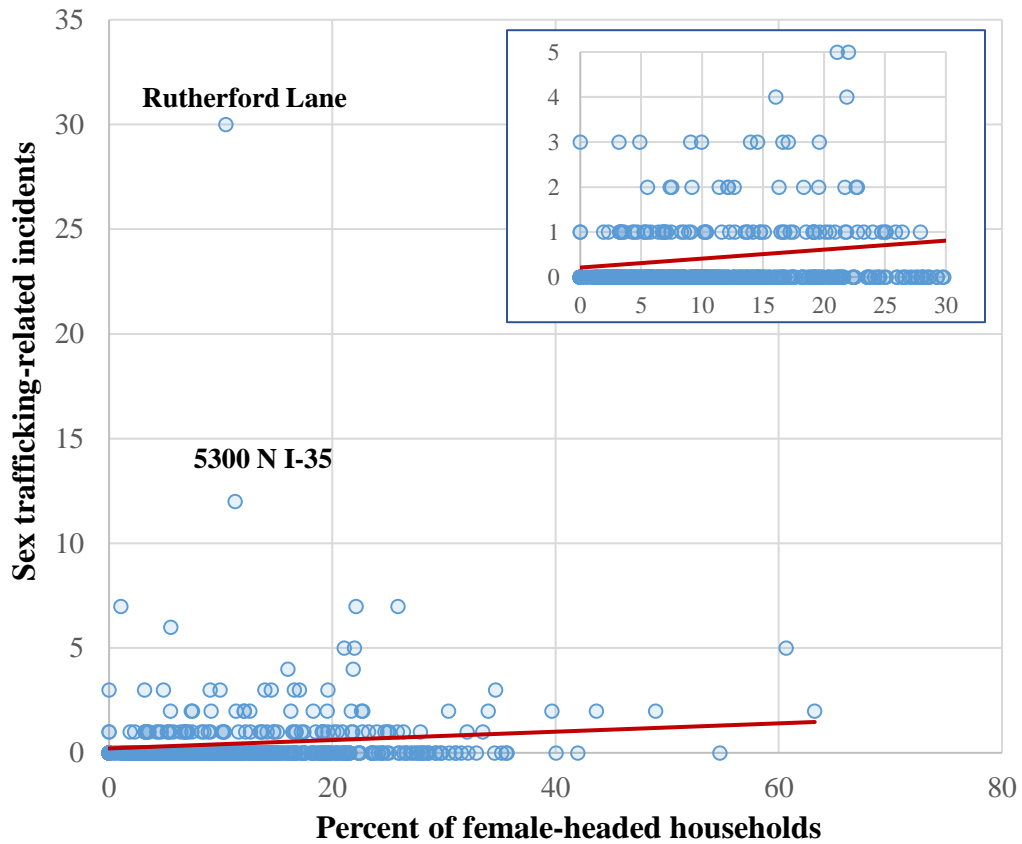


Figure 20: Scatterplot displaying association between sex trafficking-related crime counts and the percentage of female-headed households, at the census block group level (N=519).

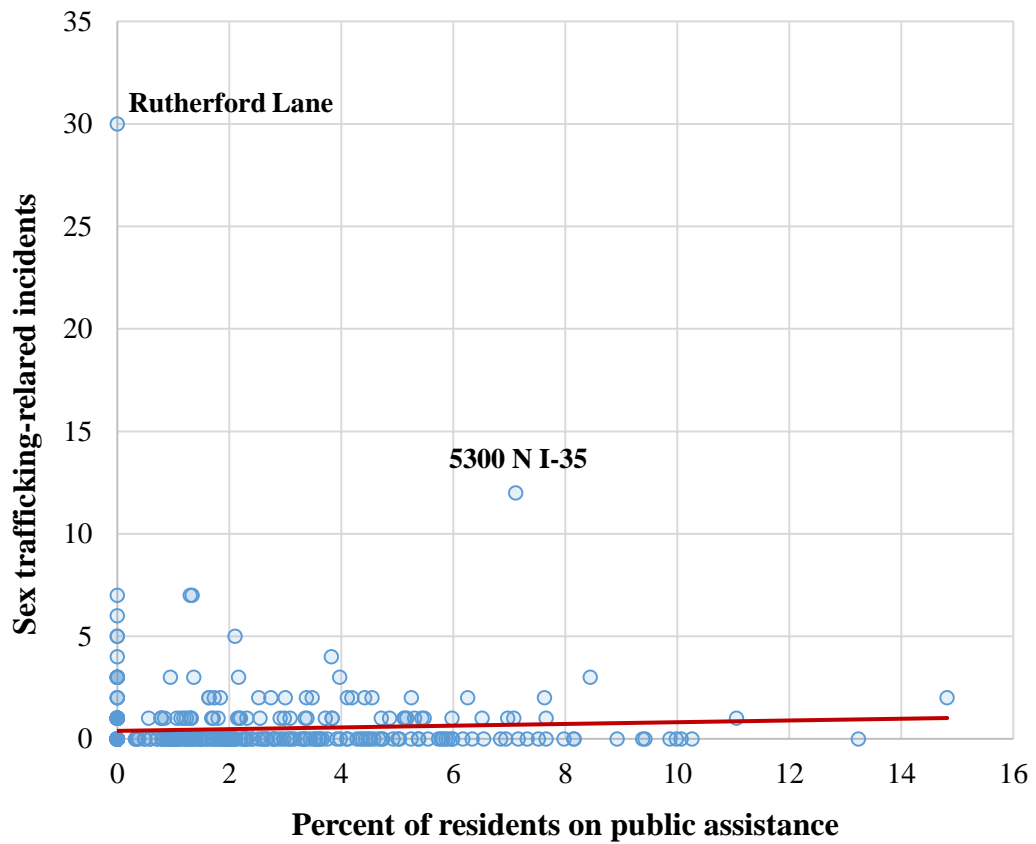


Figure 21: Scatterplot displaying association between sex trafficking-related crime counts and the percentage of households on public assistance, at the census block group level (N=519).

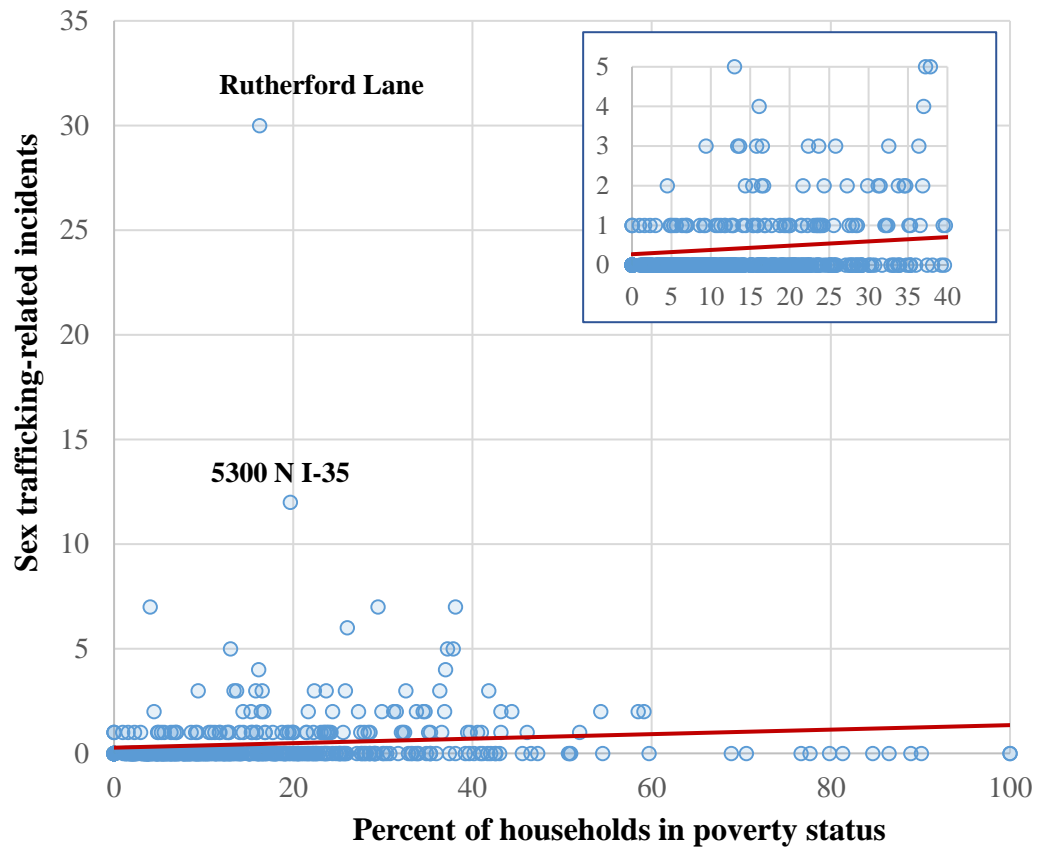


Figure 22: Scatterplot displaying association between sex trafficking-related crime counts and the percentage of households in poverty status, at the census block group level (N=519).

