Geographical Clusters of Sexual Offenders and Predators in Florida: 2015

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Introduction

Background

At the University of West Florida, Statistics Research is a two-semester course. For the first semester, Fall 2015, this class was charged with "identifying through the use of a modern cluster analysis, geographical areas in Florida where there are significantly higher (or lower) rates of Registered Sexual Predators & Offenders," by Dr. Raid Amin, Professor of Mathematics & Statistics. The class first had to learn and understand various methods of statistical research, including gathering initial data, validating, modifying the data so that it can be easily used in statistical analysis software, and then refining the data based on additional research and discussions from the students as to what would be useful or helpful in fulfilling our charge. The initial data was downloaded by Dr. Amin from the Florida Department of Law Enforcement and passed on to the students in the class. While the class had access to the names of those on the list, we were only interested in their physical addresses and race; therefore, no names are used in this report. Several students combed through the data and removed records based on several criteria, such as deceased, confined, deported, or were in some way not beneficial in reporting their whereabouts to compare to the surrounding population, such as an unknown street address. In order to use the data in a more efficient manner, the data were normalized using SAS. The addresses were geo-coded for latitude and longitude, as well as census tract, using a geo-coder provided on the Census Bureau website (United States Census Bureau). Statistical analysis software, including SAS, SaTScan and ArcGIS, were used for analysis and creating cluster maps and tables for use in the final report.

Literature Review

While there is an extensive of amount of research that has been done in the last 15 years in regards to sex offenders, a few of the more widely studied areas have been the implementation and unintended consequences of registering with local and state governments, housing restrictions, and employment related issues. This report looks at registered sex offenders (RSOs) in the state of Florida and some of the possible underlying reasons why there are more clusters located north of the I-4 corridor and in the panhandle versus the southern part of the state.

Much of the research agrees that poverty, high residential turnover, and racial and ethnic heterogeneity can create disorder in neighborhoods, which are the same or similar to the neighborhoods that RSOs came out of, and thus return to after release (Clark & Duwe, 2015; Rydberg, Grommon, Heubner, & Bynum, 2014). It has been shown that those that live in socially disorganized neighborhoods invest little in them and thus do not involve themselves in local issues, including criminal activity (Clark & Duwe, 2015). While Socia, Levenson, Ackerman, and Harris believe that the logic behind sex offender residence restriction (SORR) laws is to keep RSOs from living near gathering places of children and thus re-offending, they in fact severely restrict housing options for RSOs. In cities where there are available housing options outside of these neighborhoods, there are few places that are compliant with the SORR laws, the housing locations may be in more affluent neighborhoods

in which RSOs can't afford the dwelling, and many landlords will not renew leases of RSOs (Socia et al., 2014).

Where there are neighborhoods, there are schools and, therefore, children. In a study conducted by Mustaine, Tewksbury, and Stengel they propose that RSOs use the idea of routine activity theory to select their residential location because of the proximity to potential victims. The theory's perspective suggests that offenders choose their residence based on where there is opportunity to re-offend, rather than being forced into a location because of SORR laws or stigmatization (Mustaine, Tewksbury, & Stengel, 2006).

One question that was discussed among the students in the class, but not able to be answered with our analysis, was why do RSOs move from one city, such as Miami, to another city, such as Pensacola. While it can be easily agreed on that some factors that come into play are the SORR laws, as well as economics, Rydberg and colleagues (2014) also suggest that moving frequently affects the development of social networks by the released offenders.

Sex offenders throughout the United States are required to register themselves within their respective states. Some states, including Florida, have adopted sexual offender residency restrictions, sometimes referred to as SORRs. These restrictions keep offenders at a distance from places where children congregate, namely schools, bus stops, child care facilities, parks, and playgrounds. A study by researchers at the University of South Florida and the University of Nevada found that living options to offenders in urban residential areas may be limited to only 5% of all potential living quarters due to these restrictions, and that bus stops are the factor that impacts this figure the most (Zandbergen).

Scope/Methods

Scope

In this study, students in Dr. Amin's statistical research class gathered data about sexual offenders in Florida. Students used spatial cluster analysis tools to investigate the claims that the sexual offender population in Florida was not evenly dispersed around the entire state, but rather concentrated in certain areas. A sexual offender is defined by Florida statutes as a person who has violated at least one qualifying sex offense outlined in Appendix A. A sexual predator is defined as a person who has been convicted of a violent sexual act as outlined in Appendix A. For the purposes of this project, we did two different analyses. The first analysis was on a data set with combined totals of sexual offenders and predators for each Florida census tract. The second analysis was with sexual predator data only.

To investigate the dispersion of sexual offenders in Florida, we used the software SaTScan to do a cluster analysis, looking for clusters of sexual offenders that are unusually concentrated. We used

current location data for sexual offenders and separated them into census tracts. We analyzed the plain data, and then we analyzed the clusters after adjusting them for the following characteristics of the census tracts: median age, poverty, population density, and school density.

Data Cleaning

The sexual offender and predator data is current through September 15, 2015 and was downloaded from the Florida Department of Law Enforcement. The listing originally included 67,365 records, but the majority of these records were unusable for various reasons. The following numbers of records were removed due to the statuses of the offenders: 996 'deceased,' 2,426 'deported,' 756 'absconded,' 580 'civil commitment,' 17,797 'confinement,' 1,822 'supervised (due to duplication, confinement, out-of-state, hospitalization).' Records with unusable addresses or other address conflicts were then excluded; 18,169 records were removed. Duplicates were removed as well, totaling 61 records. All records were then geo-coded for longitude/latitude coordinates using the Census Bureau's geo-coder. The geo-coder did not recognize 2,665 addresses, so we removed these addresses. The final dataset on which to conduct our analysis included 19,740 offenders and 2,353 predators for a combined total of 22,093 subjects.

Basic Data Exploration

A spatial distribution of sex offenders residing in Florida at the 2010 census tract level is revealed in the following choropleth map.

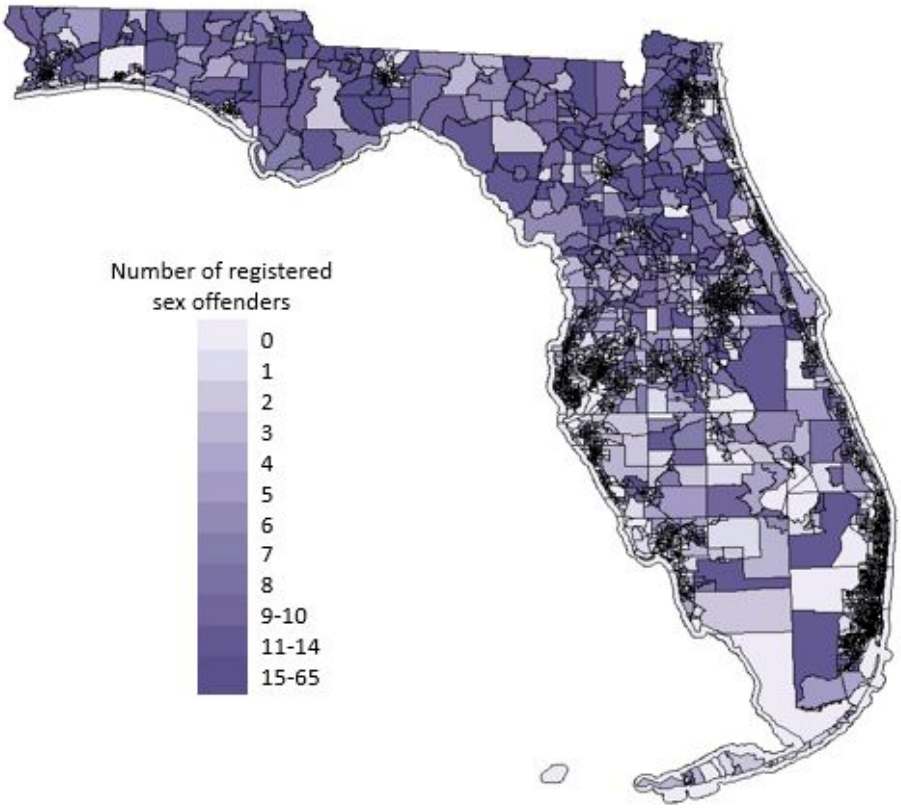

Figure: Spatial distribution of Florida sex offenders at the census tract level.

