Distance Traveled by Lost Dogs from Lost Location to Found Location

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Keywords: Geographic Information System (GIS), Animal Care Agency (ACA), Animal Control, Lost Dog, Found Dog, Distance Traveled, Collar, Dog License

Abstract

Spatial and statistical analyses were performed on data submitted by government-run animal care agencies (ACAs) from three southeast Minnesota municipalities for the purpose of using a Geographic Information System (GIS) to determine the distance traveled by lost dogs from lost location to found location. Data submitted included descriptions of each dog and the location where the dog was lost and was found. An individual or ACA that finds a dog expends time and money attempting to reunite the dog with its owner. Likewise, a dog's owner expends time and money attempting to find his or her dog. Determining the distance traveled by lost dogs has the potential to help owners refine their search efforts for their lost dogs, as well as to assist ACAs in locating owners of found dogs impounded. Knowledge of the distance traveled by lost dogs also will be useful for developing proactive strategies for reuniting dogs and owners. The proactive reunification strategy discussed in this research is a GIS application which ACAs could use to identify households with licensed dogs nearby the location where a dog is found. A GIS application would help reunite dog and owner regardless of whether a dog was found wearing a collar with an attached license tag. Using a GIS application to proactively reunite dogs and owners could reduce monetary and nonmonetary costs incurred by dogs, owners, finders and ACAs.

Introduction

Approximately 14% of dogs in the United States have become lost in the last five years (Slater, 2012). The experience of being lost can be traumatic for both a dog and its owner. The dog may become ill, injured and stressed while away from home. Additionally, it may be stressful for an individual who finds a lost dog but is unable to locate its owner. Eventually, a lost dog may end up impounded at an ACA where it may be reunited with its owner, adopted by a new owner or euthanized (Lepper, Kass, and Hart, 2002).

The *U.S. Pet Ownership and Demographics Sourcebook* found that almost half of pet owners consider their pets to be members of the family (American Veterinary Medical Association, 2007). Further suggesting that pets are considered by many to be members of the family, the American Animal Hospital Association (2004) found that, when asked to choose one companion if stranded on a deserted island, 47% of people would choose a person and 40% would choose a dog. Responses to this hypothetical scenario illustrate the importance of dogs in the lives of many people.

There are monetary and non-monetary costs associated with finding a dog. A person who finds a lost dog (a finder) may experience stress trying to reunite the dog with its owner. A finder may expend time and money searching for the owner by calling, going door-to-door, posting signs and advertisements, and/or locating an ACA that is open and able to impound the dog. Furthermore, while the finder has the dog, the finder may care for it by providing food and shelter. The finder might feel an obligation to locate the owner and, if unable to do so, he or she might become frustrated or disappointed. A finder might be hesitant to bring the dog to an ACA for impoundment. Lord's (2006) study found that almost all finders of dogs notified one or more ACAs, but "only 8% initially brought the pet to an ACA for impoundment." The study found that when an owner could not be located, about 23% of finders brought the dog to an

ACA for impoundment. More than 66% of the finders kept the dog or gave the dog to another person. Fifty-five percent of finders who did not bring the dog to an ACA for impoundment were afraid the dog would be euthanized. This concern could cause great distress for a finder and may reduce the chance of a dog being reunited with its owner because, as Lord's (2006) study found, "the largest percentage of owners was found when the finders called one of the animal agencies." Additionally, "owners who found their dogs visited ACAs sooner and more frequently than owners who did not find their dogs (Lord, 2006)." This affirms the importance of ACAs in lost dog recovery (Lord, 2006). Whether or not they are reunited with their owners, dogs that are lost, found, captured and then impounded, consume the resources of ACAs. In fact, each year efforts by ACAs in the United States to manage lost, found and unwanted pets exhaust one billion dollars (Rowan, 1992).

The primary goal of this research is to determine the distance traveled by lost dogs from lost location to found location. Doing so has the potential to help owners refine search efforts for their lost dogs, as well as to assist ACAs in locating owners of found dogs impounded.

The secondary goal is to determine if the data exists to support the creation of a GIS application that identifies households with licensed dogs nearby the location where a dog is found and to explain the potential effectiveness of such an application. Using a GIS application to proactively reunite dogs and owners could reduce monetary and nonmonetary costs incurred by dogs, owners, finders and ACAs.

Methods

Study Areas

The primary study area is the three large municipalities in southeast Minnesota: Rochester, Faribault and Winona (about 220.15 km^2 (85 mi^2), 158,000 people) (Figure 1) (U.S. Census Bureau, 2010a; U.S. Census Bureau, 2010b; U.S. Census Bureau, 2010c).

Figure 1. Primary study area (red): the municipalities of Rochester, Faribault, and Winona, Minnesota.

The secondary study area is the City of Rochester including census block groups which have at least 10% of their area within 2011.68 meters (1.25 miles) of the city boundary (Figure 2).

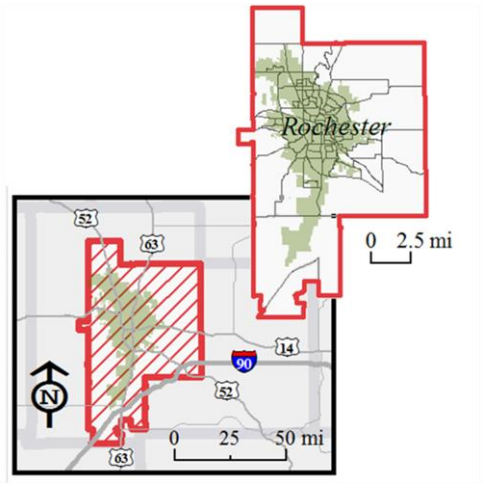

Figure 2. Secondary study area: The area (boundary outlined in red) includes the block groups within the City of Rochester (green) and those block groups that have 10% of their area within 2011.68 meters (1.25 miles) of the Rochester city boundary (white).