In regards to spatial concentrations of CBGs with high percentages of households receiving public assistance, these also appear to mirror those of sex trafficking activity, but only to a small extent (see Figures 18 and 21). The CBGs containing high, and even moderate, concentrations of sex trafficking do not appear to be in areas of high percentages of households on public assistance. There is a significant, positive, but weak relationship between the percentage of households on public assistance and the number of sex trafficking-related offenses ($r=.192$, $p<.001$). This is further represented in the scatterplot in Figure 21 which shows a very flat trendline.

Sex trafficking activity is also found to be significantly related to the percentage of households living below the poverty line (i.e., in poverty status). Such an association was again positive but weak ($\rho=.281$, $p<.001$), and is visually displayed in Figures 19 and 22.

Residential mobility

The second proxy for social disorganization was residential mobility. Figure 23 represents the percentage of residents that had moved in the previous year, at the census block group level. As before, the green graduated symbols represent the concentration of sex trafficking incidents. Figures 23 and 24 capture the fact that the relationship between sex trafficking activity and resident mobility is weak at best. This was confirmed by a Spearman correlation test which failed to reveal a significant association ($\rho=.093$, ns).

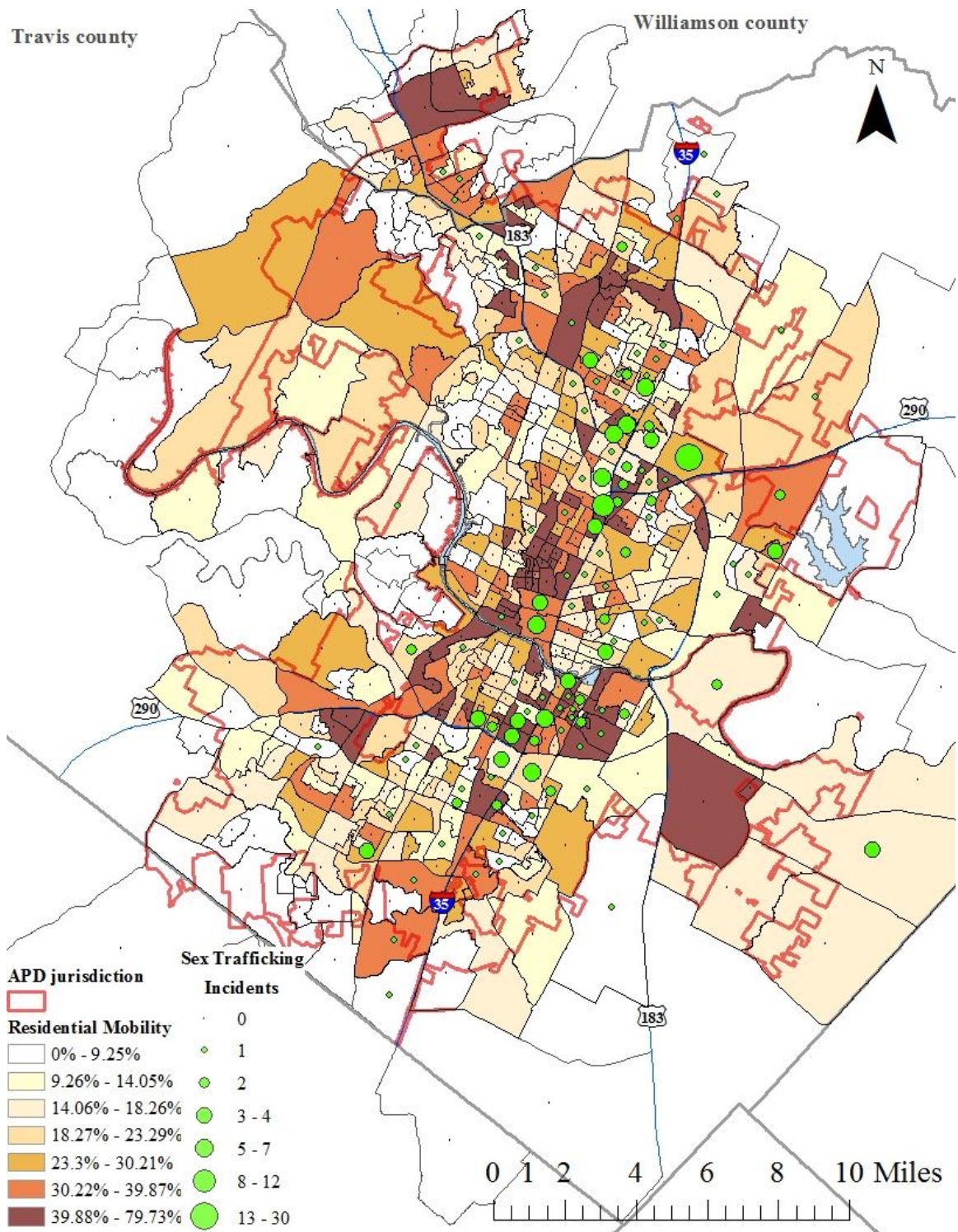


Figure 23: Percent of residents having moved in the previous year and sex trafficking activity in Austin, Texas at the census block group level (N=519).

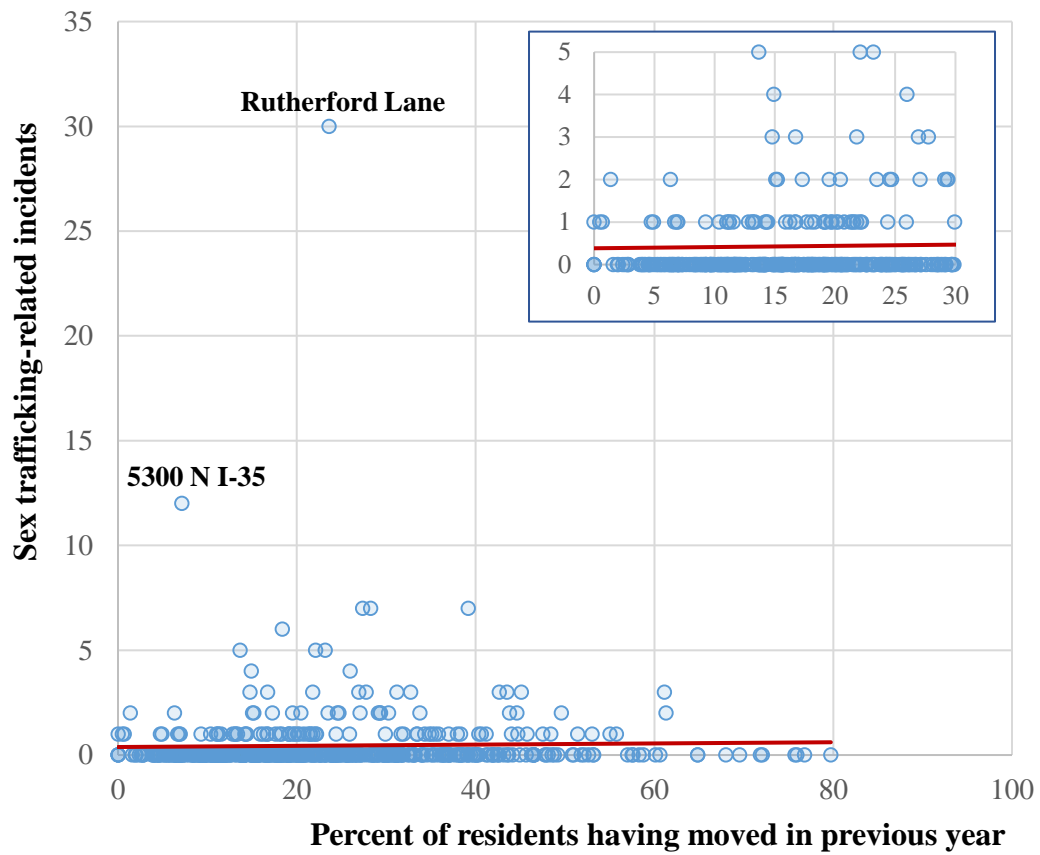


Figure 24: Scatterplot displaying association between sex trafficking-related crime counts and the percentage of residents having moved in the previous year, at the census block group level (N=519).

