

When and Why Companion Dogs are Returned to Animal Shelters – A Multifactorial Analysis

Kristen Thanawala

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Master of Science

In

Applied Animal Behavior and Welfare

Agricultural and Life Sciences

Erica Feuerbacher, PhD (Chair)

Allison Andrukonis, PhD

Lisa Gunter, PhD

April 15, 2024

Copyright Kristen Thanawala

When and Why Companion Dogs are Returned to Animal Shelters – A Multifactorial Analysis

Kristen Thanawala

ABSTRACT

Millions of dogs come through the shelter system each year, and it is estimated that between 7% and 15% of the dogs that are adopted are returned after a failed adoption. Understanding the factors that predict canine returns to animal shelters might help to inform adoption counseling, reducing intake and euthanasia rates in shelters. Additionally, understanding when returns are more likely to occur following adoption might influence the strategic deployment of resources by shelters to mitigate commonly reported behavior issues. This study utilized intake data from three related animal shelters over a five-year period to investigate what variables were predictors of canine return post-adoption, with a particular interest in dogs' origin geography compared to their adoptive home geography, as well as time following adoption in which failed adoptions were more likely to occur. The results of our analysis showed no significant relationship between the geographical origin of dogs and returns, but it did suggest a relationship between dogs adopted into urban locations and likelihood of return. Additionally, our analysis supports the findings of prior research that dog breed groupings and age are predictors of adoption success. Finally, we were able to identify that returned dogs have a 66% likelihood of being relinquished by their adopters within the first 30 days following placement.

ACKNOWLEDGEMENTS

My husband. Thank you for believing in me and supporting me in this endeavor. I would not have had the courage to do this without you.

My family and friends. Thank you for helping me believe I was smart enough to do this.

Dr. Erica Feuerbacher, Dr. Allie Andrukonis, and Dr. Lisa Gunter. Thank you for serving as my committee. Your ideas, edits, support, and encouragement got me to the finish line. Thank you for helping me become a scientist.

Alicia Arneson and Simin Zheng. Thank you for your excitement and your commitment to this project. I really could not have done this without you.

Laney Nee and the Animal Rescue League of Boston. Thank you for taking me under your wing and giving me the encouragement and tools to grow. Thank you for sharing this data. I truly hope this work envelops our mission to keep more animals and their humans together.

Jessica Harder-Leeson, Tiffany Score, Emily Sanders, Miranda Hitchcock, Glenna Cupp, Jenni Pfafman, Dr. Robin Foster, Dr. Jessica Hekman, and Dr. Kristina Spaulding. You have all provided me with support, encouragement, ideas, and advice throughout my time at Virginia Tech. I will be forever grateful.

And finally, for all the shelter dogs who never found their forever home. This research is for you.

Table of Contents

INTRODUCTION.....	1
1.1 Shelter Dog Overview.....	1
1.2 Returns as an Issue of Concern for Shelters.....	1
1.3 Issues Defining Returns.....	2
1.4 When Returns Typically Occur.....	2
1.5 Factors that Influence Unsuccessful Adoptions.....	3
1.6 Issues Surrounding Matchmaking and Behavior.....	4
1.7 Geographic and Environmental Considerations.....	5
1.8 Current Study.....	10
MATERIALS AND METHODS.....	12
2.1 Data Sources and Shelter Characteristics.....	12
2.2 Data Count and Exclusions.....	12
2.3 Data Variables and Coding.....	14
2.4 Statistical Analysis.....	18
RESULTS.....	20
3.1 Descriptive Statistics.....	20
3.2 Predictors of Returns.....	26
3.3 When Returns are Likely to Occur.....	30
DISCUSSION.....	32
4.1 General Overview.....	32
4.2 Geographical Influence on Returns.....	32
4.3 Dog Related Factors that Influence Returns.....	35
4.4 When Returns are More Likely to Occur.....	39
4.5 Limitations.....	40
4.6 Future Directions and Considerations.....	41
CONCLUSION.....	43
REFERENCES.....	44