The secondary study area was used to determine if data exist to support the creation of a GIS application and the potential effectiveness of that application. This secondary study area was chosen because dog ownership data was reported at the block group level, and because data collected by the Rochester ACA is expected to fall within this area.

Study Timeframe

The timeframe of this study was April 4, 2011 to July 14, 2011 (102 days).

Population of Interest and Analyses Samples

The population of interest for these analyses is dogs that were reported as lost. The accessible population, or study population, is those dogs that were reported loose and that were found and captured by an individual or ACA employee and impounded until reunited with their owners within the study area and timeframe.

The dogs selected to be in the distance traveled analyses sample are those in which the reports contained locational information sufficient to geocode, were found and were lost within the primary study area and during the study timeframe, and had traveled a distance greater than zero meters (0 miles) and less than 2,011.68 meters (1.25 miles).

A component of determining the current licensing system's effectiveness of reuniting dogs and owners is determining the percentage of dogs that wear collars (and therefore could be wearing a license tag). The accessible population included dogs that were reported as lost to the Rochester ACA within the secondary study area and timeframe (in addition to the accessible population of the distance analyses). In determining the percentage of dogs that wear tags, also a component of determining the current licensing system's effectiveness of reuniting dogs and owners, the accessible population was only dogs that were reported as lost to the Rochester ACA within the secondary study area and timeframe.

The dogs selected to be in the collar and tags analyses sample are those for which the reports contained locational information sufficient to confirm that the report was generated from within the secondary study area and during the study timeframe.

Procedures

Acquiring and Processing Data

This research required the following components:

- The locations where dogs were lost and were found
- Attributes of dogs (including presence of collar and tags)
- Lines connecting the lost points and the found points used to find the distance traveled by dogs
- Dog licensing data that includes location attributes (i.e. address, block group)
- Dog ownership data that includes location attributes (i.e. block group)
- Municipality, county and state boundary data and road data for analytic and cartographic purposes

The following describes the sources and creation processes of the above components.

Dog Attribute and Location Data

The ACAs were provided with standardized data collection forms on which to submit data; however, data about dogs from the three ACAs were submitted to the researcher in various formats. One ACA utilized the data collection form provided, while another submitted information taken from receipts (e.g. for fines paid by owners, or by the ACA to a veterinarian or humane society), while the other provided paper records created by employees who had captured dogs and brought them to the ACA. Reports about dogs lost but not impounded, used in the collar and tag analyses, were recorded from phone calls, in person visits, or via email for the Rochester ACA.

All ACAs recorded basic locational data and some description data (color, breed, sex, etc.) about each dog. While all data provided to the researcher were retained, only a portion was universal across all three ACAs and useable for this study.

The raw data regarding found dogs impounded were entered into a Microsoft Excel table. Records that had a lost location (generally the home address of

the owner) and a found location were earmarked for distance traveled analyses. It was presumed that a dog was lost from the home address if no other information was given. Both the lost locations and the found locations were geocoded to create two point feature classes.

The raw data from the Rochester ACA regarding lost dogs reported was entered into a Microsoft Excel table. Records that had a lost location from within the secondary study area and timeframe were earmarked for collar and tag analyses.

Block Groups

The block group polygons (from years 2000 and 2010) for the study areas were obtained from the Census Bureau's FactFinder website. These polygons were used to explore dog licensing and dog ownership in the City of Rochester. The 2010 block group polygons were used for display and analysis of the data. The 2000 block group polygons were used to examine the dog ownership data as explained in the subsequent dog ownership data section.

Address Points

The address point feature class used for geocoding was obtained from a local source. To determine the number of address points per block group, the address point feature class was spatially joined to the block group polygons. Each block group polygon was assigned the sum of the address points which it contained.

Dog Licenses

To create a point feature class of the location of licensed dogs, the City of Rochester dog licenses were geocoded from a Microsoft Excel table provided by the City Clerk's Office.

To determine the number of households with one or more licensed dogs per block group, the dog license feature class was dissolved by owner name into a new point feature class. The households with one or more licensed dogs point feature class was spatially joined to the block group polygons. Each block group was assigned the sum of the households with one or more licensed dogs which it contained.

The percentage of households with one or more licensed dogs was calculated for each block group by dividing the sum of the households with one or more licensed dogs by the sum of the address points. A discussion of issues arising from the assumption that address points represent households is found in the sources of error section.

Dog Ownership Data

Dog ownership data was obtained from the Esri Community Analyst data service. This data service was designed to provide businesses with information for use in examining market potential. The dog ownership data was determined through a combination of existing Esri data, e.g., Tapestry™ Segmentation data and Doublebase® 2009 data from Gfk MRI (Esri, 2011).

In order to compare the Esri dog ownership data with the licensing data using the 2010 census block groups, the Esri dog ownership data were adjusted to the 2010 boundaries utilizing the Esri ArcGIS Intersect Tool. Where a 2010 block group polygon intersected only one 2000 block group polygon (74 of 92), the percentage of households predicted to have one or more dogs was transferred from the 2000 block group polygon to the 2010 block group polygon using the Esri ArcGIS Attribute Transfer Tool. Where a 2010 block group polygon intersected more than one 2000 block group polygon (18 of 92), the percentage of households predicted to have one or more dogs was calculated using the following equation:

$$\textit{Percentage of Households Predicted to Have One or More Dogs in Block Group}_{2010.A} = \sum_{i=1}^{n}\left[\left(\frac{\#\ of\ Households\ in\ (Block\ Group_{2000.i} \cap Block\ Group_{2010.A})}{\#\ of\ Households\ in\ Block\ Group_{2010.A}}\right) \times \left(\begin{matrix}\%\ of\ Households\ Predicted\ to\ Have\ One\ or\ More \\ Dogs\ in\ Block\ Group_{2000.i}\end{matrix}\right)\right]$$

Figure 3 illustrates the calculation of the value for percentage of households predicted to have one or more dogs for a 2010 Block Group that intersects two 2000 Block Groups.

