12-4-2014

Spartanburg Humane Society Data Analysis: Hotspots and Resource Management

Leigh Robertson
Furman University

Spartanburg Humane Society Data Analysis

Hotspots and Resource Management

Leigh Robertson

EES201 – Introduction to Geographic Information Systems – Fall 2014, Furman University, Greenville, SC

I. Introduction / Lit Review

A data set from the Spartanburg Humane Society was provided with the hope that the use of GIS could show patterns and hotspots of dog and cat pickup locations. With a better understanding of where the majority of the animals come from, the Humane Society can better distribute their man power and resources to help as many homeless animals as possible.

According to Beck (1973) the main reasons for stray and abandoned animals is negligence causing pet releases or escapes, and also breeding. Therefore, finding and targeting areas where there are many strays (potentially as a result of a release, escape, or breeding) is imperative to educating the people there on the importance of overall pet care and spaying or neutering their pets. Other reasons for animal pickups by the Humane Society are listed in the data set and include anything from "moving" to "destructive". In this study I identified statistically significant hotspots of cat and dog surrenders and strays. The hotspot method was deemed an appropriate process through personal discretion and literature on cluster analysis with crime data. Using spatial relationships, hotspots can show where there is significantly higher animal location concentrations. Papers on crime data by Grubesic & Murray (2001) along with Ratcliffe & McCullagh (1999) discussed different methods for calculating these spatial relationships while taking into account the surrounding urban factors. Since population density is likely to be a contributing factor to the number of animals present in an area, population density was factored into the analysis or normalized to identify hotspots based on factors other than population. Hotspots were also calculated without normalizing for population in order to give the Spartanburg Humane Society a good idea about where most of their animals are coming from despite the number of people there. This will assist in determining the best areas for resource distribution.

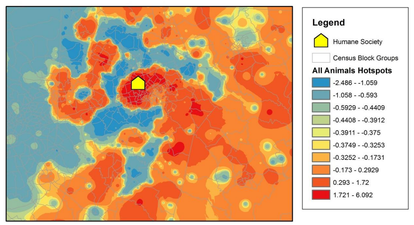
II. Methodology

The dataset provided by the Spartanburg Humane Society was used in order to carry out an analysis of any significance behind cat and dog pickup locations. Pickup location addresses were included in that dataset and geocoded into point data. Several other categories were included in the data set including which pickups were surrenders and which were strays. This data was transferred into the attribute table. Using GIS statistical tools, a determination of animal hotspots was mapped. First, the point data was integrated using a 50 foot distance and then collected into events in order to better display spatial clustering. Collecting the points into events gives each point a unique value greater than one, this is necessary for running the hotspot spatial correlations. In order to determine the optimal animal "neighborhood size" the Incremental Spatial Autocorrelation Tool was used to generate a report and show the distance at which there was the most statistically significant spatial relationships. This distance was used in a Getis-Ord-Gi Hotspot analysis to display where statistically significant clusters resided. For the maps that normalized for population, the collected events were spatially joined to a census block shapefile and then a new attribute was added. This attribute was the value given by the collected events divided by the population density. Geostatistical IDW was then used to create a raster of the hotspot data and fill in the gaps within the cells for a clearer visual representation of the hotspots themselves. For the stray vs non-stray map the stray animals were separated from the merged Dogs/Cats attribute table. The same process was used to determine significant hotspots, then the 90%+ confidence points were exported into a new table. These points were symbolized by intake type (stray or surrender) and added to a simple road map of Spartanburg. The hotspot IDW raster and stray vs non-stray hotspots were not normalized for population in order to simply visualize the statistically significant areas by volume of animal pickups.