Racial/ethnic heterogeneity

The racial/ethnic heterogeneity variable was meant to capture the cohesiveness of the neighborhoods and is measured with an index that theoretically ranges from 0 (fully homogeneous) to 1 (uniform distribution among categories; highest heterogeneity).

Figures 25 and 26 present the relationship between racial/ethnic heterogeneity and sex trafficking activity. It appears the CBGs containing the highest concentrations of sex trafficking activity are also those of high ethnic heterogeneity. However, the slope in the trendline reveals a weak relationship, which was confirmed by a Spearman test ($\rho=.209$, $p<.001$).

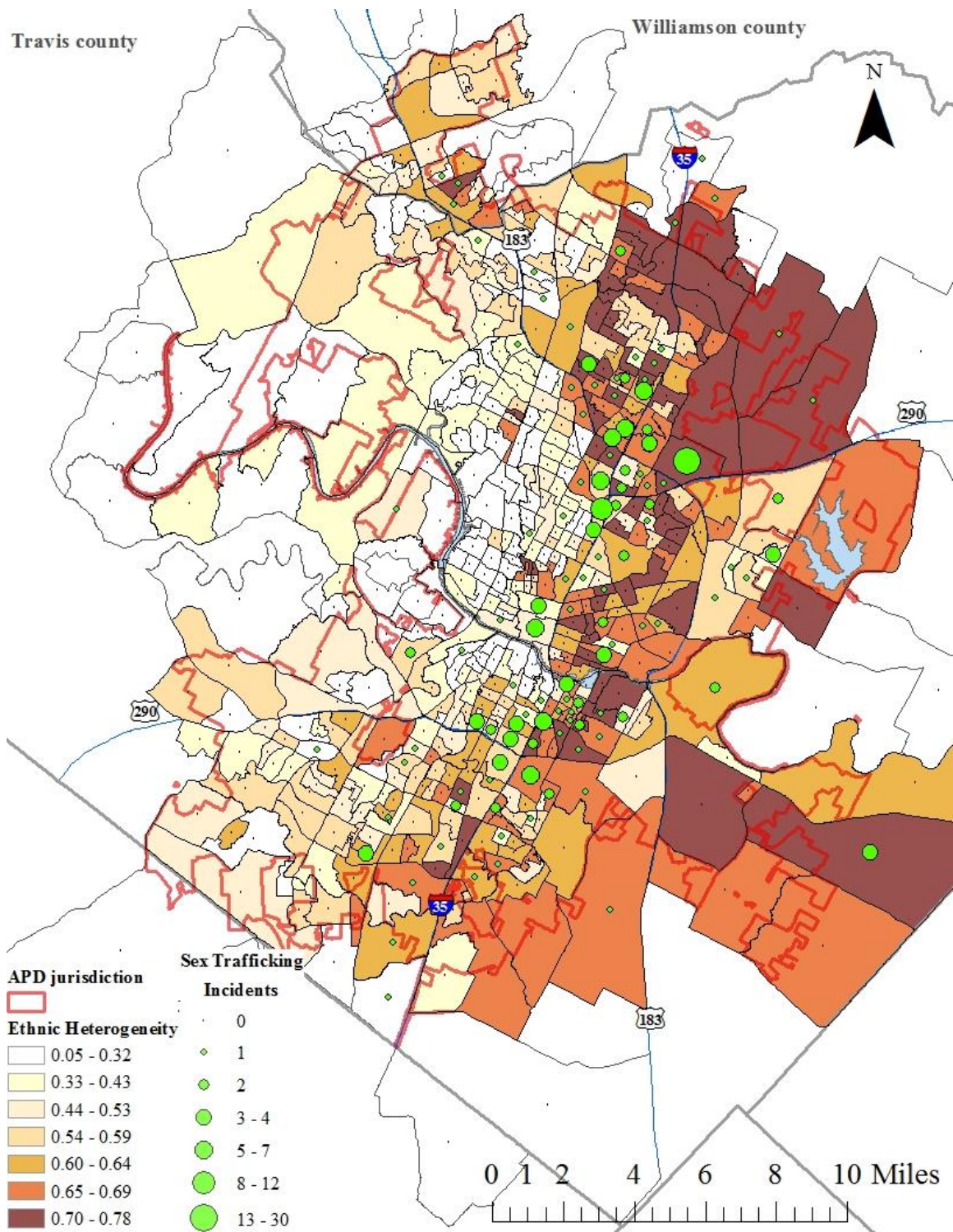


Figure 25: Racial/ethnic heterogeneity and sex trafficking activity in Austin, Texas at the census block group level (N=519).

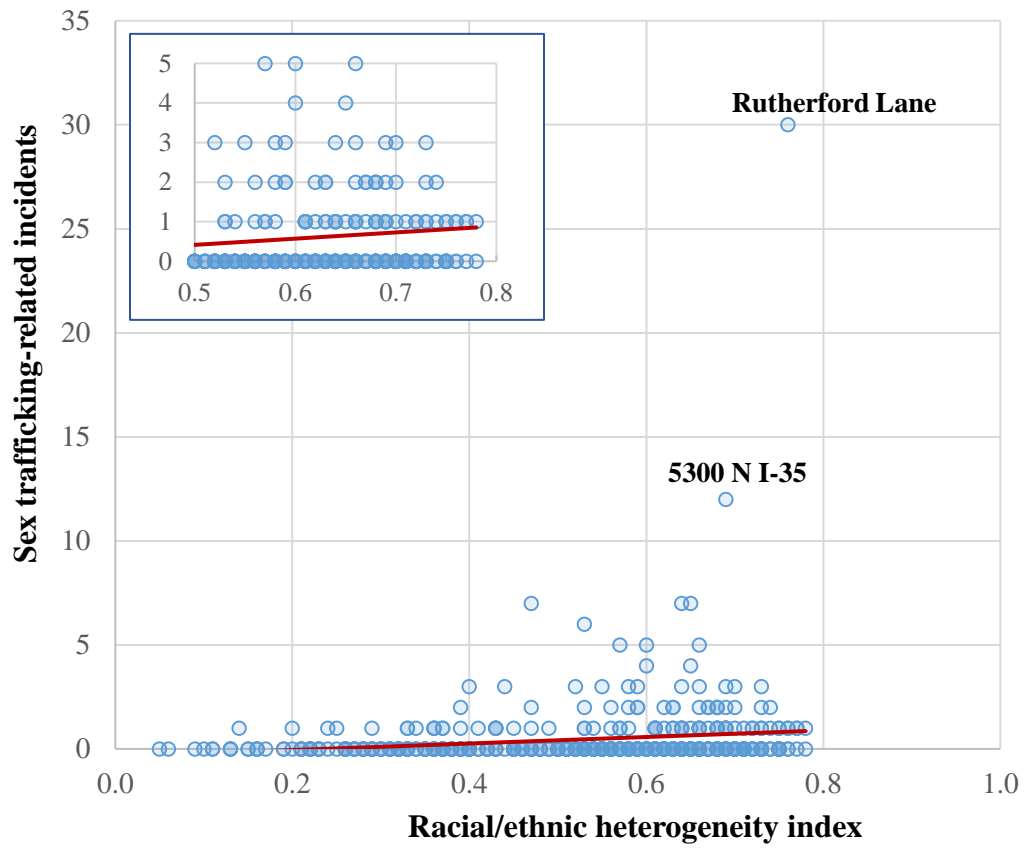


Figure 26: Scatterplot displaying association between sex trafficking-related crime counts and racial/ethnic heterogeneity, at the census block group level (N=519).