1. Introduction

1.1 Shelter Dog Overview

Each year, roughly 3.1 million dogs come through the sheltering system in the United States (U.S.), of which about 390,000 are euthanized (Association for the Prevention of Cruelty to Animals [ASPCA], n.d.). While that number may seem staggering, this is a vast improvement (nearly tenfold) over the last 40-50 years in part due to sterilization programs, pet identification, and increased numbers of dogs being adopted from shelters (Rowan & Kartel, 2018). Improving the live outcome rates for shelter animals is one measure of success that continues to be of great importance, but there are other measures to explore that might be indicative of successful efforts in animal sheltering. One example might be to further investigate post-adoption return rates to better understand the factors that influence adopter satisfaction, ultimately informing the success of the adoption.

1.2 Returns as an Issue of Concern for Shelters

While many pet adoptions are successful, it is estimated that between 7% and 15% of dogs are returned to the shelter post adoption (Diesel et al., 2008; Powell et al., 2021). These estimates do not consider alternatives to relinquishment such as rehoming websites, social media, or word of mouth, making unsuccessful adoptions very difficult to track and understand in totality. Fortunately, many dogs that are returned after failed adoptions are readopted (Patronek & Crowe, 2018; Powell et al., 2021). While studying returns does not tell us everything about the successes or failures of adoptions, understanding the variables that correlate with returns can be

useful. Similarly, getting firsthand knowledge from the adopters might provide shelters with the opportunity to identify why the first match was unsatisfactory. Ultimately, any information gained from the return process might help to inform more accurate matches in the future and reduce intake and euthanasia rates in shelters.

1.3 Issues Defining Returns

When a dog re-enters the shelter, the intake type can either be categorized as a return or an owner-surrender, both of which are ultimately defined by the length of the adoption. This poses an additional challenge in tracking return rates because of the variability in how shelters define returns, as demonstrated by current research. Of the literature reviewed, the variability ranged from: returns classified as <30 days post-adoption, after which the intake type was reclassified as owner-surrender (Patronek & Crowe, 2018), returns classified as <4 months post-adoption (Hawes et al., 2020; Powell et al., 2022), returns classified as <6 months post-adoption (Diesel et al., 2008; Powell et al., 2021), returns classified as <2 years post-adoption (Shore, 2005), or not classified by any specific time period (Cannas et al., 2014). Greater uniformity on how shelters classify, track, and report intake data might provide a clearer picture of when returns are more likely to occur and better document the experiences of individual animals.

1.4 When Returns Typically Occur

Understanding when returns typically occur might assist shelters in creating a logical delineation between adoption returns and owner surrenders. Additionally, aligning post adoption check-in programs, which offer general support and training advice, with peak return times could

potentially help to mitigate common transitional challenges and improve overall retention rates. A recent study by Thumpkin et al. (2022) used survival analysis (time-to-event) to look at retrospective return rates in an Australian RSPCA over a two-year period. Of the 6,212 dog adoptions (from 5,587 individual dogs), 865 of the adoptions were returned to the shelter. The researchers found that return rates were highest during the first 14 days post-adoption (64% of returns), gradually declining after the 30-day mark for an overall return rate of around 15%. Interestingly, 14% of returns occurred within just one day of adoption. Another, older study from Shore (2005), conducted interviews with 78 adopters who had recently returned their pets and found that nearly half of animals were returned within 14 days of adoption. Some of the adopters in this survey referenced adoption fee refund as one reason for returning within this timeframe which indicates this might be a variable to take into consideration. Similarly, Mondelli et al. (2004) found that 40% of the dogs returned in their study were returned within the first week, whereas Hawes et al. (2020) found that 50% of dogs that were returned to the shelter were returned after 60 days. Collectively, these studies indicate variability around when a dog is typically returned by its adopter, which might partially be an artifact of how returns are categorized. Similarly, the factors that influence returns might also vary depending on the shelter, region, or individual dog or adopter, suggesting that there is opportunity to further study when and why returns most typically occur.