Census tract data contain a wealth of demographic data. In this summary narrative, census tract demographic data were combined with other demographic data sources and those data were spatio-statistically transformed in order to expose significant localized distributions (clusters) of sex offenders. Attributes of census tracts spatially bounded by those clusters were revealed by a series of statistical analysis. In 2010, Florida had 4,173 census tracts which meant the data sample size for each covariate was that number. These census tracts were used on all the analyses in this report. A summary statistical calculation showed the following:

Variable	Mean	Standard Deviation	Median	Minimum	Maximum
Sex Offender Rate	0.00129	0.00242	0.0007326	0	0.07692
Poverty Rate	0.16930	0.11674	0.14199	0	0.93365
Schools per Square Kilometer	0.45877	0.75841	0.16000	0	11.71766
Median Age	42.95611	10.60673	41.20000	18.40000	82.70000
White Percent	0.77254	0.21965	0.84163	0	1.00000
Population per Square Kilometer	1486	1834	1051	0.00540	26214

Table: Sex Offender Summary Statistics at the Census Tract Level

Variable	Definition
Sex Offender Rate	count of sex offenders divided by the interpolated 2015 census tract population
Poverty Rate	2015 interpolated count of households below poverty income level divided by interpolated 2015 census tract population
Schools per Square Kilometer	2015 count of schools in the State of Florida divided by the land area of that state
Median Age	median age of a census tract population in year 2013
White Percent	2015 interpolated Caucasian population density at the census tract level
Population per Square Kilometer	state population divided by the state land area

Table: Variable Definitions

Covariate Selection

Pearson Correlation Analysis

The Pearson correlation coefficients were calculated and showed the following results:

	Sex Offender Rate	Poverty Rate	Schools per Square Kilometer	Median Age	White Percent	Population per Square Kilometer
Sex Offender Rate	1.00000	0.24139	-0.01501	-0.04391	-0.13032	-0.16034
		<0.0001	*0.3324*	*0.0046*	*<0.0001*	*<0.0001*
Poverty Rate	0.24139	1.0000	0.26612	-0.42162	-0.54535	0.15589
	<0.0001		*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Schools per Square Kilometer	-0.01501	0.26612	1.0000	-0.20628	-0.22349	0.40154
	0.3324	*<0.0001*		*<0.0001*	*<0.0001*	*<0.0001*
Median Age	-0.04391	-0.42162	-0.20628	1.0000	0.52413	-0.14973
	0.0046	*<0.0001*	*<0.0001*		*<0.0001*	*<0.0001*
White Percent	-0.13032	-0.54535	-0.22349	0.52413	1.0000	-0.09826
	<0.0001	*<0.0001*	*<0.0001*	*<0.0001*		*<0.0001*
Population per Square Kilometer	-0.16034	0.15589	0.40154	-0.14973	-0.09826	1.0000
	<0.0001	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	

Table: Pearson Covariate Correlation Matrix

From the correlation matrix, sex offender distribution showed a positive linear relationship with poverty distribution. Sex offender distributions exhibited significant negative linear relationships with 2013 median age, Caucasian population density, and total population density. No discernable correlation was observed with school density. The analysis was conducted at the census tract level.

The Pearson and Spearman Correlations are used to measure the strength of the association between two variables. The Pearson r correlation is calculated using the following formula (Correlation, 25 Nov. 2015).

$$r = \frac{N \sum xy - \sum (x)(y)}{\sqrt{N \sum x^2 - \sum (x^2)][N \sum y^2 - \sum (y^2)]}}$$

r = The Pearson r correlation coefficient

$N =$ the number of value in each data set

$\sum xy =$ the sum of the product of pairs score

$\sum x =$ sum of the x scores

$\sum y =$ sum of the y scores

$\sum x2=$ sum of the squared x scores

$\sum y2=$ sum of the squared y scores

A value of -1 indicates a perfect negative linear relationship, whereas a value of 1 indicated a perfect positive linear relationship. This test assumes that both data sets have values that are normally distributed, linear, and include homoscedasticity (the data is normally distributed along a linear regression line).

Spearman Correlation Analysis

The Spearman correlation coefficients were calculated and showed the following results:

	Sex Offender Rate	Poverty Rate	Schools per Square Kilometer	Median Age	White Percent	Population per Square Kilometer
Sex Offender Rate	1.00000	0.38376	0.00665	-0.08538	-0.19557	-0.33767
		<0.0001	*0.6674*	*<0.0001*	*<0.0001*	*<0.0001*
Poverty Rate	0.38376	1.0000	0.23044	-0.42039	-0.47896	0.14974
	<0.0001		*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*
Schools per Square Kilometer	0.00665	0.23044	1.0000	-0.26750	-0.26669	0.35721
	0.6674	*<0.0001*		*<0.0001*	*<0.0001*	*<0.0001*
Median Age	-0.08538	-0.42039	-0.26750	1.0000	0.66501	-0.21967
	<0.0001	*<0.0001*	*<0.0001*		*<0.0001*	*<0.0001*
White Percent	-0.19557	-0.47896	-0.26669	0.66501	1.0000	-0.19364
	<0.0001	*<0.0001*	*<0.0001*	*<0.0001*		*<0.0001*
Population per Square Kilometer	-0.33767	0.14974	0.35721	-0.21967	-0.19364	1.0000
	<0.0001	*<0.0001*	*<0.0001*	*<0.0001*	*<0.0001*	

Table: Spearman Covariate Correlation Matrix

The Spearman rank correlation has no assumptions about the distribution of the data and is a non-parametric test that measures the degree of the association between two variables. The Spearman rank correlation formula is below where d_i is the difference between the ranks of the corresponding x and y values, and n is the number of values in each data set (Correlation, 25 Nov. 2015).

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)}$$

Jonckheere-Terpstra Test

The Jonckheere-Terpstra test was conducted at the Florida census tract level for the following sex-offender covariates:

- population per square kilometer,
- median age per census tract for year 2013,
- poverty rate per census tract for year 2013,
- schools per square kilometer, and
- population of Caucasians per square kilometer for year 2013.

The Jonckheere-Terpstra test (or JT-test) is a nonparametric test for ordered differences among classes. In this study, SAS `PROC UNIVARIATE` was used to order each covariate into *k* quantiles which formed the basis for the JT-test classes. Designating each class of the covariate as θ i, $1 \le i \le k$, the JT-test null hypothesis was that the covariate median was the same:

$$H0: \theta 1 = \theta 2 = \cdots = \theta k$$

The alternative hypothesis was that the covariate median had an a priori ordering:

$$HA: \theta 1 \le \theta 2 \le \cdots \le \theta k, \text{ with at least one strict inequality.}$$

The computation of the JT-test statistic may be described as follows:

1. Given k classes, a sum *U* was calculated.

$$U = r=1k-1Urs, s>r.$$

A value for Urs was calculated by obtaining the sum of the number of sample *s* values that exceeded each sample *r* value, where r is the index of summation and s is an index greater than r.

2. The JT-test statistic, *Z,* was calculated using the following equation:

$$Z = U-E(U)Var(U)$$

3. With N set to the total covariate sample size and ni set to the sample size of group θ i, the variance, *Var(U)*, was calculated as:

$$\mathrm{Var(U)= N2(2N+3)- i[ni2(2ni+3)]72}$$

4. In addition, the expected value for U was calculated as:

$$\mathrm{E(U)= N2- ini24}$$

5. The z-score table was subsequently used to obtain the one-tail p-value for each covariate test statistic. The one-tail p-value was used because the hypothesis was directional.

The application of the SAS implementation of the JT-test on the aforementioned covariates yielded the following results:

1. For the population density covariate, the following JT-test p-value was calculated:

Jonckheere-Terpstra Test Population per Square Kilometer	
Statistic	2,306,143.000
Z	-22.0412
One-sided Pr < Z	<0.0001
Two-sided Pr > |Z|	<0.0001

The JT-test showed a significant difference in the sex offender proportion ordering. Based on the Z value, the proportion of sex offenders in a census tract population was inversely related to the population density of the corresponding census tract. In other words, as the population density of a census tract increased, then the proportion of sex offenders in that census tract decreased.