Overview of Bivariate Relationships between Sex Trafficking and Other Variables

Overall, significant positive associations were mostly detected between the number of sex trafficking-related incidents and the variables considered, with the exception of the combined distance to the highways, which was a negative association (as predicted; i.e., as distance to the highways increases, sex trafficking decreases). The other exceptions were for the number of distance-weights ATMs, where the positive association was only marginally significant, and the residential mobility variable, which yielded a non-significant association. Apart from prostitution and drug-related offenses, which yielded moderately strong coefficients (.432 and .454, respectively), all correlations were weak (see Table 2). Most correlations amongst the predictor variables were weak or moderate, with the exception of the relationship between the combined distance to the highways and the spatial lag, which yielded a significant, negative, strong correlation coefficient ($\rho = -.961$).

Table 2: Correlation matrix between sex trafficking-related incidents and all other variables.

	A	B	C	D	E	F	G	H	I	J	K	L	M
A Sex trafficking													
B Prostitution	0.43***												
C Drug-related crime	0.45***	0.61***											
D Combined distance to highways	-0.28***	-0.45***	-0.58***										
E Distance-weighted ATMs	0.15†	0.22***	0.34***	-0.19**									
F Distance-weighted gas stations	0.24***	0.36***	0.44***	-0.28***	0.38***								
G Distance-weighted cheaper (<=\$100) hotels	0.26***	0.28***	0.32***	-0.19**	0.21***	0.24***							
H Percent female-headed households	0.19**	0.21***	0.41***	-0.12	-0.03	0.11	0.05						
I Percent households on public assistance	0.19***	0.12	0.23***	-0.05	0.01	0.11	-0.03	0.21***					
J Percent households in poverty status	0.28***	0.36***	0.56***	-0.58***	0.14	0.20***	0.12	0.36***	0.18**				
K Percent residents moved prior year	0.09	0.18**	0.26***	-0.28***	0.22***	0.13	0.08	-0.07	0.06	0.32***			
L Racial/ethnic heterogeneity	0.21***	0.34***	0.48***	-0.24***	0.10	0.19**	0.12	0.45***	0.25***	0.43***	0.23***		
M Spatial lag	0.26***	0.44***	0.57***	-0.96***	0.17**	0.25***	0.16*	0.13	0.03	0.58***	0.28***	0.23***	
N Resident population	0.20***	0.14	0.31***	0.01	0.18**	0.18**	0.11	0.22***	0.14	0.19**	0.14	0.23***	0.00

Using Regression to Predict Sex Trafficking-Related Offenses

To measure the relative influence of each predictor variable on the number of sex trafficking-related incidents, regression analyses were conducted. As stated earlier, of the 519 CBGs in the sample, 408 had no sex trafficking incidents between 2013 and 2015. Because there were so many CBGs containing zero values on the outcome variable, hurdle models were implemented (Mullahy, 1986). Hurdle models involve the use of two separate regression analyses: the first is a binary logistic regression which, in this case, is implemented to determine whether a CBG contains any sex trafficking-related incidents or not; the second is a count model that is performed on only those CBGs where at least one incident was recorded, and predicts the actual number of incidents on the CBG.

Predicting presence of sex trafficking activity

Table 3 shows the differences between CBGs containing no sex trafficking-related offenses and those containing at least one. As indicated by the median and mean values presented, all patterns were in the expected direction, with CBGs containing at least one sex trafficking-related incident having higher levels of prostitution, drug-related crime, economic disadvantage, residential mobility, racial/ethnic heterogeneity, a great number of distance-weighted ATMs, gas stations and cheaper hotels, and being positioned closer to the three highways considered. Whether such differences were statistically significant was determined by the binary logistic regression described next.

Table 3: Descriptive statistics for predictor variables, for census block groups with no sex trafficking-related activity and those with at least one recorded incident.

	CBGs with no sex trafficking (N=408)			CBGs with sex trafficking (N=111)		
	Median	Mean	SD	Median	Mean	SD
Prostitution offenses	0.00	0.72	2.38	1.00	4.80	9.27
Drug-related offenses	11.00	23.44	35.23	50.00	84.37	170.33
Combined distance to highways (miles)	12.61	14.24	7.24	8.47	10.04	5.44
Distance-weighted facilities						
ATMs	0.00	0.06	0.13	0.00	0.21	0.60
Gas stations	0.00	0.06	0.11	7.46	0.15	0.17
Cheaper (\leq \$100) hotels	0.00	0.01	0.04	0.00	0.06	0.17
Concentrated disadvantage						
Percent female-headed households	9.25	11.09	8.70	13.96	15.64	11.47
Percent households on public assistance	0.00	1.28	2.22	1.32	2.24	2.70
Percent households in poverty status	10.14	15.12	16.60	20.02	22.25	13.45
Residential mobility						
Percent residents moving in prior year	19.75	23.26	15.15	22.10	25.41	14.00
Racial/ethnic heterogeneity index	0.54	0.51	0.17	0.63	0.58	0.14
Spatial lag	44.62	46.54	18.34	60.57	59.23	20.77
Resident population	1,268.00	1,466.53	906.86	1,762.00	1,850.29	970.54

In the first instance, all predictor variables were included in the regression analysis. However, there was a potential multicollinearity issue due to strong correlation between the combined distance to the highways variable and the spatial lag term. The variance inflation factor (VIF) for the combined distance to highways variable was 4.63, and the VIF for the spatial lag term was 4.82 (the mean VIF for all predictors was 2.12). Both of these are higher than the suggested acceptable VIF of 2.50, which represents an R^2 of .60 between the relevant variable and all others in the analysis (Allison, 2012). By setting this standard in the study, it became unsuitable to include the combined distance of centroids to highways variable into the regression. Since the guiding hypothesis only required a correlation to be completed for this variable, it was excluded from the regression so that the weighted facilities would not be corrupted.

For this reason, the binary regression model was rerun excluding each of these variables at a time. Due to the inherent spatial dependency of the data, it was deemed unadvisable to remove the spatial lag variable, as this might bias the results and reveal patterns that would have otherwise been explained by the spatial lag term. The adjusted models were similar to the original, however, so a decision was made to stick with the original model. Different authors call for different standards in acceptable VIF values, but it was important to perform these quality checks.

Table 3 shows the results from the binary logistic regression, which was conducted on all 519 CBGs and was determined to be statistically significant with an adjusted McFadden pseudo- p^2 value of .157 (likelihood ratio $\chi^2(13)=112.77$, $p<.001$). Only two of the predictors yielded significant coefficients, however, namely the number of drug-related offenses and the percentage of households on public assistance. A one

unit increase in the number of drug-related offenses was associated with a 0.8% increase in the odds of the CBG containing at least one sex trafficking offense. A one unit increase in the percentage of households receiving public assistance income was associated with a 12.6% increase in the odds of the CBG containing at least one sex trafficking offense.

Table 4: Binary logistic regression results with sex trafficking-related incidents as the outcome measure (N=519).