1.5 Factors that Influence Unsuccessful Adoptions

There are numerous variables that might influence animals being returned to the shelter. Current research has identified dog behavior as the primary reason for unsuccessful adoptions (Diesel et al., 2008, Friend & Bench, 2020; Hawes et al., 2020; Powell et al., 2021). After

behavior, subsequent reasons for return include unrealistic expectations of the adopter or caretaker, medical concerns of the dog, and caretaker health, financial, or housing obstacles (Diesel et al., 2008; Friend & Bench, 2020; Hawes et al., 2020; Powell et al., 2022). In Patronek & Crowe's (2018) study, researchers found that a dog's probability for live release from the adoptable population went down significantly if they had medical concerns and more so as the medical concerns increased in their severity. Considering adopters' disinterest in dogs with health problems, it is possible that the onset of such problems after adoption could potentially influence adoption success.

Some adopters may underestimate the care requirements when adopting a pet. Shore's (2005) study in which the researcher asked open-ended interview questions to participants who had returned an adopted dog, suggested a common theme of returners feeling as though they rushed into the decision to adopt without fully understanding the ramifications of the time commitment, or the size/breed/age of the dog fitting into their current lifestyle. Similarly, 40% of returns at an Italian shelter as described by Mondelli et al. (2004) were due to owner management problems. Collectively, owners' reasons for relinquishment suggest that there is an opportunity to better understand these variables in an effort to improve the adoption matchmaking process.

1.6 Issues Surrounding Behavior and Matchmaking

Behaviors that have been correlated with unsuccessful adoptions include aggression, separation anxiety, house soiling, and not getting along with other pets (Diesel et al., 2008, Friend & Bench, 2020; Hawes et al., 2020; Powell et al., 2021;). Of the literature reviewed, when

behaviors were broken down by individual concerns rather than being categorized into groups containing multiple behaviors, aggression was most often stated as the top risk factor for relinquishment, followed closely by destructiveness (Coe et al., 2014; Diesel et al., 2008; Hawes et al., 2020; Powell et al., 2021; Powell et al., 2022). Identifying risk profiles (e.g., aggression to other dogs) upon entry into the shelter might enable staff to appropriately match dogs with adopters, potentially reducing their risk of relinquishment. However, due to the stressful nature of animal shelters (Newbury et al., 2010; Taylor & Mills, 2007), it is unclear how certain behaviors exhibited in the shelter will translate to other environments. Research surrounding behavioral assessments in shelter dogs suggests that they might not be entirely valid or reliable in predicting future behaviors in the home. However, they might still be informative and provide value when considered alongside medical information, owner-reports, and natural observations such as walks, playgroups, and shelter staff interactions (ASPCA, n.d.; Clay et al., 2020; Marder et al., 2013; Patronek & Bradley, 2016; Patronek et al., 2019;). Additionally, some of the commonly utilized shelter behavior assessments in the U.S. (SAFER, Assess-a-Pet, and Match-Up-II) might offer insight into the general personality of the dog being assessed, as well as potential risk factors to look out for when picking a suitable adopter (ASPCA, 2010; Bollen & Horowitz, 2008; Center for Shelter Dogs, n.d.; Marder et al., 2013; McGuire et al., 2020; Sternberg, n.d.).

1.7 Geographic and Environmental Considerations

Preventing animals from being returned post adoption is a consistent challenge that shelters experience, and several studies have focused their efforts on identifying risk factors that inform these returns. To our knowledge, the disparity between the environment a dog comes

from and the environment a dog is adopted into has not been explored as a risk factor for returns or a consideration when placing dogs into adoptive homes. However, having a greater understanding of where a dog comes from might aid in matching dogs with appropriate adopters who can either provide an environment similar the one the dog is accustomed to, or support them through the transition to a different environment.

One example of an environmental change that could potentially lead to adoption mismatches is the relocation of dogs from less resourced shelters to organizations with more resources. Given the differences in legislation, education, and sterilization programs across the United States, some parts of the country have seen substantial decreases in the population of homeless dogs (Rowan & Kartal, 2018). Conversely, in other areas of the country, many shelters struggle to place unwanted dogs and do not have the resources to care for a growing, often overcrowded shelter population (Simmons & Hoffman, 2016). For context, the South Atlantic region of the U.S. makes up about 17% of the human population, and accounts for roughly 23.4% of yearly shelter dog intakes, while New England and the Mid-Atlantic together make up about 15% of the human population and only accounts for about 6.8% of yearly shelter dog intakes (Democratic Statistical Atlas of the United States, n.d.; Shelter Animals Count, 2021).