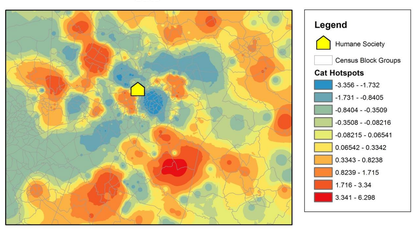
Hot Spot Analysis Maps

Not Normalized for Population

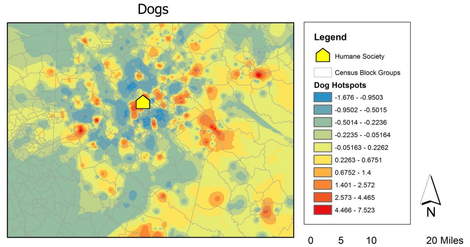
All Animals



Cats

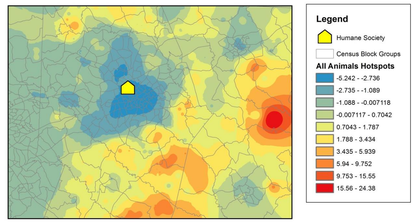


Dogs

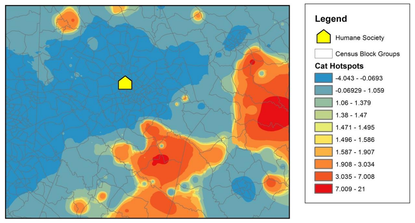


Normalized for Population

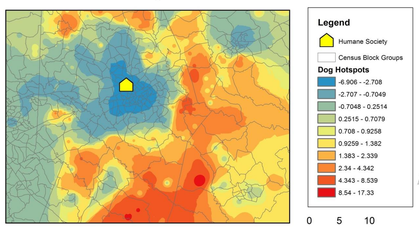
All Animals



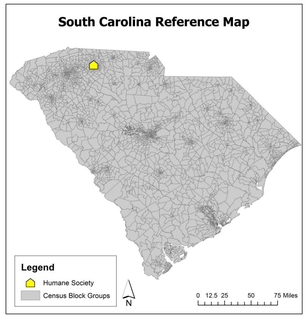
Cats



Dogs



South Carolina Reference Map



Scan me to go to the Spartanburg Humane Society Website!

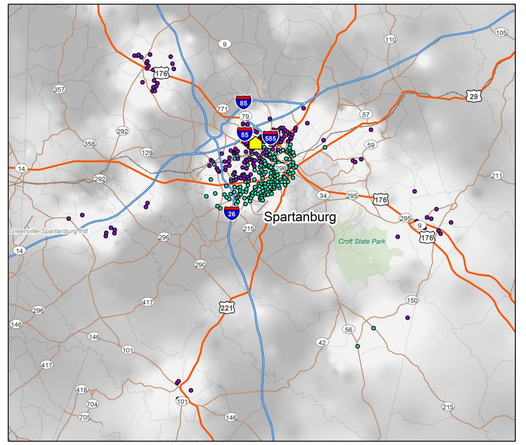
III. Understand the Statistics

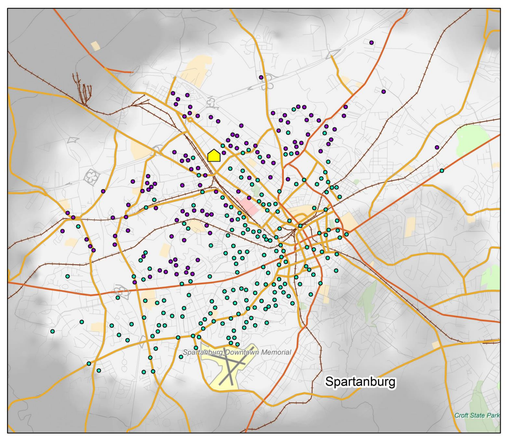
In order to be able to interpret what the hotspot maps are showing you need to have a basic understanding of the stats behind them. The ranges under the hotspots that you see in the legend are the "z-scores" or "standard scores" and indicate how many standard deviations or the amount of dispersion from the mean (spatial distance between clusters). The standard score is a useful method because it allows us to calculate the probability of a score occurring within a normal distribution while also letting us compare two scores that are from two distributions. The positive scores indicate points that fell above the mean and the negative scores indicate points that fell below the mean. Very high and very low z-scores indicate low probability that those points are randomly spatially distributed, which means there is a higher confidence that there are significant animal location quantities in those areas. These red areas or "higher confidence areas" therefore do the best job of rejecting the null hypothesis which states that there is no significant difference between the points and their spatial relationships. This results in statistically significant "hotspots". (ESRI, 2009)