	OR	Z
Prostitution offenses	1.047	1.19
Drug-related offenses	1.008	2.12 *
Combined distance to highways (miles)	0.960	-0.89
Distance-weighted facilities		
ATMs	3.418	1.83
Gas stations	3.925	1.45
Cheaper (\leq \$100) hotels	14.888	1.48
Economic disadvantage		
Percent female-headed households	1.021	1.44
Percent households on public assistance	1.126	2.44 *
Percent households in poverty status	0.995	-0.49
Residential mobility		
Percent residents moving in prior year	0.998	-0.19
Racial/ethnic heterogeneity index	1.697	0.55
Spatial lag	1.000	0.02
Resident population	1.000	1.55
Likelihood ratio $\chi^2(13)=112.77$, $p<.001$, adjusted McFadden pseudo $\rho^2=.157$		

N.B.: (*) $p<.05$; (**) $p<.01$; (***) $p<.001$. OR = odds ratio. Constant term has been excluded from display.

Predicting incidence of sex trafficking in affected census block groups

The second model in the hurdle model approach adopted was a Poisson regression model which considered only the CBGs that contained one or more incidents of sex trafficking-related offenses (N=111). A Poisson model was determined to be a better fit because this model assumes that the dependent variable is equidispersed (i.e., the variance is equal to the mean), which was the case here. A likelihood ratio test that $\alpha=0$ (i.e., α is the dispersion parameter) confirmed this ($\chi^2=1.70$, ns). As in the binary logistic regression, all predictors were included in the model but, this time, the resident population was included as the exposure variable. The mean VIF was 2.55 (no VIF values were greater than 5) and, once again, the combined distance variable appeared to be the source of the problem. After rerunning the model and establishing the patterns remained consistent, a decision was made to retain the original model with all 14 predictors.

The model was determined to be statistically significant (likelihood ratio $\chi^2=165.11$, $p<.001$) and to have a McFadden pseudo ρ^2 of .262 (see Table 4). In this case, there were six variables that were statistically significant, namely the number of prostitution- and drug-related incidents, the combined distance to the highways, the distance-weighted hotel and ATM counts, and the spatial lag term.

An additional prostitution offense was associated with a 3.8% increase in the incidence rate of sex trafficking in the CBG, while an additional drug-related offense was associated with a 0.2% *decrease*. The latter pattern was contrary to expectation and is discussed in the next section. An additional mile in the combined distance to the highways was associated with a 7.4% decrease in the incidence ratio of sex trafficking. A

unit increase in the distance-weighted ATM variable was associated with a 71.6% increase in the incidence rate of sex trafficking in the CBG. Recall this variable was created by calculating the inverse combined distance from each ATM to the three highways, and then aggregating these to the CBG level. Thus, a unit increase in this variable may represent an additional ATM that is a total of one mile away from the highway (e.g., 0.2 miles from IH-35, 0.5 miles from U.S. 183, and 0.3 miles from U.S. 290), or an additional two ATMs each being a combined two miles away. Additional combinations and scenarios are of course possible, as this is just an illustration. The incidence rate ratio (IRR) for the distance-weighted hotel variable can be interpreted in the same fashion. In this case, a unit increase was associated with a 320.94% increase in the incidence rate of sex trafficking. Finally, a unit increase in the spatial lag term was associated with a 2.6% decrease in the incidence rate of sex trafficking.

Table 5: Poisson regression results with sex trafficking-related incidents as the outcome measure, for census block groups containing at least one sex trafficking-related incident (N=111).

	IRR	Z
Prostitution offenses	1.038	5.382 ***
Drug-related offenses	0.998	-2.514 *
Concentrated disadvantage		
Percent female-headed households	0.998	-0.277
Percent households on public assistance	0.983	-0.551
Percent households in poverty status	1.003	0.393
Residential mobility		
Percent residents moving in prior year	0.989	-1.753
Racial/ethnic heterogeneity index	1.847	0.918
Combined distance to highways (miles)	0.926	-2.455 *
Distance-weighted facilities		
ATMs	1.716	2.448 *
Gas stations	1.17	0.353
Cheaper (\leq \$100) hotels	4.209	3.975 ***
Spatial lag	0.974	-3.831 ***
Likelihood ratio $\chi^2(12)=165.11$, $p<.001$, adjusted McFadden pseudo $\rho^2=.262$		

N.B.: (*) $p<.05$; (**) $p<.01$; (***) $p<.001$. IRR = incidence rate ratio. Constant term has been excluded from display. Resident population was included as the exposure variable.

VI. DISCUSSION

The present study aimed to better understand the spatial dynamics of sex trafficking in Austin, Texas, and to identify the environmental and neighborhood variables that may influence these. The first step in the analysis, guided by *hypothesis 1*, was to determine whether sex trafficking-related offenses clustered geographically. Through KDE and thematic maps, and nearest neighbor analyses, it was determined that sex trafficking does, in fact, cluster in space. The areas of highest sex trafficking-related activity appeared to be along the IH-35 in the South Congress-Riverside area (where IH-35 intersects with US-290 south of the river), downtown, and the Rutherford Lane area (where IH-35, US-290, and US-183 converge), hinting at the possible influence of the highways in driving or facilitating this type of criminal activity.

Hypothesis 2a and *2b* referred to the association of sex trafficking-related offenses to other crime types: prostitution and drug-related offenses. The Spearman's rho correlations found that there were statistically significant positive moderate relationships between sex trafficking related-offenses and both prostitution- and drug-related offenses. Unsurprisingly, sex trafficking and prostitution had very similar spatial distributions. The spatial distribution of drug-related offenses was visually different, but this might have been due to scaling effects; in other words, the number of drug-related offenses was much greater than the number of sex trafficking- and prostitution-related offenses, and this might have affected the visual display in the KDE maps. Within the multivariate analyses, the number of drug-related offenses was found to be a significant predictor of both the presence and the incidence of sex trafficking. In contrast, the number of prostitution-related offenses was a statistically significant predictor of the number of sex

trafficking-related incidents in affected CBGs (i.e., those containing at least one sex trafficking-related offense), but not of whether a CBG would be affected in the first place.

The present results mirror those of the TXDPS and the FBI that sex trafficking and prostitution are closely linked which can at times lead to confusion in law enforcement (TXDPS, 2014; Walker-Rodriguez & Hill, 2011). For instance, both sex trafficking and prostitution were found to spatially concentrate in Rundberg and around Rutherford Lane in Austin. Rundberg Lane is known for prostitution so it is possible law enforcement may focus on arresting prostitutes and wrongly assume that victims of sex trafficking are prostitutes. The reverse, where sex workers are classified as sex trafficking victims, may also be a possibility.

Cole and Sprang (2015) and TXDPS (2014) suggested drugs are highly related to sex trafficking through several mechanisms, including victims becoming addicts, and pimps and traffickers selling drugs to prostitution clients and traffickers carrying small amounts themselves. These types of drug offenses may not always be recorded, however, in that when arresting someone for involvement in sex trafficking, law enforcement officers may not always record any co-occurring (lesser) drug-related offenses. This may have underestimated the relationship as measured.

To test *hypothesis 3a*, a combined distance from the centroid of each CBG to the three highways considered (IH-35, U.S. 183, and U.S. 290) was created, and this was found to be a statistically significant predictor of the incidence of sex trafficking-related activity (in the Poisson regression), but not of its presence (in the binary logistic regression). The importance of this variable can be seen in the maps of sex trafficking

activity in Austin, with the CBGs with the highest concentrations of sex trafficking-related activity being those that share borders with at least one highway.

These results were (partly) in line with the geography of crime literature (Brantingham & Brantingham, 1995; Cohen & Felson, 1979). Highways are said to provide anonymity to criminals in that they can enter a highway and exit it miles away in between activities and in commission of crimes (Brantingham & Brantingham, 1995; Cohen & Felson, 1979). Additionally, highways are a vital part of routine activities that people conduct in their daily lives as they travel between errands, work, home, and school (Cohen & Felson, 1979). It is only rational that such a mobile crime as sex trafficking makes use of highways to travel between various facilities that are involved in different stages of the crime and in between cities.

Hypothesis 3b predicted relevant facilities would be positively associated with sex trafficking-related incidents. Cheaper hotels (<\$100 per room per night), gas stations, and ATMs were weighted by their proximity to all three highways and shown to be positively correlated with sex trafficking, but such relationships were weak. The only facility variables that yielded significant coefficients in the multivariate regression analyses were the distance-weighted ATM and cheaper hotel counts, both of which were predictive of the incidence, but not the presence, of sex trafficking-related incidents.