The mismatch of supply and demand has inspired partnerships between shelters and rescue organizations, where the transfer of dogs between locations might help to better manage dog population with adoption demand. While transporting animals is not a novel intervention, the number of animals transported between shelter organizations has grown exponentially, more than doubling year over year between 2015-2019 and is expected to increase (ASPCA, n.d.). Certainly, transport partnerships benefit homeless animals; roughly 230,000 animals have been relocated through the ASPCA relocation program alone since 2014 who might have otherwise

been euthanized. Additionally, survey research has suggested that relocation programs bring diversity to adoptable dog populations which potential adopters find appealing, increasing the attractiveness of shelter dog populations, potentially aiding adoption efforts (Garrison & Weiss, 2014). Despite the steady decline in shelter dog euthanasia numbers since 2011 (ASPCA, n.d.), further research is needed to understand if relocation programs have any influence on the overall shelter dog population outcomes.

Though beneficial, relocation programs are not without risks such as safety issues and the potential for disease spread and/or exposure while in transit. Additionally, the physical and psychological stress some animals experience during transport can be an immunosuppressant, causing increased susceptibility to viruses and infections (Newbury et al., 2010). Organizations are encouraged to follow transport guidelines to minimize health and safety risks, but there are many considerations for those involved and the logistics can be quite complicated. Mode of transportation (e.g., land versus air), training for transport staff, appropriately sized and spaced kennels, adequate ventilation and temperature regulation, accessibility of food and water, and rest and elimination breaks are some of the guidelines described in The Association for Animal Welfare Advancement (2019). However, there are no federal regulations regarding limitations on distance traveled or the use of sedatives for animals being transported (Newbury et. al., 2010; United States Department of Agriculture, 2022).

Regardless of the mode of transportation, several studies have reported that travel can be physiologically stressful for dogs with measurable effects lasting for up to 48h or longer (Bergeron et al., 2002; Romaniuk et al., 2022; Tateo et al., 2022), and the long-term effects of this stress are not well understood. Furthermore, it is difficult to appreciate the role of temperament in dogs' ability to cope with transport stress and/or a new home environment. To

our knowledge, the protocols used by shelters to identify suitable dogs for transport vary by organization, although the American Veterinary Medical Association (AVMA) recommends that origin and destination facilities establish agreements on medical and behavioral requirements for dogs being transported (AVMA.org, n.d.). The use of standardized behavioral evaluations is one way for organizations to align on behavioral criteria for dogs suitable for adoptions. As previously mentioned, behavioral evaluations are unlikely to fully predict future behaviors in the home, but they might be useful in identifying high-risk dogs that may not be suitable for travel or adoption.

When evaluating adoption matches for animals relocated through transport programs, one consideration might be to assess the disparity between a dog's origin environment and the one they are being adopted into. Early socialization and experiences can influence a dog's ability to adapt to environmental changes (Foraita et al., 2021). Recognizing notable differences between environments might shape adopters' expectations on how a dog might respond to these differences. For example, if a dog comes from a rural, free-roaming environment (e.g., as a stray), we might consider how a transition into a city apartment could impact their behavior and general welfare. Additional research could help to provide a greater understanding of how early life experiences influence a dog's adaptability in different home environments, ultimately influencing the adoption matchmaking process, and setting dogs and their adopters up for success. Similarly, understanding adopter expectations when adopting a dog might help to create better matches that lead to successful adoptions.