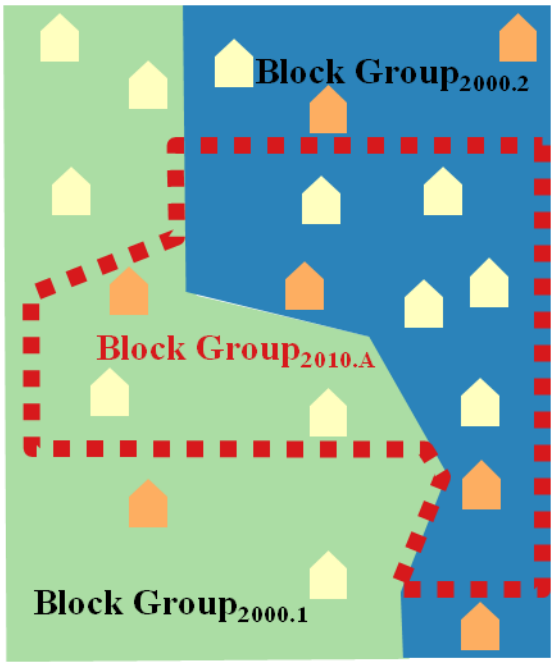

Figure 3. Block Group$_{2010.A}$ (red dotted outline) intersects two 2000 block groups: Block Group$_{2000.1}$ (green) and Block Group$_{2000.2}$ (blue). Also shown are households (yellow house symbols) and households predicted to have one or more dogs (orange house symbols). The value for the percentage of households predicted to have one or more dogs in Block Group$_{2010.A}$ is calculated using a weighted-mean formula. In this figure, 25% of households in Block Group$_{2000.1}$ are predicted to have one or more dogs, this value is 45.4% for Block Group$_{2000.2}$. The weighted-mean formula found that 39.35% of households in Block Group$_{2010.A}$ were predicted to have one or more dogs.

Licensing Gap

The licensing gap was calculated as the percentage difference between the percentage of households with one or more licensed dogs and the percentage of households predicted to have one or more dogs. The equation for the licensing gap is as follows:

$$Licensing\ Gap_{Block\ Group_{2010.x}} = 100 \times \left[\frac{\left(\begin{array}{c}\%\ of\ Households\ with\ One\ or\ More\ Licensed\ Dogs\ -\\ \%\ of\ Households\ Predicted\ to\ Have\ One\ or\ More\ Dogs\end{array}\right)}{\%\ of\ Households\ Predicted\ to\ Have\ One\ or\ More\ \ Dogs}\right]$$

Determining Distance Traveled

A line feature class was created by connecting the lost location points to the found location points using the shortest distance possible (Figure 4).

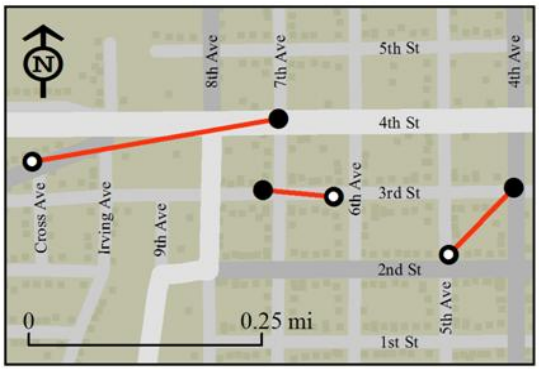

Figure 4. Lines (red) representing distances traveled by dogs from lost location (open circle) to found location (closed circle).

The distance traveled was found using the Esri ArcGIS Calculate Geometry Tool. The distance traveled by dogs from each of the three municipalities was examined using the Modified Levene's Test, the Kruskal-Wallis Test and the One-Sample Wilcoxon-Signed Rank Test.

Data from three municipalities were used in the distance analyses for the purposes of comparison and validation of the findings to ensure that no one municipality's distances were anomalous and that findings could be applicable to other municipalities outside the study area.

Collars and Tags

Analyses about dogs from within the secondary study area were conducted on collar and tag data provided by the Rochester ACA. The percentage of dogs wearing a collar was determined (using the found dog impounded data and the lost dog reported data). The percentage of dogs wearing a tag was also determined (using

the lost dog reported data).

Cartographic Layers

The road layer and boundary layers for the municipalities, counties and state were obtained from the Minnesota Department of Natural Resources' Data Deli.

Projection

All data was projected using the North American Datum 1983 Universal Transverse Mercator Zone 15 North projection.

Results

Describing the Data

Types of Reports Received for Distance Analyses

A total of 199 found dogs that were impounded were reported. Of these dogs, 130 were reclaimed (65.3%), and 113 of these reclaimed dogs had reports which contained sufficient locational information to be geocoded.

Dogs that traveled more than zero meters (0 miles) but less than 2,011.68 meters (1.25 miles) were included in the study (n=96). Discussion of the outliers can be found in the sources of error section. The breakdown of reports received from the ACAs is found in Table 1.

Attributes of Dogs in the Distance Analyses Sample

Of the 96 dogs included in the distance analyses sample, 49 were female (51.0%) and 47 were male (48.9%). The most common breeds reported were retriever and retriever crosses (31 dogs).