ATMs were examined on the rationale they provide convenience for individuals preparing to purchase sexual services, as well as generally for pimps and traffickers (Voloshin et al., 2016). The significant findings regarding the presence of ATMs in this study were consistent with Voloshin et al.'s results (2016) highlighting the influence of banks. This implies cash withdrawals and deposits may be a routine activity involved in

the various stages of the sex trafficking process. It makes sense that ATMs provide the anonymity and convenience desired for customers and traffickers involved.

In regard to hotels, Voloshin et al. (2016) found extended-stay facilities significantly predicted the spatial distribution of sex trade events. In the current study, information on whether hotels offered extended-stay rates was available, but no differences in sex trafficking activity were observed between these and other hotels, so this factor was omitted, in the interest of simplicity. Both hotels and gas stations have been facilities of particular interest to law enforcement in investigations related to sex trafficking (TXDPS, 2014; Walker-Rodriguez & Hill, 2011), but no significant patterns were detected for gas stations in the multivariate analyses conducted here.

Hypothesis 4a focused on variables representing concentrated disadvantage and their association to the spatial distribution of sex trafficking-related offenses. The percentage of female-headed households, the percentage of households on public assistance income, and the percentage of households below the poverty line were chosen to represent concentrated disadvantage and found to be weakly associated with sex trafficking activity at the CBG level in the bivariate analyses. This was consistent with Chin et al.'s (2015) findings that poverty levels were significantly related to the location of illicit massage parlors (Chin et al., 2015).

In the regression analyses, however, only the percentage of households on public assistance was found to be a significant predictor of whether a CBG would be affected by sex trafficking or not (binary logistic regression). No other variables were found to be significant predictors in the binary logistic regression model, and none of the concentrated disadvantaged variables were found to be significant in the Poisson

regression, which predicted the incidence of sex trafficking. The lack of significant findings in this area may be due to the fact it is likely the (police-recorded) sex trafficking-related incidents considered in this study relate to the *transaction* stage; it is possible areas of high concentrated disadvantage are instead targeted for the *recruitment* and/or *harboring* of victims. Incidents relating to victim recruitment and harboring would be less likely to be recorded by police, as they are meant to be covert to all besides the victim and the trafficker, leaving the potential for a large dark figure of crime. Further research with alternative data sources, such as intelligence records of closed cases or ethnographic observations, would be needed to clarify these issues.

The second measure related to social disorganization was the racial/ethnic heterogeneity of neighborhoods, and this was the focus of *hypothesis 4b*. As predicted, and in line with previous research (e.g., Chin et al., 2015), there was a significant positive bivariate correlation between this variable and the number of sex trafficking-related incidents, but this relationship was weak. The regression models failed to detect a significant effect, either for the presence or the incidence of sex trafficking. This may be due to the scenario described above: ethnic heterogeneity may not be a significant predictor of police-recorded sex trafficking-related offenses because it drives recruitment and/or harboring, rather than commercial sex transactions. Again, further research needs to be conducted on which stages of the crime of sex trafficking are captured most often by police data to fully understand the relationship between these variables.

Hypothesis 4c predicted residential mobility would be associated with an increase in the number of sex trafficking-related offenses. This variable is thought to lead to social disorganization as neighbors moving frequently would disrupt the unity and ownership of

the community. Once again, a bivariate correlation hinted at a significant weak association in the expected direction, but no statistical effects were detected in the multivariate analyses. Again, this may be due to the data not capturing specific stages of sex trafficking that may take place in such communities. Alternatively, residential mobility – and the other social disorganization variables – may not be related to sex trafficking when other factors are considered.

Overall, the current findings had both similarities and differences when compared to the guiding literature. Any discrepancies observed could be resulting from differences in the settings or how data are recorded. Sex trafficking has many different facets and the data gathered from APD may only capture specific stages of sex trafficking such as the selling or purchasing of the victim/sex. There may be few sex trafficking-related incidents that are detected by law enforcement in residential areas, or relating to the harboring, transporting, or recruiting of victims. Were such data available, any associations observed, especially in regard to the social disorganization variables, may have been stronger.

Policy Implications

Given the findings of this study, there are several potential considerations and implications for policy and practice. Since sex trafficking was found to significantly cluster in specific places, some of which are the very same areas where prostitution clusters, it would be rational to take a deeper look into these areas. A more detailed problem-solving analysis may be performed to determine what makes these areas criminogenic. There may be some environmental factor was not considered in the present study that can account for the spatial concentrations observed. Law enforcement could

take a closer look into these areas to determine what else may be going on in these neighborhoods and develop prevention measures to disrupt the activity. Following these analyses, one possible response may be to implement community policing or problem-oriented policing programs in these communities in an effort to reduce and prevent future sex trafficking-related activity. Further research is clearly needed, ideally using alternative data sources that would better help determine how law enforcement and other community institutions can disrupt the activity.

Areas where sex trafficking and prostitution cluster may need further enforcement and prevention efforts implemented by law enforcement. Since increasing enforcement is often too expensive, partnering with non-profit organizations may be a logical pursuit. Non-profit organizations could provide services to sex workers and possible sex trafficking victims in getting them involved with education or skill development programs, addressing their housing and health needs, and providing them with alternative options outside of the sex trade. Short-term shelters for victims wishing to escape the sex trade life could be built in these areas to enable their engagement and provide a safe place for them to hide before they are transported to longer-term safe houses further away.

In regard to hotels, especially those close to highways and/or where sex trafficking-related offenses have been previously detected, law enforcement and other agencies could educate owners/managers about the dangers involved in sex trafficking and how they may be liable if such activity is detected on their premises. The city could also provide incentives for hotels partnering with law enforcement to combat this issue.

Further research is needed to determine whether the significant effects observed (or lack thereof) may be a reflection of the data possibly concentrating on specific stages

of the sex trafficking process. Additional studies could expand this research into other cities in Texas, as well as other states, to determine whether broader patterns are discovered. These results may be specific to Austin, Texas, and cannot be generalized to other cities without further study replications. It would be beneficial to the scientific community and local law enforcement agencies for studies to focus on specific stages in the sex trafficking process to develop and implement more direct strategies to combat every stage in the process.

APPENDIX SECTION

Scatterplots representing the relationship between sex trafficking activity and the number of ATMs, gas stations, and cheaper hotels (i.e., up to \$100 per room per night) are presented below.