2. For the median age covariate, the following JT-test p-value was calculated:

Jonckheere-Terpstra Test Median Age	
Statistic	3,046,228.500
Z	-5.0309
One-sided Pr < Z	<0.0001
Two-sided Pr > |Z|	<0.0001

The JT-test showed a significant difference in the sex offender proportion ordering. Based on the Z value, the proportion of sex offenders in a census tract population was inversely related to the median age of the population of the corresponding census tract. In other words, as the median age of the population increased in a given census tract, then the proportion of sex offenders in that census tract decreased.

3. For the poverty covariate, the following JT-test p-value was calculated:

Jonckheere-Terpstra Test Poverty Rate	
Statistic	4,305,393.000
Z	-23.9101
One-sided Pr < Z	<0.0001
Two-sided Pr > |Z|	<0.0001

The JT-test showed a significant difference in the sex offender proportion ordering. Based on the Z value, the proportion of sex offenders in a census tract population was directly related to the poverty rate of the population of the corresponding census tract. In other words, as the poverty rate increased in a given census tract, then the proportion of sex offenders in that census tract increased.

4. For the school density covariate, the following JT-test p-value was calculated:

Jonckheere-Terpstra Test Schools per Square Kilometer	
Statistic	3,249,799.000
Z	-0.3586
One-sided Pr < Z	0.3600
Two-sided Pr > |Z|	0.7199

The JT-test showed that there was not a significant difference in the sex offender ordering based on the number of schools in a given census tract. The one-sided statistic value of 0.36 indicated that the null hypothesis cannot be rejected in favor of the alternative hypothesis.

5. Lastly, for the Caucasian covariate, the following JT-test p-value was calculated:

Jonckheere-Terpstra Test White Percent	
Statistic	2,724,795.000
Z	-12.4188
One-sided Pr < Z	<0.0001
Two-sided Pr > |Z|	<0.0001

Mann-Whitney U (Wilcoxon Rank Sum) test

The JT test showed that the “schools per census tract” variable is only significant when tracts with zero schools are removed from the data set. Unfortunately, this caused a loss of one-third of all the data, which is far too great a number to simply ignore. Because of this problem, the Mann-Whitney

test was run to test whether there is a significant difference between the tracts with zero schools and tracts with one school or more. “ScRank” represents the 2 categories: “0” includes tracts with no schools and “1” includes tracts with one school or more. “SoRate” is the rate of sex offenders per census tract.

Wilcoxon Scores (Rank Sums) for Variable SoRate Classified by Variable ScRank					
ScRank	N	Sum of Scores	Expected Under H0	Std Dev Under H0	Mean Score
0	1387	2624294.0	2894669.0	36566.3910	1892.06489
1	2786	6084757.0	5814382.0	36566.3910	2184.04774
Average scores were used for ties.					

Kruskal-Wallis Test	
Chi-Square	54.6725
DF	1
Pr > Chi-Square	<.0001

The Mann-Whitney U test shows that the rate of sex offenders is higher when there are school(s) present in the tract (one or more) versus zero schools present in the tract. This finding is significant with p-value < 0.001.

As for the theory behind the Mann-Whitney(Wilcoxon Rank Sum test):

Our null and alternative hypothesis are as follows:

$H_0 : F_1(x) = F_2(x);$

$H_1 : F_1(x) \neq F_2(x)$

where $F_j(x)$ is the distribution function for sample j = 1, 2.

Now, a few variables will be explained:

W = sum of the ranks of the observations for Treatment 1 (or Treatment 2).

Whether treatment 1 or 2 is chosen is arbitrary. Usually, it is treatment 1 by convention.

There are special modifications to the test statistic in the event of ties but, since the variable “SoRate” is continuous we do not have to concern ourselves with that right now. Assume that treatment 1 has m observations and treatment 2 has n observations.

1 Combine the $m + n$ observations into one group and rank the observations from smallest to largest. Find the observed rank sum, W, of treatment 1.

2 Find all the possible permutation of the ranks into which *m* ranks are assigned to treatment 1 and *n* ranks are assigned into treatment 2.

3 For each permutation of the ranks, find the sum of the ranks for treatment 1.

4 Determine the *p*-value:

Pupper=#of rank sums ≤observed rank sum W

Methodology of Poisson Regression to Adjust for Covariates

A Poisson Regression was used in SAS to predict covariate population values based on the data. The Poisson regression model used was a log-linear model of the form $log(\mu/t)= \alpha + \beta x$, where μ is the predicted sex offender number, *t* was the 2015 population estimate, α and β are model parameter estimates for the y-intercept and slope, and *x* is the value of a covariate for a particular tract. To generate this model in SAS, procedure GENMOD was used with an offset parameter specified as the log(t + 1), where *t* refers to the 2015 population estimate. The offset parameter was necessary to predict a sex offender count proportional to the population of each tract.

The six covariates which had Poisson Regression predicted values were:

1. Median Age
2. Poverty
3. Population Density
4. School Density
5. Median Age & Poverty
6. Poverty and Population Density

The predicted values were checked in triplicate by different students to ensure matching output files. These predicted values were then inputted as population files into SatScan.

Methodology of SaTScan

Using data from the FDLE-Florida Offender Registration and Tracking Services, sexual offenders and predators were identified by county (census tract). Since the number of sexual offenders and predators per county was identified in the data set, the Poisson model was incorporated for the discrete data. According to an article by Haung et al.,

> The Poisson model based spatial scan statistic (Kulldorff 1997) is a spatial statistic that has been widely used for detecting clusters of high mortality counts or rates. It uses the indirect standardization technique to obtain the expected cases under the null hypothesis of homogeneous relative risk in each strata (www.satscan.org). The key difference between the Poisson model and the weighted normal model is that the Poisson model

> approach works on count data with population information and evaluates clusters of individual cases, however, the weighted normal model approach works on regional continuous data with varying regional uncertainty and evaluates clusters of regions (such as counties) (Haung, 2009).

The population estimate for 2015 for each census tract was used for the population file. The class incorporated the respective Latitude and Longitude for each census tract in SatScan for the coordinates file.

The Likelihood Ratio Test

SaTScan utilizes the Likelihood Ratio Test for the Spatial scan statistic and obtains the p-value through Monte Carlo simulation (Han et al., 2011). According to the SaTScan user guide:

> For each location and size of the scanning window, the alternative hypothesis is that there is an elevated risk within the window as compared to outside. Under the Poisson assumption, the likelihood function for a specific window is proportional to 1:
>
> $$\left(\frac{c}{E[c]}\right)^{c}\left(\frac{C-c}{C-E[c]}\right)^{C-c} I(\ )$$
>
> where C is the total number of cases, c is the observed number of cases within the window and E[c] is the covariate adjusted expected number of cases within the window under the null-hypothesis. Note that since the analysis is conditioned on the total number of cases observed, C- E[c] is the expected number of cases outside the window. I() is an indicator function. When SaTScan is set to scan only for clusters with high rates, I() is equal to 1 when the window has more cases than expected under the null-hypothesis, and 0 otherwise. (Kulldorf, 2015).

The class used SatScan to identify high rates only for sex offenders and predators.

Methodology of SaTScan restrictions for outputs

SatScan output parameters to screen and refine the results were determined and discussed prior to running spatial analysis in SatScan. The following parameters were decided upon and then later used in ArcGIS to limit and select clusters that matched the following criteria:

1. A p-value of 0.01 was chosen when examining clusters of sex offenders and / or predators to ensure with 99% or greater accuracy that clusters were not formed by chance.

2. Gini clusters only were used. Gini clusters are clusters that belong to a distinct non-overlapping spatial region that has high (or low) rates comparative to the surrounding areas not within the cluster. Non-Gini clusters were not considered and screened out of the results because they overlap a Gini cluster and have lower rates of severity compared to the Gini cluster in which they overlap.

3. To focus more on severe sex offender and / or predator areas, clusters with relative risk < 2.0 were excluded from the results. Thus, the study is limited to clusters with rates of sex offenders and / or predators two times or more above the norm.