In the distance analyses sample, about 40% of the dogs were one of the five top-reported lost breeds as reported by the lost dog website "Fido Finder" (Fido Finder, n.d.). It should be noted that each of these five top-reported lost dog breeds, except for the American Pit Bull Terrier which the American Kennel Club (AKC) does not register, are in the top 15 dog breeds registered in 2010 by the AKC (American Kennel Club, n.d.). This suggests that the frequency with which certain breeds are lost and are found may be a result of their prevalence.

Table 1. Found dogs impounded reports received from ACAs broken down by agency, outcome, sufficiency of lost location information, and inclusion in the study.

Breakdown of Reports	Agency			Total
	*R	^F	+W	
Found Dogs Impounded	99	45	55	199
Dogs Not Reclaimed	35	18	16	69
Dogs Reclaimed	64	27	39	130
Dogs Reclaimed: Lost Location Information Insufficient	13	0	4	17
Dogs Reclaimed: Lost Location Information Sufficient	51	27	35	113
Number of Outliers Not Included in the Study	9	2	6	17
Total Number of Dogs Included in the Study	42	25	29	96

*Rochester, ^Faribault, +Winona

Distance Traveled

In order to pool the data from the three municipalities for analyses, it was necessary to determine if the distances traveled by dogs in the three municipalities could be considered from the same population. In other words, did dogs in Faribault and dogs in Winona travel similar distances as dogs in Rochester? Upon inspection of the histogram and box plot, it was evident that the data did not exhibit a normal bell curve distribution, but rather were positively skewed. It was determined that non-parametric tests were needed. The box plot and histogram can be seen in Figure 6.

First, the variance was examined using the Modified Levene's Test. Next, the median was examined using the Kruskal-Wallis Test. Finally, the One-Sample Wilcoxon-Signed Rank Test was

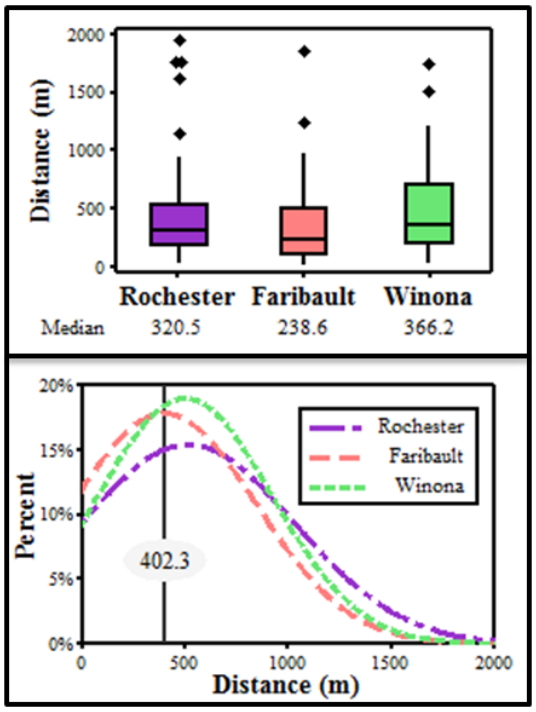

Figure 6. Box plot and histogram of the distance traveled, shown by municipality (Rochester: purple and dash-dot line, Faribault: pink and dashed line, Winona: green and dotted line).

used to determine if the median distance traveled was equal to 402.3 meters (0.25 miles) (treating the samples as if they were from the same population). This distance was chosen based upon conversations with ACA personnel as well as existing research by Lord (2006), which found that 71% of owners of lost dogs stated that their dogs were found less than one mile from home.

Comparing the Populations' Distance Traveled Variance and Distance Traveled Median

Using the Modified Levene's Test, it was determined that the variance of the distance traveled was the same for the found dogs impounded at the three agencies (Table 2) (Montgomery, 2004). Using the Kruskal-Wallis Test, it was determined that the distance traveled median was the same for the found dogs impounded at the three agencies (Table 3). It was determined that the found dogs impounded at the three agencies are from the same population and that it is reasonable to generalize to the population based on the sample.

Determining the Median Distance Traveled

A One-Sample Wilcoxon-Signed Rank Test was performed on the single 96-value sample. This test was performed to determine if, in fact, half of dogs travel 402.3 meters (0.25 miles) or less. The hypotheses are as follows:
H_0: the population median distance traveled is equal to 402.3 meters;
H_A: the population median distance traveled is not equal to 402.3 meters.
Because the P-value (0.4932) is greater than α (0.05), the null hypothesis is not rejected: that the distance traveled by half of dogs is 402.3 meters (0.25 miles) or less.

Table 2. Summary of Modified Levene's Test. This test is essentially the one-way ANOVA test, but compares the means of the deviations of the three agencies, where deviations refer to the absolute value of the difference between the distances traveled in a group from the median distance traveled value of that group.

Agency	Number of Dogs	Median Distance Traveled (m)	Avg. Rank	Z
Rochester	42	320.50	50.30	0.55
Faribault	25	238.70	41.20	-1.53
Winona	29	366.20	52.30	0.87
$H_{calculated}$=2.44, DF=2, and P=0.296 $H_{0.05,2}$ (5.991) $H_{calculated}$ (2.44) < $H_{0.05,2}$(5.991) Therefore, do not reject H_0 0.25 < P < 0.3 [P = 0.296]				

Table 3. Kruskal-Wallis Test Results.