Acknowledgements

I would like to acknowledge Ingrid Norris, the Humane Education Coordinator for the Spartanburg Humane Society. Ingrid provided the dataset and idea to analyze it using GIS. In addition I would like to acknowledge Mike Winiski for making the connection between community outreach and untapped GIS student potential. Suresh Muthukrishnan and Mike Winiski also helped with the data analysis and appropriate statistical methods for this project. Lastly I would like to acknowledge Brianne Pochard for reviewing the documentation for the data set and promptly moving it along to the IRB committee for approval.

Strays vs Non-Strays





IV. Results and Discussion

From the resultant maps, a drastic difference between the normalized and non-normalized maps can be observed. The areas with the highest standard scores cluster around the Humane Society location. This is more than likely attributed to the higher population density in the area and also the convenience of distance. Based off of the hotspot calculations for all the animal points (not normalized) the areas with a z-score between 1.7 and 6 are the areas with the least chance of random clusters. On the maps that are normalized for population, areas south and east of the Humane Society show the highest significant clustering. This might be a good area for the Humane Society to search for other reasons for why there may be a large quantity of animal pickups there.

I think that the strays vs non-strays maps reveal a lot about the stray animal population of Spartanburg. The Humane Society seems to be suitably placed for the needs of the city. The stray populations exclusively cluster south of the Humane Society. This observation is definitely indicative of another factor coming into play since such a distinctive pattern is shown. The potential reason for why the stray population exclusively clusters in that area needs further investigation. In addition to the concentration of strays just south of the Humane Society, there is also an area approximately 7.5 miles wide south of Croft State Park that also has a some significant stray animal clusters. That area should be looked into as well. As for the outlying areas, there seems to be just clusters of surrendered animals. This makes sense since those are residential areas of Spartanburg, and those collected animals were probably all pets prior to collection.

V. Conclusions

What can be concluded thus far is that there are significant clusters of animal pickup locations around the Spartanburg Humane Society itself and those areas should therefore receive the most attention and resources. The area on the strays vs non-strays map where the majority of the stray hotspots fall would be an excellent location to distribute more education and information about spaying and neutering animals. This could prevent stray animals from breeding or pets being released and breeding which just propagates the stray population size.

VI. Future Research

The maps normalized for population need further investigation in order to determine what may be happening the in the hotspot areas besides there just being a higher population density. Future research could explore some potential socio-economic or land cover reasons that might result in these hotspots. In addition, the Strays Vs. Non-Strays comparison maps revealing the "stray only" and "non stray only" areas can be investigated in order to find a reason for the exclusiveness of intake type by area.

Some additional factors to look into include seeing how the hotspots look during seasons (temporal investigation) or possibly finding other correlations between the age of the animal and the time they were brought in or found. The hotspot map for dogs shows an interesting dispersed pattern that could also be further investigated.

VII. References/ Data Sources

Beck, A. M. (1973). *The ecology of stray dogs: a study of free-ranging urban animals*. Purdue University Press.

ESRI (Environmental Systems Resource Institute). 2009. ArcMap 9.2. ESRI, Redlands, California.

Grubesic, T. H., & Murray, A. T. (2001, December). Detecting hot spots using cluster analysis and GIS. In *Proceedings from the Fifth Annual International Crime Mapping Research Conference* (Vol. 26).

Ratcliffe, J. H., & McCullagh, M. J. (1999). Hotbeds of crime and the search for spatial accuracy. *Journal of Geographical Systems*, *1*(4), 385-398.

Spartanburg Humane Society Data Set (2013).