One area of interest would be to investigate if dogs coming into the shelter from one geographical setting (e.g., rural) and are then adopted into another geographical setting (e.g., urban) has any influence on return rates. This could potentially provide some insight as to what

degree a dog's origin story impacts their ability to adapt in new or changing environments as well as the influence origin has on adoption success. Much of the research focused on the geographical movement of dogs pertains to population, pathogens, and disease (DiGangi et al., 2021; Wright et al., 2020; Villatoro et al., 2016). The few studies that have investigated the relationship between geographic location and pet retention suggest that there is a growing curiosity around where pet dogs come from. von Rentzell and colleagues (2022) surveyed over 800 pet owners to investigate if there were any notable differences in the human-dog relationship between dogs that were imported into Canada from other countries versus Canadian born dogs. They found no significant owner-reported differences in owner-dog relationships with Canadian and non-Canadian dogs, and there were no greater behavioral or health risks associated with imported dogs compared to Canadian dogs. Another study utilized Canadian zip codes to gain a better of understand human community vulnerability and the potential influence on animal relinquishment (Ly et al., 2021). Their research uncovered socio-economic imbalances in areas where surrendered animals originated from, indicating that some pet owners do not have access to resources that might minimize the risk of relinquishing their pets. Utilizing zip codes in future research pertaining to animal relinquishments might offer insight into the geographical and environmental background of dogs. It might also provide additional context for behaviors exhibited by dogs in the shelter, better informing adopters and improving the matchmaking process and shelter outcomes.

When a dog comes into the shelter, their zip code of origin is recorded, but to our knowledge, there is limited research of zip codes as a variable of interest when considering outcomes. Future studies utilizing zip codes could potentially provide more context about shelter dog populations, providing a greater understanding of where dogs are coming from, where they

are going, and if there is any disparity between the locations that could better inform placement decisions.

Direct observations of dogs in different environments might also provide useful information about potential behavior differences between dog populations. In a Brazilian study investigating the behavioral differences between free roaming dogs in different geographical settings, researchers observed 55 dogs (15 rural, 40 urban) over 516 hours and concluded that the rural dogs displayed more territorial-defensive behaviors than the urban dogs and were generally more vigilant and reactive to noises generated by people, vehicles, and other animals. Conversely, the urban dogs were generally more sociable and less aggressive toward other species (Martinez et al., 2022).

Animal shelters accept dogs from a variety of sources, including animal relocation transports from overcrowded shelters, often from different regions of the country. It is possible that a sizable portion of the adoptable dog population experiences a geographical shift from where they originate to where they are ultimately adopted. How this geographical shift influences adoption success has not been widely explored or well understood.

1.8 Current Study

The aim of this study was to identify factors that influence a dog being returned to the shelter, with a particular interest in the geographical shift of transported dogs from their origin location to their adoptive home. We were also interested in identifying periods of time following adoption that returns are more likely to occur. To accomplish this, we utilized five years of canine intake data from the Animal Rescue League of Boston which has three campuses of three

geographic types: urban (Boston), suburban (Dedham), and rural (Brewster). We investigated possible correlations between age, breed grouping, intake type, location of shelter, geographical and population information at dog origin and destination, documented aggression, and the relationship (if any) to individual outcomes including return rates of adoptable shelter dogs. With this study, our intent was to gain a better understanding of the dog population across the three shelter campuses and identify variables that correlate with outcomes. Retrospective analysis of the existing intake data has the potential to offer insight into population management across shelter locations, better inform dog relocation and placement strategies within multiple communities and improve live outcomes and adoption retention rates. Additionally, understanding when returns are likely to occur might influence when post-adoption counseling is offered in an effort to mitigate commonly reported behavior problems that can lead to relinquishment.

2. Materials and Methods

2.1 Data Sources and Shelter Characteristics

All data were collected from the Animal Rescue League of Boston. It is an open admission, 501(c)3 rescue organization, shelter, and adoption center. They have three separate campuses in Eastern Massachusetts, each representing a different geographical setting (i.e., rural, urban, suburban). They receive no government grants or public funding and rely entirely on the financial support of donors. Animals arrive at the shelters as strays, from local rescue operations, owner-surrender intakes, and local or out-of-state transports/transfers. Intake and outcome records were collected for all dogs entering the three shelters between January 2017 through June 2022 via the shelters computerized database system Chameleon and converted into Microsoft Excel for use in this study.