Source of Variation	SS	DF	MS
Group	31103	2	15551
Error	14414037	93	154990
Total	14445140	95	
$F_{calculated}$ = 0.10, DF = 95, P-Value = 0.905 $F_{0.05,2,95}$ (3.094) $F_{calculated}$ (0.1) < $F_{0.05,2,95}$ (3.092) Therefore, do not reject H_0 0.90 < P < 0.95 [P = 0.905]			

Percentage of Dogs Reunited with Owners

In this study, the percentage of dogs that are impounded at ACAs with no known owner (not as an owner release, cruelty/neglect case, quarantine or other circumstance), and then are reunited with their owners, is 65.3% (130 of 199 dogs). Other studies estimate that as few as 15% to 20% of dogs that are impounded at an ACA are reunited with their owners (Lord, 2006; National Council on Pet Population Study and Policy, 1997). A discussion of the reasons for the discrepancy between this study and other studies is found in the discussion session.

Effectiveness of Reuniting Dogs and Owners: the Current Licensing System Versus a GIS Application

Components of the Current Licensing System and a GIS Application

Licensing compliance is vital to both the current licensing system's effectiveness and the effectiveness of a GIS application. To be an effective means of reuniting a dog with its owner, the current system relies on the dog being licensed and wearing a license tag. For a GIS application, licensing compliance is important because a dog location layer would be developed using information from the city dog license records. An application, designed to identify households with licensed dogs nearby the location where a dog is found, would only be useful to reunite dogs with owners for those dogs that are licensed. Additionally, the effectiveness of the current licensing system for reuniting a dog and owner depends upon the dog being licensed and the dog wearing a collar with an attached licensed tag. A GIS application would rely on the dog being licensed, the license data containing complete location information, and the dog being found within the search radius (median distance traveled, determined in previous section(s)). These components are herein determined: *completeness of location information within the dog licensing data, licensing compliance, percentage of dogs wearing collars* and *percentage of dogs wearing collars with an attached tag*.

Dog Licensing in Rochester

The Microsoft Excel table of Rochester city dog licenses contained 8,055 records. The addresses from the dog licensing data were geocoded, and only the points which were located within the secondary study area and which were matched at the address point level, were retained for analysis (n=7,340). It was found that in the secondary study area there were 45,060 address points, 7,340 licensed dogs (matched at the address point level), and 5,756 unique households with one or more licensed dogs.

Licensed dogs per block group ranged from 0 to 272, with an average of 79.7. The number of households with one or more licensed dogs per block group ranged from 0 to 223, with an average of 62.5.

This research did not verify the dog license record information (i.e., correct dog, correct owner, correct address), but rather examined the data for sufficient locational information and the completeness of that information for the purpose of mapping. Ninety-one percent of dog license records were matched at the address point level and therefore this data is believed to contain sufficient locational information for use in a GIS application.

Licensing Compliance Rate

About 13% of households were found to have one or more licensed dogs (in the secondary study area), whereas the Esri ownership data predicts that about 36% of households have at least one dog (calculated to the block group level). Nationally, the percentage of household dog ownership is similar to that predicted, at about 37% to 40% (American Veterinary Medical Association, 2007; American Pet Products Association Inc., 2011). Simply, it appears that within the secondary study area only one-third of households license their dogs (Figures 7a, 7b, 8).

The secondary study area's dog licensing compliance rate was determined to be 33.5%. This rate is comparable to cities such as Phoenix, Albuquerque and Miami, which have rates between 30% and 40%. Across the nation, licensing compliance rates less than 15% appear to be more common (as found in cities such as Los Angeles, Denver, Houston, Chicago and New York) (Fischer, Schwieterman, Shankle, and Bathurst, 2010).

Collars and Tags

For a dog license tag to be an effective means of reuniting a dog with its owner, the dog must be wearing a collar with an attached license tag at the time it becomes lost and at the time it is impounded. The collar analyses were performed on data only from the secondary study area. Both data about dogs that were reported loose, found, captured and impounded at the Rochester ACA (n=99) and data about dogs that were reported to the Rochester ACA as being lost (n=61) within the secondary study area and timeframe, were analyzed for collar wearing (note that of these dogs reported lost, eight were determined to have been found, captured and impounded and they are included in both the found dogs impounded sample and the dogs reported lost sample).

Chi-squared analyses determined that both found dogs impounded and dogs reported lost wear collars at equal percentages and that those percentages are: dogs wearing collars (58%), dogs not wearing collars (28%) and dogs that the presence of a collar was unknown (14%).

For a dog license tag to be effective in reuniting a dog with its owner, the dog must be wearing the license tag, which it cannot do if it is not wearing a collar. Even if licensed, 28% of dogs are not wearing collars, and therefore, they could not be reunited via a license tag. Fifty-eight percent of dogs wear collars and could be wearing license tags, which could help reunite them with their owners.

Data provided did not allow for the exact determination of the percentage of licensed dogs wearing license tags at any

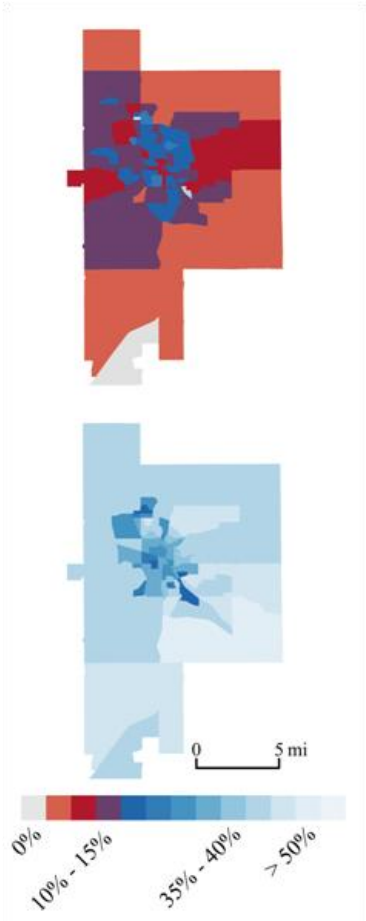

Figure 7a (top). Percentage of households with one or more licensed dogs; Figure 7b (bottom). Percentage of households predicted to have dogs (in the secondary study area, symbolized by block group).