4. Maximum cluster size was limited to be no more than 5% of the population at risk (approximately 965797 people based on the 2015 population estimate of Florida) or no greater than a maximum radius size of 30 km. The radius number was determined by considering average census tract land area. This requirement helped to limit the number of low rate tracts that were grouped within high rate cluster circles when no maximum radius size requirement was established.

5. Finally, clusters were screened by the sum population of the tracts within. Clusters less than 25,000 people were removed to focus this study on small to average town size up to large cities rather than obscure locations.

Florida Ordinances & Policies Regarding Sex Offenders & Predators

Florida Statutes as written by the Florida State Legislature provide the laws by which sexual offenders and predators are required to abide. Some of these laws regulate where they can live, whom they can come in contact with, and what areas of a community they can be near or visit. For the purpose of this analysis, we focus only on the laws contained in the Florida Statutes. It is important to note that the law may differ from place to place or even from person to person. For example, individual cities and/or counties may have stricter ordinances in place. Also, it is possible for an offender/predator to have stricter guidelines or restrictions set forth by a judge if he or she is under supervision. Although an offender or predator is required by the state of Florida to register this does not prohibit them from living with a child or minor (The Florida Senate).

An offender or predator whose victim was under the age of 16 may not reside within 1,000 feet of a school, park, playground, or child-care facility in the case the offense was committed on or after October 1, 2004. However, if one of these gathering places is subsequently established, the offender/ predator is *not* in violation of the statute and does *not* have to relocate (The Florida Senate).

An offender or predator can visit a school or child-care facility when he notifies the principal's office and remains under direct supervision while at the facility. For purposes of voting or picking up and dropping off their own children, an offender/predator is not in violation of the statute (The Florida Senate).

Furthermore, most city and county ordinances include the following two additional exceptions to the Florida residency restriction: 1.) The offender establishes residency prior to the effective date of the ordinance, and 2.) The offender was a minor when the offense was committed and thus was not convicted as an adult. If a city and corresponding county did not adopt residency restrictions on sexual offenders and sexual predators, then the Florida statute applies.

We investigated the ordinances surrounding the top ten (by relative risk) cluster locations for non-adjusted sexual offender and sexual predator data, as well as the ordinances pertaining to eleven non-cluster locations, in an attempt to help explain the existence, or lack thereof, of clusters in certain cities.

The eleven cities that do not belong to clusters are listed from top to bottom by cardinal location; the northernmost city is listed at the top and the southernmost city is listed at the bottom. Six of the eleven cities do not have city or county ordinances that are more restrictive than Florida's SORR. However, five of the seven locations south of I-4 do have more restrictive ordinances than Florida law. Thus, the ordinances appear to help explain the non-existence of clusters in certain locations.

Non-Cluster Location	Age of Victim	Date of Ordinance	Minimum Residency Restriction
Tallahassee	<16 years	N/A	Florida Law
St. Augustine	<16 years	N/A	Florida Law. Additional extensive restrictions on physical presence within 300 feet of safe zones, including YMCA and YWCA facilities, Boys and Girls Club facilities, youth camp grounds, parks, arcades, libraries, and other locations primarily used children (09/01/09) (USA)
Apalachicola	<16 years	N/A	Florida Law ("The City of...")
Cross City	<16 years	N/A	Florida Law ("Dixie County...")
Melbourne	Any Age	05/16/06	1,000 feet of any school, day care center, park or playground (Melbourne FL)
Winter Haven	<18 years	09/24/08	2,500 feet of any school, day care center, public park, playground, or public library. Predators also prohibited from residing within 1,000 feet of any designated school bus stop or church (Winter Haven FL)
Sarasota	<16 years	N/A	Florida Law (Rose)
Arcadia	<16 years	N/A	Florida Law (Mays)
West Palm Beach	<16 years	07/28/08	1,500 feet of any school, designated school bus stop, childcare facility, park, playground, community center, or other place where children regularly congregate (West Palm Beach FL)
Coral Springs	<16 years	03/06/07	2,500 feet of any school, designated public school bus stop, child care facility, family day care home, park, playground or other place where children regularly congregate (Coral Springs FL)

Ft. Lauderdale	<16 years	10/02/07	1,400 feet of any school (students 16 or under), designated school bus stop, childcare facility, park, or playground (Ft Lauderdale FL)

The second table details the ordinances for the top ten clusters of sexual offenders and sexual predators. Nine of the top ten cluster are located in the northern half of Florida, north of Interstate 4, which connects Orlando and Tampa. Cocoa is the only cluster located south of I-4. The table shows that six of the ten cluster locations (Orlando, Cocoa, Palatka, Tampa, Marianna, and Quincy) restrict sexual offender residency based on Florida law. Two of these locations enacted additional restrictions that do not change the 1,000 minimum-foot rule. The remaining four (Jacksonville, Apopka, Daytona Beach, and Starke) cities have city or county ordinances that extend the buffer zone to 2,500 feet, which is the strictest residency restriction in Florida we have encountered in our investigation. Therefore, factors other than local ordinances must explain the locations of sexual offender and predator clusters.

Cluster Location	Relative Risk	Age of Victim	Date of Ordinance	Minimum Residency Restriction
Orlando	10.3	<16 years	N/A	Florida Law (Orlando FL)
Jacksonville	4.2	Any Age	07/01/05	2,500 feet of any school, public library, day care center, park, playground, or other place where children regularly congregate (Jacksonville FL)
Apopka	3.6	<16 years	03/07/07	2,500 feet of any school, day care center, park, playground, or other place where children regularly congregate (Apopka FL)
Cocoa	3.6	<16 years	01/10/06	Florida Law, with the addition: regardless of whether the school, day care center, park or playground lies within the jurisdictional limits of the city (Cocoa FL)
Daytona Beach	3.5	<16 years	09/21/11	2,500 feet of any school, day care center, public park, playground, library, or church, regardless of whether the school, day care center,

				park, playground, library, or church lies within the city limits (Daytona Beach FL)
Palatka	3.2	<16 years	N/A	Florida Law (Palatka FL)
Tampa	3.2	<16 years	10/03/08	Florida Law. In addition, predators cannot live at the same address as another predator, or within 1,000 feet of senior safety zones, including locations occupied primarily by senior citizens. Additional extensive restrictions on physical presence within 300 feet of child safe zones , including playgrounds and play facilities, YMCA and YWCA facilities and Boys and Girls Club's facilities, libraries, parks, youth sports facilities, youth campgrounds, skating parks and rinks, public swimming pools, amusement parks, and public zoos (Tampa FL)
Starke	3.2	<16 years	01/17/06	2,500 feet of any school, day care center, park, playground or other place where children regularly congregate (Starke FL)
Marianna	3.1	<16 years	N/A	Florida Law
Quincy	3.1	<16 years	N/A	Florida Law

Results: NOT FOR DISTRIBUTION IN ANY WAY

Though many covariates were considered, it became evident through our statistical testing that poverty and population density covariates have the most ability to explain sexual offender and / or predator clusters in Florida. Before the influence of each of these covariates is considered, clusters of sexual offenders and predators combined are discussed on the non-adjusted data, which are evident in the table below and in Figure 1.