2.2 Data Count and Exclusions

A total of 5,949 lines of Chameleon data were provided via Microsoft Excel and were representative of every dog intake between January 1, 2017, through June 20, 2022. Data variables included animal identification number, age of dog in years and months, sex, primary breed, intake type, intake date, intake location, origin zip code, behavior condition of the dog, source of the dog (if known), reason for intake, outcome date, outcome type, outcome zip code, known medical conditions (if any), behavior assessment results and assessment score if applicable, and recommendations regarding adoption. Data were first sorted by animal identification number, filtered by outcome, and manually reviewed to identify which lines met

inclusion criteria. For inclusion in the analyzed data set, dogs were to be considered available for adoption. Animals that were lost, found, and subsequently returned to their owner ($n=743$) did not meet the inclusion criteria and were excluded from data analysis. Dogs who were euthanized as per their owner's request ($n=467$) were also excluded from analysis. Due to Chameleon programming, any known medical condition at intake created a duplicate line in the spreadsheet. For example, if animal A123456 had kennel cough and dental disease at intake, there would be three A123456 intake records: A123456 with medical condition blank, A123456 with medical condition kennel cough, and A123456 with medical condition dental disease. Therefore, the data were manually coded to include all medical conditions on the original line, and duplicate lines were removed accordingly before analysis ($n=843$). A total of 2,053 (35%) lines of data were excluded from the analyzed data set. The final data set used for analysis consisted of 3,895 unique intake records (Table 1). All data were maintained in Microsoft Excel and then exported to JMP for statistical analysis.

Table 1. Breakdown of canine intake records received from January 2017-January 2022

Record Description	n (%)
Canine intake records received:	5,949 (100)
Records Excluded:	
Lost, found, and subsequently returned to owner	743 (12.5)
Owner request for euthanasia	467 (7.8)
Duplicate lines	844 (14.2)
Total records analyzed:	3,895 (65.5)

2.3 Data Variables and Coding

2.3a Intake Type

Intake type was defined and reclassified into seven categories. 1. Owner-surrender: dogs that were relinquished by their owners to the shelter directly. The shelter may or may not have been provided with additional history, such as where the dog was originally obtained, and reason(s) for relinquishment. 2. Transport: dogs that came to the shelter as out-of-state transport through a relocation program in partnership with another rescue organization or shelter. 3. Local Transfer: dogs that were transferred into the shelter by an in-state veterinary practice, law enforcement agency, or other in-state shelter or rescue organization. 4. Confiscate: dogs that came into the shelter without the owner's consent. Reasons for confiscation can vary due but include abuse, neglect, or overcrowding. 5. Strays: dogs with no known owner. 6. Born in care:

dogs born in the shelter or in foster care. 7. Returns: defined in this study as dogs that were relinquished by their adopter ≤ 182 days of adoption (Diesel et al, 2008; Powell et al., 2021).

Any individual that was returned to the shelter appeared in the data set more than once (the initial intake to the shelter and the return intake). To maintain accurate representation of individual dogs in the analysis and to appropriately categorize returns prior to analysis, each line was provided with a numerical code that corresponded to a specific intake type and date. For example, if A123456 had an original intake date of 1/1/2017, it was labeled “1”. If the dog was adopted out, and subsequently returned ≤ 182 days, the next intake would be labeled “2”. If that dog was returned a subsequent time, within ≤ 182 days of the first return, the numbering system would continue, and the next intake would be labeled “3”. If, however, A123456 was relinquished *after* 182 days, the numerical code would read “1.2”.

2.3b Zip Codes

Shelter location, zip code of origin, and zip code of outcome were variables collected in the initial data set that were then assigned geographic labels: urban (U), rural (R), and suburban (S), to be used for data analysis. These labels were categorized and defined by a paid database considering three main variables: “population density (people per square mile), distance from nearest city, and size of the nearest city (suburban areas for larger cities extend greater distances) (Great Data, 2023)”. Great Data utilizes Census counts to estimate current populations, and releases updates to their database on a quarterly basis. Upon purchasing a subscription to the database, a Microsoft Excel spreadsheet containing the classification of every zip code in the U.S., Canada, and Puerto Rico (as was current in October 2023) was linked to the intake data via VLOOKUP, and all zip codes in the data set were successfully converted into their corresponding geographic labels.