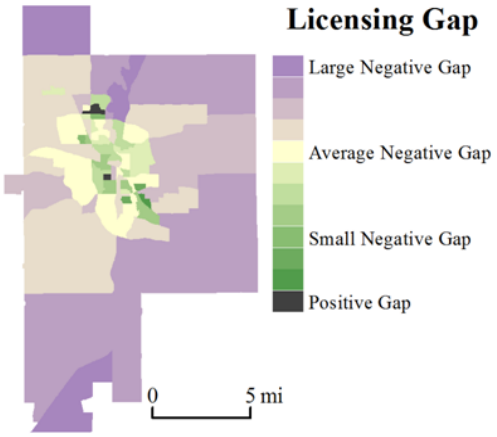

Figure 8. The licensing gap in the secondary study area, symbolized by block group. The average negative licensing gap (light yellow) is about 62%.

given time. However, a simple examination of the lost dogs reported data (but not the found dogs reported data because this information was not consistently recorded on reports submitted to the researcher) revealed: 36% of dogs that were wearing a collar were also reported as wearing a tag (identification, license, rabies), representing 20% of all lost dogs reported. Lord (2006) found that 40% of dogs were reported to be wearing a license tag, and 43% of dogs were reported to be wearing one or more tags at the time they became lost. Reasons are unknown for the differences between this study and Lord's (2006) research regarding the percentages of dogs wearing tags at the time they became lost.

This study did not determine if or how the presence of some form of identification impacted the outcome of a found dog impounded or the outcome of a lost dog reported. Other research has determined that dogs wearing some form of identification, such as a collar with an attached tag (identification, license, rabies), or a microchip are reunited with their owners in 53% of cases. Conversely, dogs without some form of identification were reunited with their owners in 35% of cases (n=187) (Lord, 2006).

Reunifications Expected: Current Licensing System Versus a GIS Application

To facilitate the reunification of dogs and owners, the current dog licensing system depends on the found dog impounded being licensed (33.5%), wearing a collar (58%) and wearing a license tag (20%). A GIS application which identifies households with licensed dogs nearby the location where a dog is found depends on the dog being licensed (33.5%) and located within a search radius around the location where it was found (50%).

For example, of 100 dogs, 14 of whom become lost, between four and five dogs (4.69 dogs) will be licensed but only about one (0.98 dogs) will be wearing a collar with an attached license tag. Half of lost dogs travel 402.3 meters or less (the default search radius distance used by the GIS application) and, if the dog were licensed, it would be identified by the GIS application as belonging to a household within a search radius around the location where the dog was found (2.35 dogs). This GIS application would facilitate reuniting licensed dogs and owners, regardless of whether a dog is wearing a collar with an attached license tag. Effectively, this application could facilitate reuniting at least twice as many licensed dogs than are currently reunited by way of the current licensing system (Figure 9).

Discussion

Percentage of Dogs Reunited with Owners

Discrepancies between this study and other studies regarding the reunification rate could be a result of many factors, but most apparent is the sample size and number of participating agencies. The use of a larger sample size and more participating agencies with different levels of service from a larger study area would likely decrease the value for the dog and owner reunification rate determined by this study. Furthermore, the use of social media and online classified ads by owners, finders and ACAs is likely to have increased the chances of dogs and owners being reunited in the timeframe of this study. These tools are more available, accessible and commonplace than at the time of the aforementioned studies.

This study found an owner reunification rate of 65.3%, while other studies, using data from ACAs about dogs that are impounded with no known owner, found a reunification rate of 15 to 20% (Lord, 2006; National Council on Pet Population Study and Policy, 1997). It should be noted, however, that a study using data from a survey of owners of lost dogs found a reunification rate of 93% (Slater, 2012). The discrepancy in these rates as it pertains to the source of the data may be a factor of the following:

- It is possible that some dogs impounded at an ACA without a known owner do not have an owner,

do not have an owner searching for them, or were surrendered to the ACA by an owner claiming the dog was found.

- In the case of the owners of lost dogs survey, it is possible that persons consenting to the survey had an interest in their dog, and perhaps were more likely to participate if they found their dog.

Cost to City

Data regarding the Rochester ACA budget and licensing fees were obtained from the City of Rochester web site. Data regarding calls to the 911 Communication Center in Rochester and Olmsted County were obtained through a public data request. The data was provided in a Microsoft Excel table from which the number of and type of calls could be determined.

During the study timeframe, the 911 Communication Center in Rochester and Olmsted County received approximately 30,743 calls, of which 1,060 (3.45%) were about animal-related issues (ANI). Of the total ANI calls, 278 were regarding lost dogs and found dogs. Lost dogs and found dogs comprise 26.22% of all ANI calls and 0.9% of all calls received. This study estimates that there are 9.31 lost dog- and found dog-related calls per 1,000 people per year and 35.5 ANI calls per 1,000 people per year in the Rochester area. In major cities, an estimated 1.5 to 4.5 animal control calls per 1,000 people per year occur (Clifton, 2002). The reasons are unknown for the discrepancy between the number of animal-related calls per 1,000 people received in the Rochester area compared to major cities. In Rochester, the 2010 budget for animal control was about $304,000, or $2.85 per citizen of Rochester, or $31.70 per licensed dog or cat (City of Rochester Department of Finance, 2011; City of Rochester, n.d.). This per capita cost is similar to that of Phoenix, Arizona ($3.06). Cities that have a lower per capita cost ($1.20 to $2.09) include New York, Houston, Chicago and Albuquerque. Cities that spend more per capita on animal control ($3.06 to $5.30)