Top Ten Sex Offender and Predator Combined Clusters					
Location	Relative Risk	Estimated 2015 Cluster Population	P-Value	Below Poverty Level	Predators to Combined Ratio
Orlando	10.3	27694	<.0001	25.8%	30.8%
Jacksonville	4.2	153611	<.0001	28.5%	13.5%
Apopka	3.6	42867	<.0001	14.3%	19.3%
Cocoa	3.6	38689	<.0001	23.1%	13.8%
Daytona Beach	3.5	42132	<.0001	37.8%	11.4%
Tampa	3.2	121099	<.0001	32.6%	15.0%
Palatka	3.2	96318	<.0001	25.8%	15.7%
Starke	3.2	59303	<.0001	17.6%	27.6%
Quincy	3.1	72687	<.0001	25.2%	15.6%
Marianna	3.1	51416	<.0001	20.2%	11.0%

Florida Offenders and Predators Combined Results

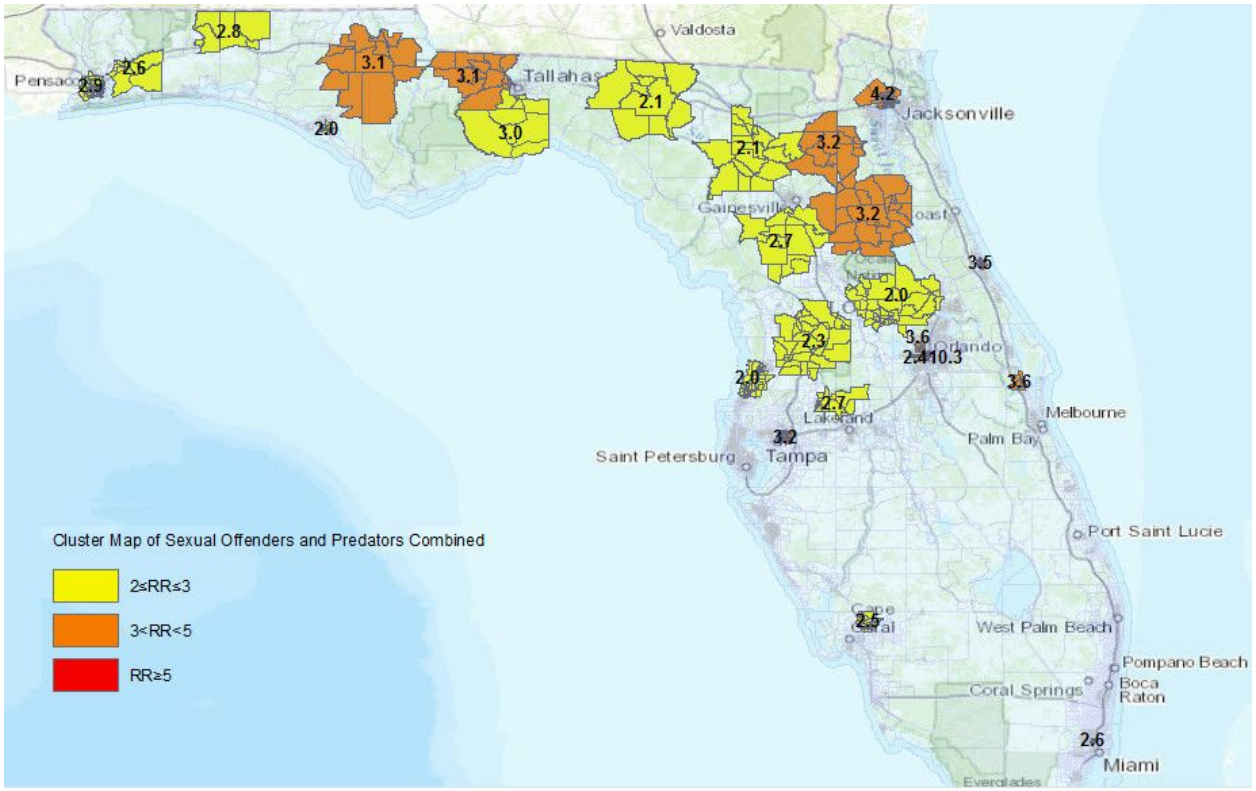

Figure 1: Cluster Map of Florida Sexual Offenders and Predators Combined by Relative Risk

For clusters of sex offenders and predators combined, most clusters are located North of Interstate 4 in Florida. The worst of these clusters based on relative risk is in proximity to Orlando with a relative risk more than ten, which indicates an elevated rate of sex offenders and predators for that area over ten times the norm. The poverty percentage here is elevated at 25.8%, which is above the state average of 16.5%. This area has the highest ratio of the offenders being predators at 30.8%, meaning roughly 3 in 10 offenders are sexual predators. This cluster has an estimated population of 27,694, which is relatively small in comparison to the second highest relative risk cluster and largest population at risk of an estimated 153,611, containing Jacksonville. The Jacksonville cluster has relative risk 4.2, over four times the rate of normal sexual offenders and predators occurrence. It also has an elevated poverty level of 28.5%, but it is less likely that the offenders are predators at a rate of 13.5%. On the outer limits of Cape Coral and Miami are two of the limited number of clusters discovered with greater than 2.0 relative risk South of Interstate 4. All of the results including the map in Figure 1 contain only clusters with relative risk greater than 2.0 and for clusters with an estimated 25,000 people or more.

Cluster Map for Sex Offenders and Predators Adjusted for Population Density

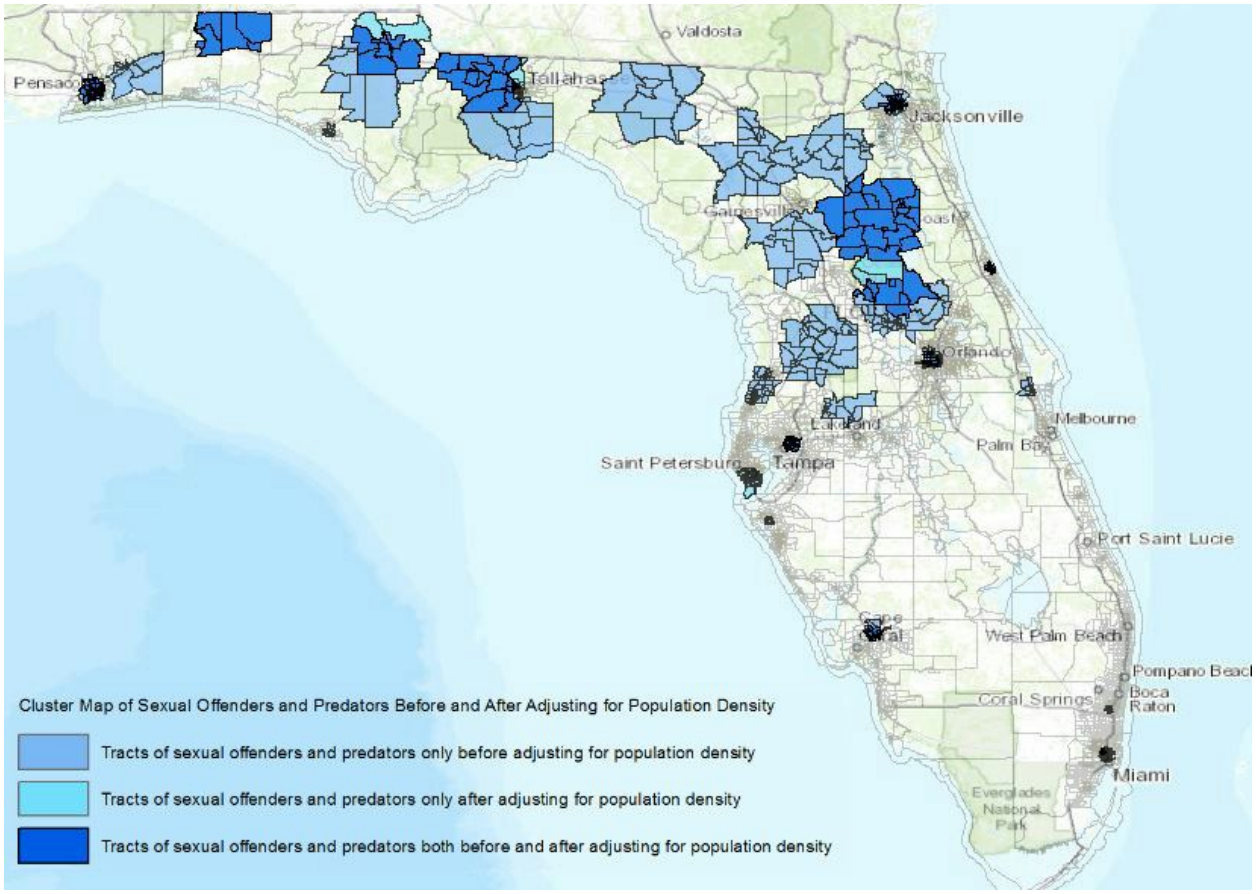

Figure 2: Map of Florida Sexual Offenders and Predators Adjusting for Population Density by Census Tract

When the data is adjusted for the role of population density, many clusters located away from major cities are explained. These clusters are shown in the first shade of light blue in Figure 2. As evidenced from the Jonckheere-Terpstra test mentioned earlier, as the population density increases, the trend is for the sexual offenders and predators is to decrease. This makes logical sense why areas away from cities, typically low population density areas, are explained by this adjustment. Significant clusters near cities, however, remained largely the same with some rising and falling in terms of their relative risks. Top clusters persisted around the major cities of Orlando and Jacksonville. Miami, Tampa, Cape Coral, Pensacola, Tallahassee, and others major cities still had unexplained clusters. A few new clusters were formed or tracts included that were previously not included in clusters. For instance, a new cluster appears North of Miami near Ft. Lauderdale. This would mean that the area north of Miami has a higher than expected rate of sex offenders and predators despite adjustment for population density.