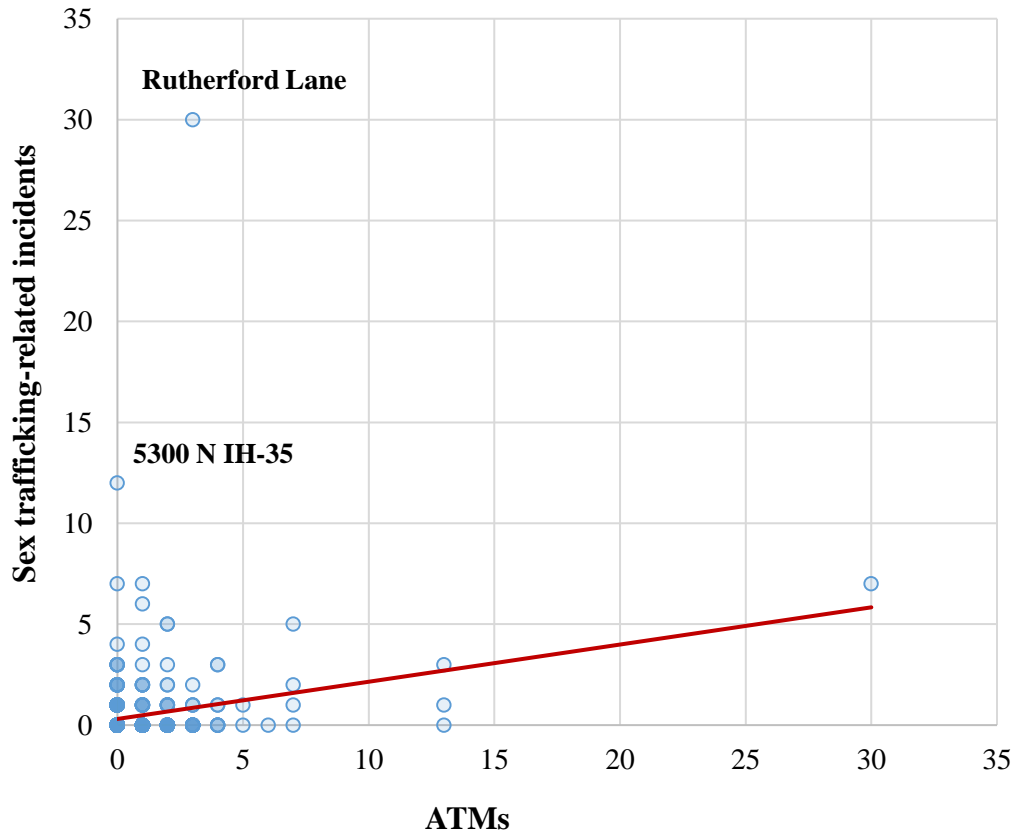


Figure 27: Scatterplot displaying association between sex trafficking-related crime counts and the number of ATMs, at the census block group level (N=519).

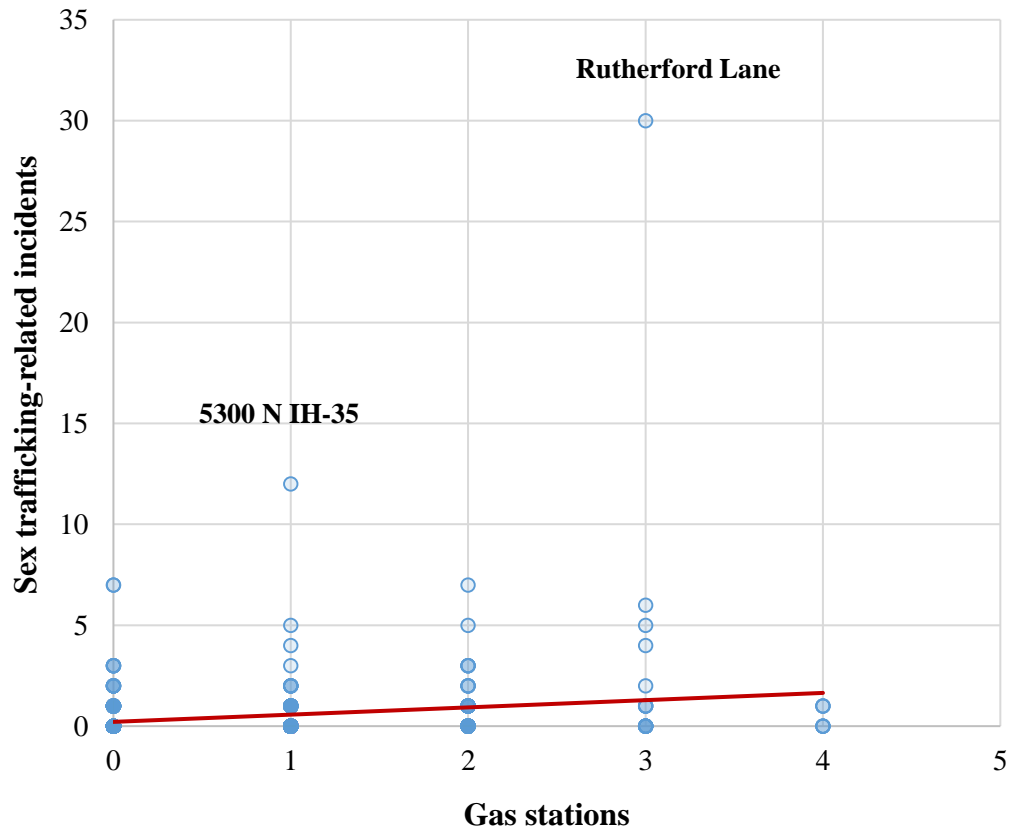


Figure 28: Scatterplot displaying association between sex trafficking-related crime counts and the number of gas stations, at the census block group level (N=519).

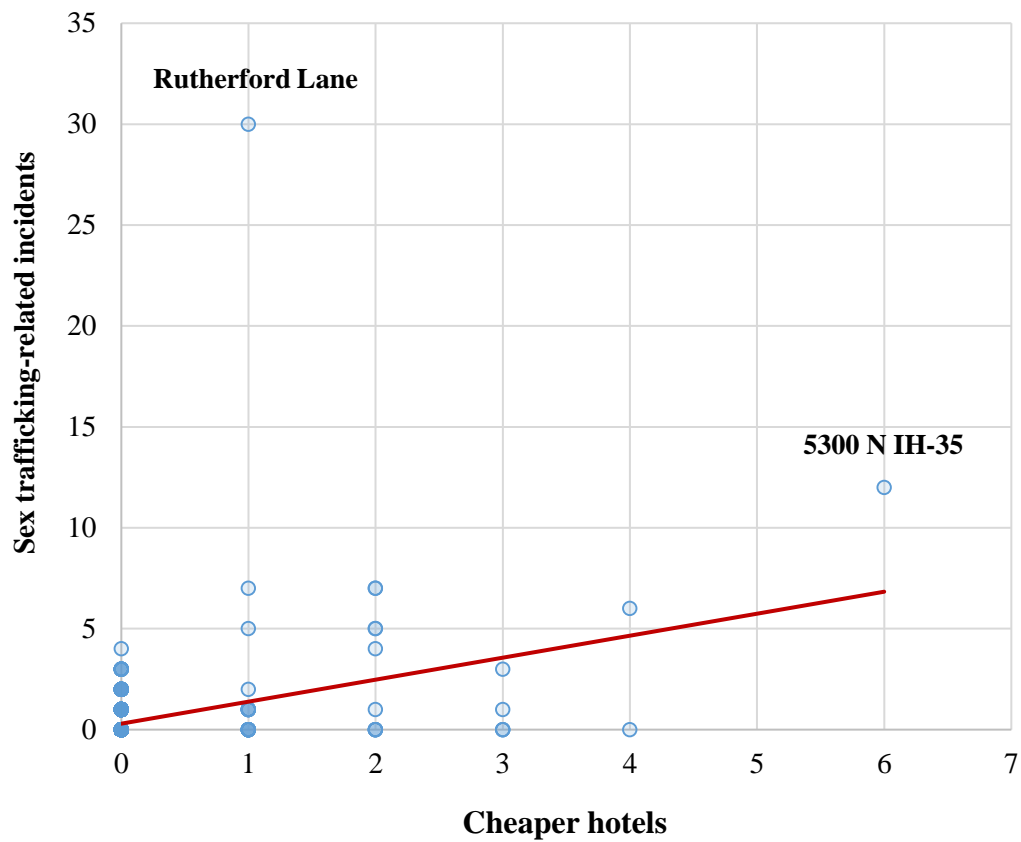


Figure 29: Scatterplot displaying association between sex trafficking-related crime counts and the number of cheaper ($\leq \$100$) hotels, at the census block group level (N=519).

REFERENCES

- A21 (2016). *Human trafficking*. Retrieved on 10/21/2016 from <http://www.a21.org/content/human-trafficking/gl0ryw>
- Agresti, A., & Agresti, B. F. (1978). Statistical analysis of qualitative variation. *Sociological Methodology*, 9, 204-237.
- Allison, P. (2012) *When can you safely ignore multicollinearity?* Retrieved on 2/23/2017 from <http://statisticalhorizons.com/multicollinearity>
- Bachman, R., & Schutt, R. K. (2013). *The practice of research in criminology/y and criminal justice* (5th ed.). Thousand Oaks, CA: Sage.
- Bernasco, W., & Block, R. (2011). Robberies in Chicago: a block-level analysis of the influence of crime generators, crime attractors, and offender anchor points. *Journal of Research in Crime and Delinquency*, 48, 33-57.
- Brantingham, P., & Brantingham, P. (1995). Criminality of place. *European Journal on Criminal Policy and Research*, 3, 5-26.
- Brayley, H., Cockbain, E., & Laycock, G. (2011). The value of crime scripting: Deconstructing internal child sex trafficking. *Policing*, 5, 132-143.
- Bureau of Justice Statistics. (2011). *Characteristics of suspected human trafficking incidents, 2008-2010* (USDJ Publication No. NCJ 233732). Washington, DC: U.S. Department of Justice.