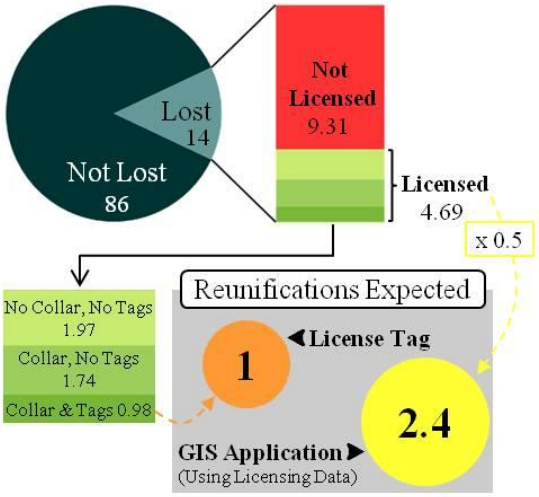

Figure 9. This figure illustrates why a GIS application using licensing data can facilitate the reunification of 2.4 times as many dogs than a license tag alone. This figure assumes: 14% of dogs become lost (and all lost dogs are found, captured and impounded), 33.5% of dogs are licensed, 58% are wearing collars (and dogs for which the presence of collar is unknown are assumed not to be wearing a collar), and about 20% wearing a collar with an attached license tag (36% of dogs wearing collars). Finally, it assumes that licensed dogs and unlicensed dogs: become lost equally, wear collars equally, wear tags equally and wear all types of tags equally. It is expected that 50% of found dogs impounded will be identified as belonging to a household within a default search radius (402.3 meters or 0.25 miles) around the location where the dog was found, and that all dogs identified as belonging to a household within the search radius are reunited with their owners. It is also expected that all dogs that are lost, found, captured and impounded, and are wearing a collar with an attached license tag, are reunited with their owners.

include Miami, Denver and Los Angeles (Fischer *et al*., 2010).

In Rochester, a pet license costs $6 to $12 per year (City of Rochester, n.d.). Licensing fees alone do not cover the costs of animal control. A deficit of about $20 per license or about $189,000 per year total needs to be financed by other means. Other taxes and fees (such as chicken coop fees and pet adoption fees) may contribute to covering the annual expenses to operate animal control. Increasing licensing

compliance by dog (and cat) owners would contribute to the cost of funding animal control services. Further study is needed to determine the specific costs of animal control services in the municipalities of Faribault and Winona.

Sources of Error

Sources of error in this project are random (sampling variability) and systematic (definition and measurement of study variability).

Sample Size

In this study, one source of random error was the small sample size. When a sample size is small, anomalies in the data will likely have a greater impact on the results parameter used to describe the population. A confidence interval of 95% is used to describe (but does not increase) the precision of the parameter being estimated (e.g. Modified Levene's Test Statistic, Kruskal-Wallis Test Statistic, One-Sample Wilcoxon-Signed Rank Test Statistic) (Schoenbach, Schildkraut, and Rosamond, 2001).

Geocoding

The geocoded locations are only as accurate as the geocoding service. In this study, the geocoding service was from a local source (E911 address points) and found to be suitable for use in a GIS application. It should be noted that the geocoding service was static, with data no older than two years, but not updated to include new addresses or changes to existing addresses. Furthermore, the Match Score for the geocoded points was equal to or greater than 85% for all points. The lost location points and found location points were manually checked by comparison to existing maps. The dog license points were not manually checked.

Data Collection

Data about lost dogs and found dogs were acquired and derived from the ACAs' reports and this researcher had no control over the data collection process. Because the raw data was not specifically collected for this project, the information available about each dog varied. The variability of the data collected limited the ability to compare the data across the three ACAs.

The percentage of dogs reported to be wearing collars and the percentage of dogs reported to be wearing tags was only evaluated for the Rochester ACA. This is because the Rochester ACA consistently recorded the presence of a collar and had the largest sample size of the three ACAs.

Data quality, completeness and standards of data collection continue to be a challenge for ACAs (Rowan, 1992). Even within an individual agency, data variability exists because data is collected and recorded by different people; this is a source of systematic error. For example, when a dog is impounded at an ACA, its description often includes its breed, which typically is determined by appearance alone. However, it has been shown that when a dog of unknown heritage is DNA-tested, 75% or more of the time the breed identification is found to be inaccurate (Voith, Ingram, Mitsouras, and Irizarry, 2009).

Another limitation was the number of reports received (about found dogs impounded and dogs reported lost) is likely representative but may not be the actual number of found dogs impounded or lost dogs reported during the study timeframe. Data about pets in ACAs are limited, so some information must be approximated or inferred (Rowan, 1992). Additionally, data about dog ownership from the commercial source was only an estimated value and not the actual percentage of households that have one or more dogs. Using estimated values instead of actual values is a source of error.

In addition to a licensing compliance rate being less than 100%, differences between the percentage of households with one or more licensed dogs and the percentage of households predicted to have one or more dogs could be the result of many factors. Examples of this are incorrect commercial estimates and the assumption that address points represent households.

The assumption that address points represent households could be a source of error and affect the value calculated for the percentage of households with one or more licensed dogs. For example, one address point could:

- Have six licensed dogs belonging to six unique owners. One explanation might be that this address point is actually a multi-household address, such as an apartment. In cases such as this, it is likely that the value for percentage of households with one or more licensed dogs is artificially large.
- Represent a non-household address such as a business. In this case, because it is not a household, the value for percentage of households with one or more licensed dogs would be artificially small.