Cluster Map for Sex Offenders and Predators Combined Adjusted for Poverty Rate

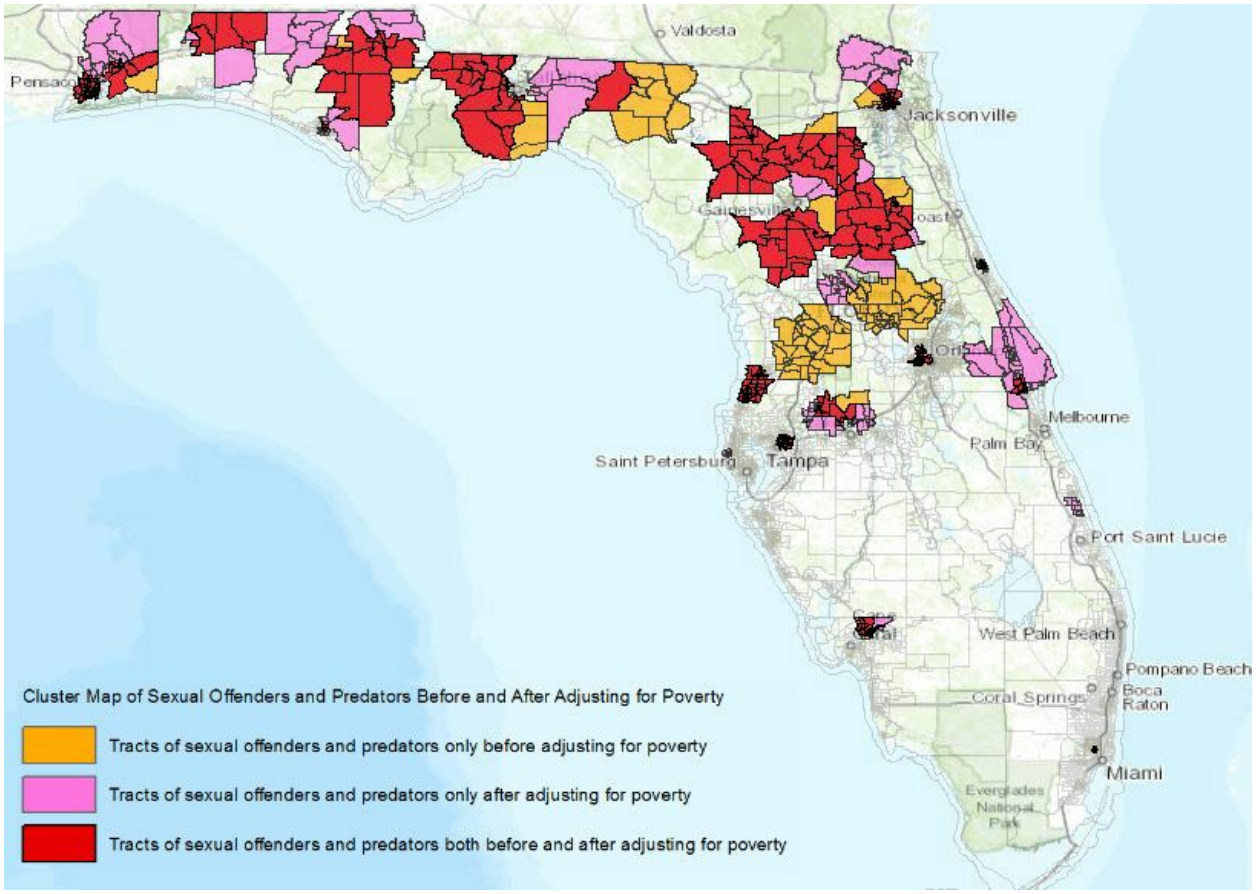

Figure 3: Map of Florida Sexual Offenders and Predators Adjusting for Poverty Rates by Census Tract

Adjusting for poverty alone explained several clusters in the middle of Florida as evidenced in the orange northwest and west of Orlando. A large region south and east of Tallahassee can also be explained by poverty adjustment. Also, a number of tracts in clusters in and around cities can be attributed to poverty. Leveling poverty rates in Florida does unmask several new clusters. New clusters formed particularly on the panhandle of Florida and also a large region east of Orlando in pink. Tracts were added to clusters or formed new adjacent clusters around Pensacola, Cape Coral, and Jacksonville. When observing relative risks of existing clusters near cities, it appears many of them decreased indicating some of the elevated sex offender and predator rates in cities can be attributed to poverty.

Clusters of sexual predators are examined next. Sexual predators are more rare and likely to be more dangerous than offenders (See Appendix A for a predator definition). Most cities that had sexual offender and predator combined clusters also have predator-only clusters with Jacksonville most noticeably missing. One difference, as evidenced in Figure 4, is that predators tend to be more concentrated with higher relative risk while offenders appear to be more widespread with less relative risk within a cluster.