- Bursik, R. J. (1988). Social disorganization and theories of crime and delinquency: Problems and prospects. *Criminology*, 26, 519-552.
- Chin, J. J., Kim, A. J., Takahashi, L., & Wiebe, D. J. (2015). Do sexually oriented massage parlors cluster in specific neighborhoods? A spatial analysis of indoor sex work in Los Angeles and Orange Counties, California. *Public Health Reports*, 130, 533-542.
- Clawson, H. J., Dutch, N., Salomon, A., & Grace, L. G. (2009). *Human trafficking into and within the United States: A review of the literature*. U.S. Department of Health and Human Services. Retrieved on 07/16/2016 from <https://aspe.hhs.gov/basic-report/human-trafficking-and-within-united-states-review-literature>
- Cohen, L. E., & Felson, M. (1979). Social change and crime rate trends: A routine activity approach. *American Sociological Review*, 44, 588-608.
- Cole, J., & Sprang, G. (2015). Sex trafficking of minors in metropolitan, micropolitan, and rural communities. *Child Abuse & Neglect*, 40, 113-123.
- Della Giusta, M., Di Tommaso, M., & Strøm, S. (2008). *Sex markets: A denied industry*. New York, NY: Routledge.

Estes, R. J., & Weiner, N. A. (2001). *The commercial sexual exploitation of children in the US, Canada and Mexico*. University of Pennsylvania, School of Social Work, Center for the Study of Youth Policy. Retrieved on 03/15/2016 from http://abolitionistmom.org/wp-content/uploads/2014/05/Complete_CSEC_0estes-weiner.pdf

Farrell, A., & Cronin, S. (2015). Policing prostitution in an era of human trafficking enforcement. *Crime, Law and Social Change*, 64, 211-228.

Felson, M. and R.V. Clarke (1998). *Opportunity makes the thief: Practical theory for crime prevention*. (Police Research Series Paper 98.) London, UK: Policing and Reducing Crime Unit, Home Office Research, Development and Statistics Directorate.

Gottfredson, D. C., McNeil, R. J., & Gottfredson, G. D. (1991). Social area influences on delinquency: A multilevel analysis. *Journal of Research in Crime and Delinquency*, 28, 197-226.

Hadjiyanni, T., Povlitzki, M., & Preble, H. (2014). The placeness of sex trafficking—instilling consciousness through Minnesota's experience. *Journal of Interior Design*, 39, 1-16.

Hom, K.A., & Woods, S. J.(2013). Trauma and its aftermath for commercially sexually exploited women as told by front-line service providers. *Issues in Mental Health Nursing*, 34, 75-81.

- Kenyon, S., & Schanz, Y. (2014). Sex trafficking: Examining links to prostitution and the routine activity theory. *International Journal of Criminology and Sociology*, 3, 61-76.
- Latonero, M. (2011). Human trafficking online: The role of social networking sites and online classifieds. *Center on Communication Leadership & Police*, University of Southern California. Retrieved on 09/18/2016 from <http://dx.doi.org/10.2139/ssrn.2045851>
- Levitt, S. D., & Venkatesh, S. A. (2007). *An empirical analysis of street-level prostitution*. Working Paper, University of Chicago. Retrieved on 10/19/2016 from http://www.prostitutionresearch.info/pdfs_all/Prostitution%205.pdf
- Lipton, R., Yang, X., A. Braga, A., Goldstick, J., Newton, M., & Rura, M. (2013). The geography of violence, alcohol outlets, and drug arrests in Boston. *American Journal of Public Health*, 103, 657-664.
- McCord, E. S., & Ratcliffe, J. H. (2007). A micro-spatial analysis of the demographic and criminogenic environment of drug markets in Philadelphia. *Australian & New Zealand Journal of Criminology*, 40, 43-63.
- Mullahy, J. (1986). Specification and testing of some modified count data models. *Journal of Econometrics*, 33, 341-365.
- Neag, R., & Deac, V. (2012). The prevention of human trafficking by geographic information systems technology. *Curentul Juridic, The Juridical Current, Le Courant Juridique*, 50, 97-103.

- Neuman, M., & Bright, E. (2008). *Texas urban triangle: Framework for future growth*. Report No. SWUTC/08/167166-1. College Station, TX: Texas Transportation Institute, Texas A&M University System.
- Reid, J. A. (2010). Doors wide shut: Barriers to the successful delivery of victim services for domestically trafficked minors in a southern US metropolitan area. *Women & Criminal Justice, 20*, 147-166.
- Reid, J. A. (2012). Exploratory review of route-specific, gendered, and age-graded dynamics of exploitation: Applying life course theory to victimization in sex trafficking in North America. *Aggression and Violent Behavior, 17*, 257-271.
- Reid, J. A. (2014). Entrapment and enmeshment schemes used by sex traffickers. *Sexual Abuse: A Journal of Research and Treatment, 1-21*. doi: 10.1177/1079063214544334.
- Sampson, R. J., & Groves, W. B. (1989). Community structure and crime: Testing social-disorganization theory. *American Journal of Sociology, 94*, 774-802.
- Sampson, R. J., & Wooldredge, J. D. (1987). Linking the micro- and macro-level dimensions of lifestyle--routine activity and opportunity models of predatory victimization. *Journal of Quantitative Criminology, 3*, 371-393.
- Shaw, C. R., & McKay, H. D. (1942). *Juvenile delinquency and urban areas*. Chicago, IL: University of Chicago Press.

- Siregar, D. (2013). *Spatial regression approach in determining factors affecting percentage of human trafficking victims in west Java*. Bogor Agricultural University, Indonesia. Retrieved from Scientific Repository (2013-03-20T07:18:40Z).
- Spina, M. (2016). *New techniques for combatting human trafficking; specifically through the analysis of anti-money laundering and geographic data visualization technology*. Doctoral dissertation, UTICA College, New York.
- Summers, L., & Johnson, S. D. (2016). Does the configuration of the street network influence where outdoor serious violence takes place? Using space syntax to test crime pattern theory. *Journal of Quantitative Criminology*, 1-24. doi: 10.1007/s10940-016-9306-9
- Texas Department of Public Safety (2014). *Assessing the threat of human trafficking in Texas*. Retrieved on 03/05/2016 from https://www.txTXDPS.state.tx.us/director_staff/media_and_communications/2014/txHumanTraffickingAssessment.pdf
- Texas Transportation Institute. (2008). *Texas urban triangle: Framework for future growth*. College Station, TX: Neuman & Bright.
- Texas Penal Code Title 9.43.05
- United States Department of State. (2010). *Trafficking in persons report*. Washington, D.C.: U.S. Government Printing Office. Retrieved on 03/05/2016 from <http://www.state.gov/documents/organization/142979.pdf>

Victims of Trafficking and Violence Protection Act of 2000, 22 U.S.C. 7101

Voloshin, D., Derevitskiy, I., Mukhina, K., & Karbovskii, V. (2016). Identifying venues for female commercial sex work using spatial analysis of geocoded advertisements. *Procedia Computer Science*, 80, 345-355.

Walker-Rodriguez, A., & Hill, R. (2011). Human sex trafficking. *FBI Law Enforcement Bulletin*. March issue.

Zhang, S. X. (2009). Beyond the 'Natasha' story—a review and critique of current research on sex trafficking. *Global Crime*, 10, 178-195.

18 U.S.C. § 1591 Sex trafficking of children or by force, fraud, or coercion.