Variability of Dogs

This study cannot control for genetics, age, training or any other characteristic or environmental factor affecting an individual dog. Every dog is unique. Even within the same breed, behavior and physiology vary greatly. This study is a generalization of dogs with many unknown, unquantifiable characteristics. When searching for a lost dog, an owner needs to consider his or her lost dog's unique characteristics because this study does not address the individual differences among dogs.

Distance Traveled Outliers

A systematic error is the source of the majority of distance traveled outliers. Incorrect address information is believed to be the primary cause. These outliers were excluded because this study is attempting to describe normality, and the data indicated that distance traveled values greater than 2,011.68 meters (1.25 miles) were not representative of the population.

The outlying values included one dog that traveled a distance of zero meters (0 miles), and 16 others which traveled a distance greater than 2,011.68 meters (1.25 miles). In the zero-distance case, the owner of the dog and the finder lived at the same address; one upstairs and one downstairs. The extreme distance cases included dogs that traveled a distance greater than 2,011.68 meters (1.25 miles). This distance value may be a result of a data collection type error. For example, a three-month-old dog traveled over 177 kilometers (110 miles). It is suspected that this dog did not, in fact, travel this far, and that the distance is a result of assuming the home address provided by the owner was also the address from where the dog was lost. It is possible that the dog was not lost from the home address, but rather was lost from some location closer to the found location. Dogs that traveled great distances may have done so because they traveled faster, more successfully evaded capture, or had been lost for a greater period of time than dogs that belong to the distance traveled analyses population. These factors were not evaluated in this study.

Limitations

The length of the study timeframe (102 days) was a limitation. A longer study timeframe would allow for the collection of additional reports and would be ideal to facilitate a comparison over time.

The inability to contact the owner of a dog that was lost and the person who found that dog (per the request of the ACAs) was a limitation. The ability to contact the owner and finder of a dog would be valuable because a survey could be administered to verify the ACA-provided information (e.g. type of dog, sex) and gather more information (e.g. circumstances surrounding the dog becoming lost and found, and actions taken to locate the dog or owner). Information provided by owners and finders would allow for better comparisons with the findings of existing studies. Moreover, asking an owner when the dog became lost would allow for the determination of the elapsed time from becoming lost to being found.

The number of participating ACAs was a limitation. Only three ACAs were able to fully participate in the study at the time requested. With increased volunteer resources and awareness of this research,

more ACAs could participate in collecting data in a manner that facilitates distance traveled determinations.

Another limitation is the scarcity of scholarly research about the distance traveled by lost dogs. One study, Lord's (2006), was found to have collected distance traveled information from the owners who found their lost dogs who reported whether their dogs were found less than one mile from home, between one and five miles from home, more than five miles from home and an unknown distance from home.

Recommendations for Future Work

Recommendations for future work include the following:

1) Develop a GIS application for ACAs. With this application, an ACA employee could create a search radius around the location where a dog was found and be provided with a map showing the locations of households with one or more licensed dogs located within that search radius, a list of addresses of those households, as well as attributes of the dogs within those households. The default search radius distance would be the median distance traveled determined by this research (402.3 meters, 0.25 miles) but could be changed by the application's user. The licensed dogs location layer could be developed using the city dog license records. A GIS application would facilitate reuniting a dog with its owner, regardless of whether the dog was found wearing a collar with an attached license tag. A GIS application would help ACAs proactively reunite dogs and owners, reducing costs incurred by ACAs.

2) Further investigate the licensing gap to determine methods to increase compliance. This could include examining:

- The characteristics of owners who license and owners who do not license their dogs.
- Strategies employed by ACAs with licensing compliance rates greater than 50%, and the costs associated with these strategies.

3) Encourage more ACAs to participate in data collection to allow for comparisons of the distance traveled by lost dogs among the ACAs. This would include working with ACAs to develop and adopt a standardized data model and data collection procedures.

4) Compare municipalities that have ACAs with overlapping service areas to municipalities where there are no agencies (governmental or other) acting as ACAs. Specifically, determine whether the impounded dogs served by ACAs with overlapping service areas and dogs in areas not served by ACAs are from the same statistical population:

- As it relates to distance traveled and/or other characteristics.
- As the dogs in this study, as it relates to distance traveled and/or other characteristics.

5) Finally, an extensive examination of ACA budgets would be useful to determine monetary and non-monetary costs incurred by ACAs. This information would be helpful in designing cost-saving solutions and justifying the creation of a GIS application to help ACAs proactively reunite dogs and owners.

Conclusions

Lost dogs impounded at the three ACAs were found to originate from the same population. It was determined that half of the dogs were found 402.3 meters (0.25 miles) or less from where they became lost.

Information about the components necessary for the development of a GIS application was determined. Overall, it was determined that a GIS application using licensing data could be at least twice as effective when compared to the current system (license tag) alone for facilitating the reunification of dogs and owners. This is because a GIS application does not depend on a dog wearing a collar with an attached license tag, important because not all dogs are wearing collars with attached license tags when they are lost and when they are impounded. However, because only approximately one-third of households license their dogs, a GIS

application would be most effective if the licensing gap was closed. The results of this study have the potential to help owners search for their dogs and also to help ACAs proactively reunite dogs and owners.

Acknowledgements

I would like to thank:

- Professor Dr. David McConville and instructors John Ebert, Greta Bernatz and Patrick Thorsell for their guidance on this project as well as throughout the program.
- The staff, volunteers and friends at the ACAs.
- My GIS colleagues and fellow students for their support and inspiration throughout this program, especially Bill Durkin for his countless hours assisting me with obtaining data and reviewing my paper, as well as Stephen Horn for reviewing my paper.
- I would like to thank my family for encouraging me to do what I love.
- And last but not at all least, I would like to thank Snickers, Squeakers, Snowflake and Golden Furry II, and all the dogs in the world, especially Reba Wildflower.

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