Cluster Map of Florida Predators

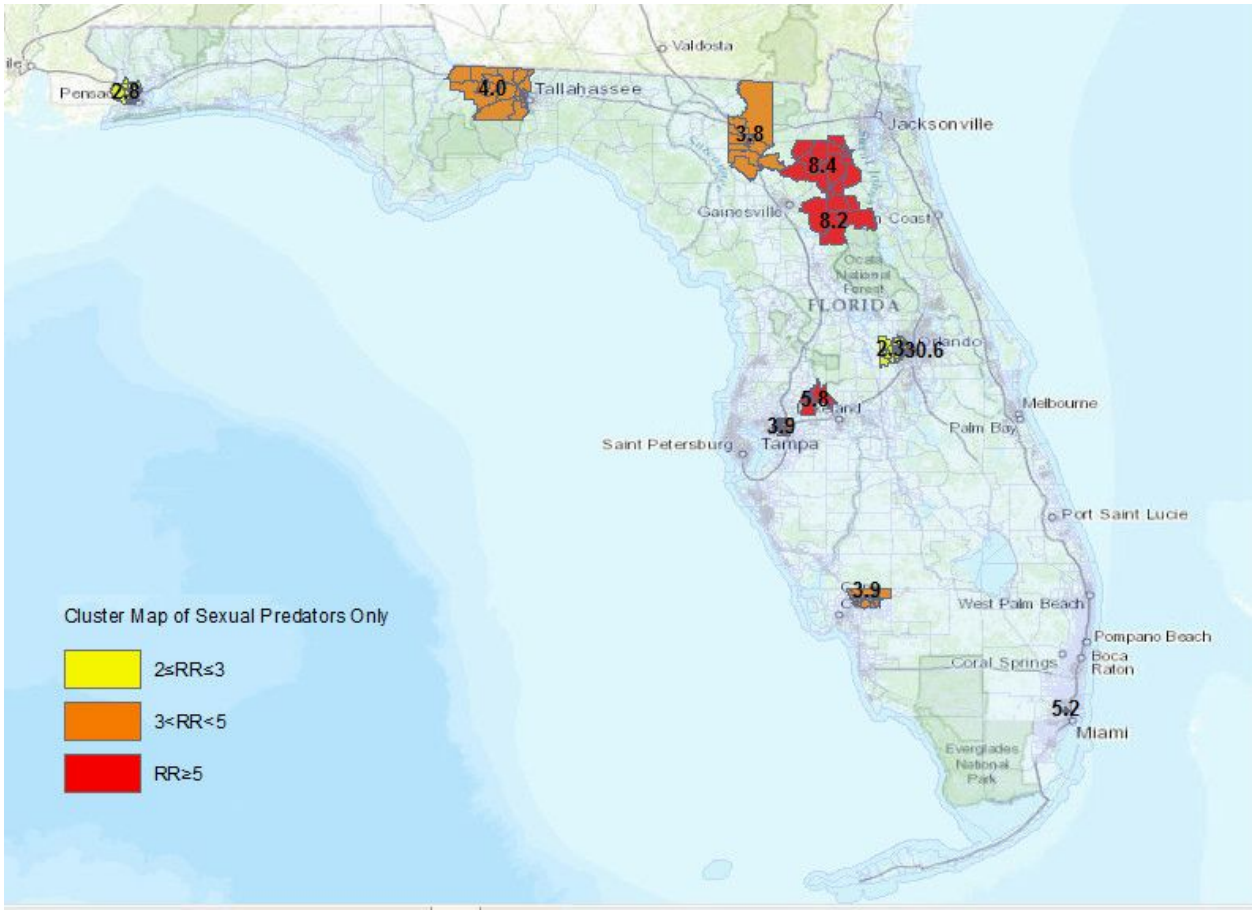

Figure 4: Cluster Map of Florida Sexual Predators Only by Relative Risk

In the table below, the top predator cluster is the same area in Orlando with a relative risk over thirty times more likely than the norm rate. An arch exists of three top ten high risk clusters (Starke, Palatka, and Lake City) between Gainesville and Jacksonville to north of Gainesville. Miami's cluster of predators encompasses the same area as with offenders and predators combined.

Top Ten Predator Clusters				
Location	Relative Risk	Estimated 2015 Cluster Population	P-Value	Below Poverty Level
Orlando	30.6	27694	<.0001	25.8%
Starke	8.4	64901	<.0001	16.4%
Palatka	8.2	175521	<.0001	22.3%
Zephyrhills	5.9	33270	<.0001	15.1%
Miami	5.2	117689	0.0038	21.8%
Quincy	4.0	44017	<.0001	31.6%
Cape Coral	3.9	68367	<.0001	23.9%
Tampa	3.9	60954	<.0001	29.4%
Lake City	3.8	125867	<.0001	20.1%
Pensacola	2.8	25595	0.0001	18.1%

Florida Predators Adjusted for Population Density

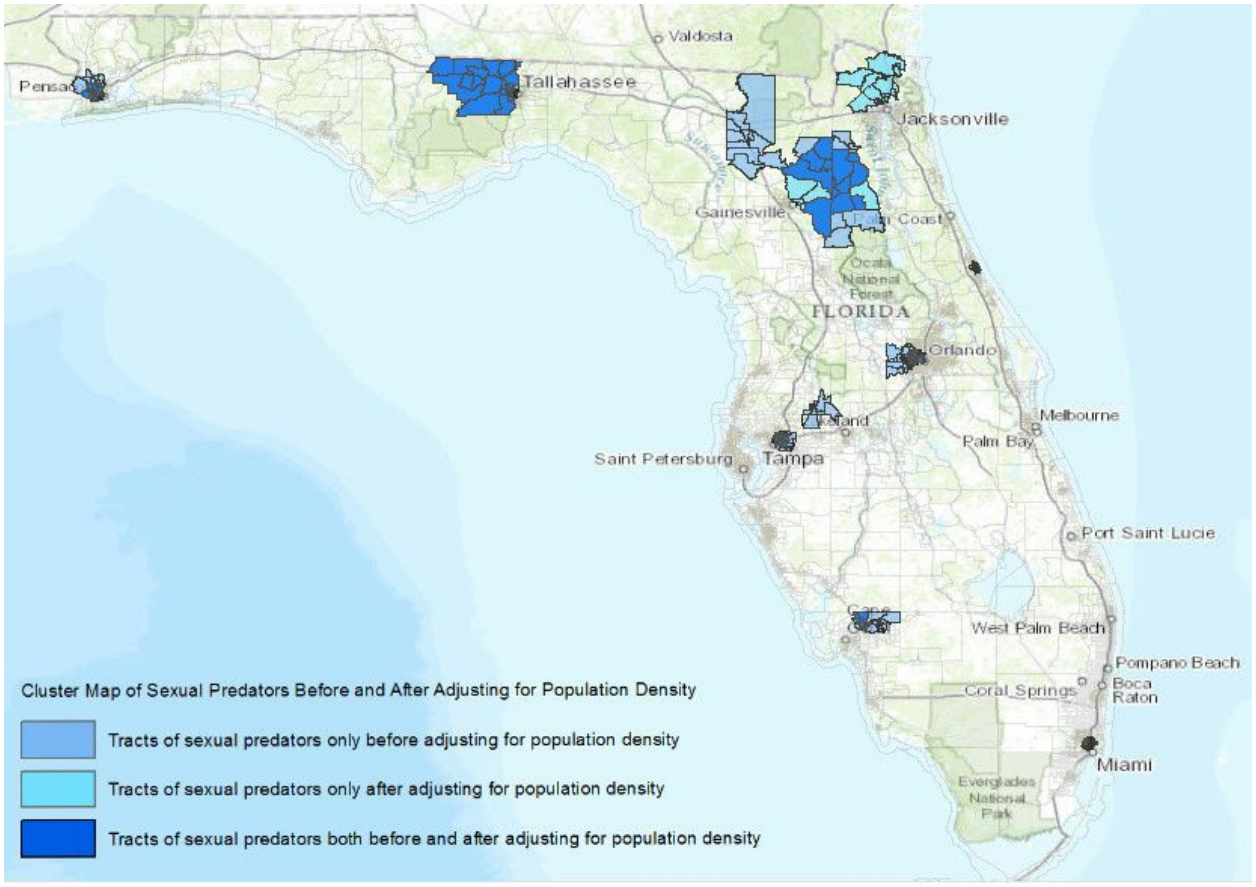

Figure 5: Map of Florida Sexual Predators Adjusting for Population Density by Census Tract

As evidenced in Figure 5, population density adjustment does explain elevated predator rates mostly on the surrounding areas of cities but not within the cities. For instance, Orlando's high risk cluster still remains, but tracts around Orlando, located in an adjacent cluster, are explained by population density (lower population density implies higher predator rates). This is similarly true for Pensacola, Tampa, and Cape Coral. Clusters are completely explained in areas away from major cities such as the Lake City cluster North of Gainesville and the Zephyrhills cluster Northwest of Tampa. Miami, Quincy (near Tallahassee), Palatka, and Starke clusters all remain unexplained. After population density adjustment, a cluster around the outskirts of Jacksonville becomes evident as well as in Daytona Beach (east of Ocala National Forest in Figure 5).

Florida Predators Adjusted for Poverty

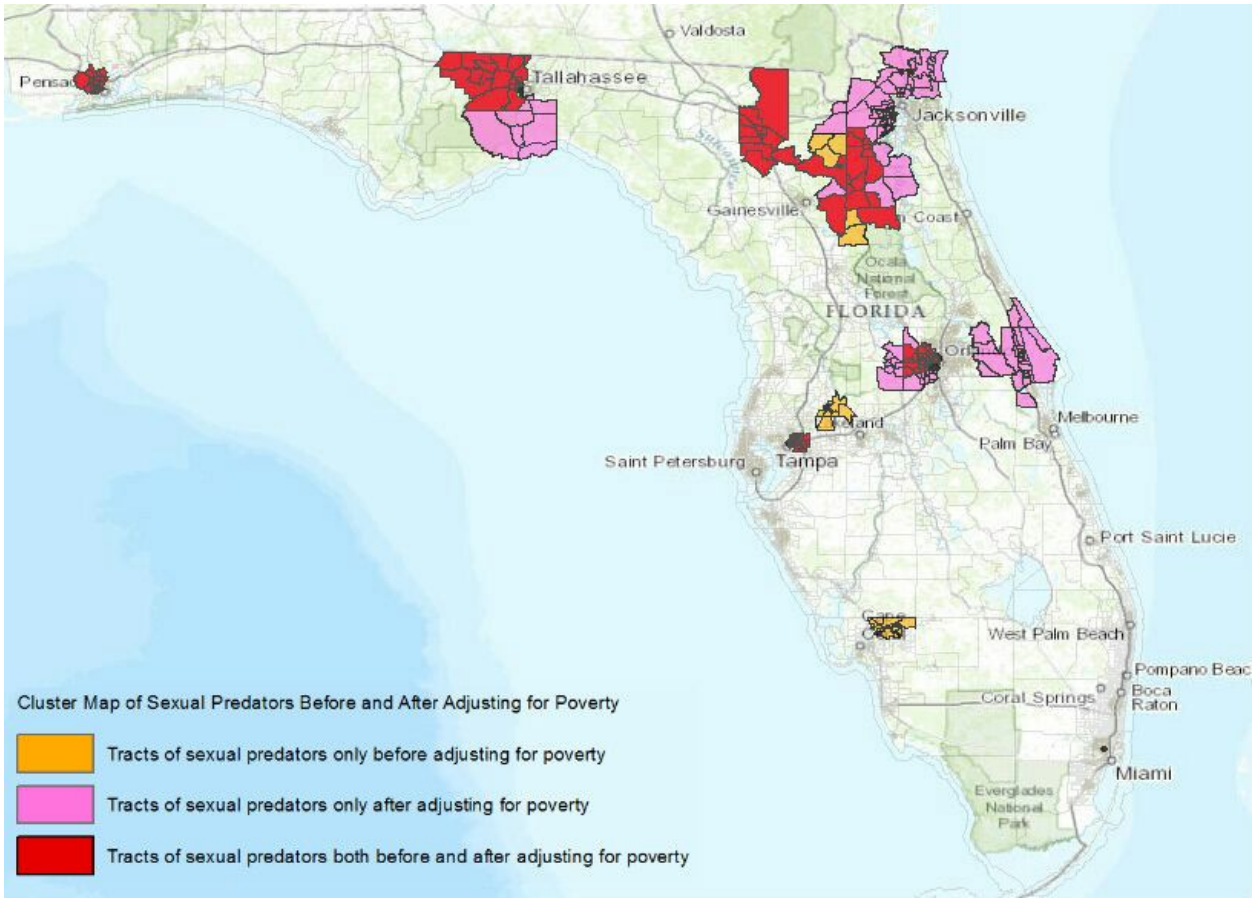

Figure 6: Map of Florida Sexual Predators Adjusting for Poverty Rate by Census Tract

When adjusted for the poverty covariate, Miami and Cape Coral no longer appear as significant clusters. This indicates that poverty plays a key role in the increased rate of sexual predators in these regions. The Zephyrhills predator cluster also no longer appears significant, though it was explained by population density as well. Thus, Zephyrhills' increased predator risk can be attributed to a

combination of these covariates. All other clusters still remain significant though with some individual tracts being explained by poverty but no entire clusters. Finally, the poverty covariate adjustment unmasks regions that have significant elevated rates of predators when all poverty levels are held as equal. These new regions of concern are west and north of Jacksonville, south of Tallahassee and due East of Orlando as evidenced in pink in Figure 6.

Conclusion

The sexual offender and predator database is updated on a continual basis. Therefore, the distribution of offenders is constantly changing. We were able to identify clusters based on only a fraction of the records in the data due to the unusability of the majority of the records. We analyzed the distribution of the residency of offenders using SAS, SatScan, and ArcGIS.

Due to sexual offender residency restrictions, the locations in which sexual offenders in Florida can reside is restricted, at a minimum, to 1,000 feet from schools, child care facilities, parks, and playgrounds. Some cities and counties enacted stricter ordinances, and because of these stricter ordinances, we would expect to see high relative risk rate clusters in locations that did not adopt their own ordinances. However, we used several statistical tests to test the relationships between sex offender rates by census tract and several covariates in order to determine which covariates might help to explain the existence of at least some of the clusters. From our tests, we determined that population density and poverty rates were the most significant covariates in determining the existence of clusters.

We found several clusters that were explained either by poverty rates or by population density, or by both. However, the city and county ordinances were less apparent in the explanation of the existence of clusters. Five of the southern seven non-cluster locations investigated have extended the residency restriction from Florida's SORR, but nearly half of the top ten cluster locations by relative risk have stricter ordinances than Florida law as well.

The explanation of high-rate sexual offender clusters in Florida is complex at best. Several reasons for the existence of clusters exist; poverty rates, SORRs, population density, school density, and percentage of whites. Any combination of these covariates could explain the reason for a high number of sexual offenders residing in a given area. Factors of local law enforcement may also come into play; some cities may be strict in the enforcement of their ordinances regarding sexual offenders, and other cities may be lackadaisical.

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(iii) Farzad Mostashari of the New York City Department of Health and Mental Hygiene."

Appendices

Appendix A: Definition of a Florida Sex Offender

Taken directly from: https://offender.fdle.state.fl.us/offender/FAQ.jsp#Question1 on 11/16/2015

"1. **Who must register as a sexual offender?**

- A sexual offender is an individual who meets one or more of the following criteria:

1. He/she has been convicted of a qualifying sexual offense in Florida or another jurisdiction. Qualifying Adult Convictions include:

1. Sexual misconduct prohibited (F.S. 393.135(2)).

2. Sexual misconduct prohibited (F.S. 394.4593(2)).

3. Kidnapping (F.S. 787.01), where the victim is a minor and the defendant is not the victim's parent or guardian.

4. False imprisonment (F.S. 787.02), where the victim is a minor and the defendant is not the victim's parent or guardian.

5. Luring or enticing a child (F.S. 787.025(2)(c)), where the victim is a minor and the defendant is not the victim's parent or guardian.

6. Human Trafficking (F.S. 787.06(3)(b), (d), (f), or (g) and former 787.06(h)).

7. Sexual battery (F.S. 794.011), excluding subsection 10.

8. Unlawful sexual activity with certain minors (F.S. 794.05).

9. Procuring a person under the age of 18 for prostitution (former F.S. 796.03).

10. Selling or buying of minors into sex trafficking or prostitution (former F.S. 796.035).

11. Lewd/lascivious offense committed upon or in the presence of persons less than 16 years of age (F.S. 800.04).

12. Video Voyeurism of a minor (F.S. 810.145(8))

13. Lewd/lascivious offense committed upon or in the presence of an elderly person or disabled adult (F.S. 825.1025).

14. Sexual performance by a child (F.S. 827.071).

15. Protection of minors; prohibition of certain acts in connection with obscenity (F.S.847.0133).

16. Computer pornography (F.S. 847.0135), excluding subsection 6.

17. Transmission of child pornography by electronic device/equipment (F.S. 847.0137).

18. Transmission of material harmful to minors to a minor by electronic device/equipment (F.S. 847.0138).

19. Selling or buying of minors (for portrayal in a visual depiction engaging in sexually explicit conduct) (F.S. 847.0145).

20. Sexual misconduct prohibited (F.S. 916.1075(2)).

21. Sexual misconduct prohibited (F.S. 985.701(1)).

22. Or a violation of a similar law of another jurisdiction (i.e. federal, military, other state or country); **AND**

2. He/she has been released from or is currently serving parole, probation, or incarceration for a qualifying sex offense (listed above) on or after October 1, 1997;**OR**

3. He/she establishes or maintains a residence (permanent, temporary, or transient) in Florida and has a requirement to register or would have a requirement to register as a sexual offender in another jurisdiction;**OR**

4. He/she was adjudicated delinquent on or after July 1, 2007, for one of the following offenses and was 14 years of age or older at the time of the offense:

1. Sexual battery (F.S. 794.011 excluding subsection 10).

2. Lewd/lascivious battery where the victim is under 12 or the court finds sexual activity by the use of force or coercion (F.S. 800.04(4)(a)2).

3. Lewd/lascivious molestation, victim under 12, where the court finds molestation involving unclothed genitals (F.S. 800.04(5)(c)1).

4. Lewd/lascivious molestation, victim under 16 but more than 12, where the court finds the use of force or coercion and unclothed genitals (F.S. 800.04(5)(d)).

5. Or a violation of a similar law of another jurisdiction (i.e. federal, military, other state). Top

2. **What is a sexual predator?**

· A sexual predator is a person who has been convicted of a sexually violent offense as defined in Florida Statute 775.21 (which may include offenses from another jurisdiction) **AND** has a written court order designating the individual a sexual predator; or

· He/she is civilly committed under the Florida Jimmy Ryce Sexually Violent Predator Act **AND** has a written court order designating the individual as a sexual predator.