2.3c Age & Length of Stay

Age of the animal was recorded upon intake as years and months based on medical records, owner reports, or shelter estimation. For numerical simplicity in analysis, years and months were converted to months. For example, if a dog was reported as being “five years, six months”, their age was converted to 66 months. *Length of stay* was defined and calculated by the number of days a dog was in care of the shelter, beginning at the intake date and ending at the outcome date.

2.3d Breed Grouping

Considering *breed*, upon a dog's intake shelter staff were required to choose only one breed from a list of breeds. If the breed was not specified at time of intake, or if the dog breed was mixed or unknown, staff chose the breed that most accurately represented the dog's physical attributes to the best of their abilities. For the purposes of analysis, specified breeds in the original data set ($n=133$) were categorized under eight *breed groupings* as established and defined by the American Kennel Club (AKC, n.d.): working (e.g., Great Pyrenees, Siberian Husky), toy (e.g., Chihuahua, Shih Tzu), terrier (e.g., Bull Terrier, Russell Terrier), sporting (e.g., English Setter, Golden Retriever), non-sporting (e.g., Poodle, Shiba Inu), hound (e.g., Beagle, Greyhound), herding (e.g., Australian Shepherd, Belgian Malinois), and foundation stock service—which refers to the certification issued by the AKC to recognize and document new or rare breeds that are not currently registered or recognized as official breeds within the AKC (e.g., Alaskan Klee Kai, Carolina Dog).

2.3e Behavior Assessment and Reason for Return

Approximately 700 of the intake records used in the analysis (18%) did not include a *behavior assessment*. For the remaining records, the assessments were free response, and did not use standardized values. For the purposes of analysis, we created a formula in excel to set criteria that would return a true or false value if the word “aggression” was stated in the behavior evaluation results.

Upon a dog entering the shelter, shelter staff chose a reason for intake from a drop-down menu consisting of 34 choices. For the purposes of this analysis, the reasons were collapsed and defined into ten distinct categories: 1. Aggressive – includes aggression to people and aggression to other animals (e.g., lunging, barring teeth, biting). 2. Owner health – includes allergies, owner health, and owner death. 3. Other animal related behaviors – includes barking/vocalizing, destructiveness, escaping, house soiling, too shy. 4. Fearful – includes fearfulness towards adults, fearfulness towards children, fearfulness towards other animals. 5. Animal health – includes illness, injury, and old age. 6. Other owner reasons – includes landlord restrictions, insurance restrictions, cost, divorce, moving, new baby. 7. No time. 8. Other pet – includes other pets and too many pets. 9. Too active – includes too big, too active, too strong. 10. Other – includes stray, transfer, born in care, confiscate, law enforcement, and temp housing. This variable was used in analysis specifically for returned dogs and will be referred to as *reason for return* in future sections.

2.3f Outcomes

There were five possible *outcomes* for every dog leaving the shelter: 1. Adoption – the animal was adopted. 2. Euthanasia – the animal was humanely euthanized for behavioral or medical reasons, 3. Transfer – the animal was transferred to another rescue, shelter, or medical facility. 4. Death – the animal died in care due to injury, illness, or natural causes. 5. Foster – the animal was placed in temporary foster care.

2.4 Statistical Analysis

Intake type, intake location, zip code of origin, zip code of outcome, approximate age, length of stay, breed grouping, behavior assessment results, reason for return, and outcomes were the final variables used for data analysis. We used a logistic regression model for analyses using JMP Pro 16 (SAS Institute, Cary, NC) to investigate what variables were correlated with a dog being returned to the shelter. Analyses included overall descriptive statistics and year-over-year data. Geography of dog origin and adoption outcome (categorized by urban, rural, and suburban labels based on zip codes), shelter geography (categorized by urban, rural, and suburban labels depending on which of the three campuses the dog entered), and all interactions were included in the model as fixed effects. The dog's age, sex, breed group, whether it showed signs of aggression, length of stay in the shelter, and the route by which it entered the shelter (e.g., transport, confiscation, owner surrender) were also included in the model as fixed effects, but no interactions were initially explored. Finally, the square of the dog's age was included to allow for curvature in the relationship between age and return probability based on findings from exploratory graphing. Stepwise variable selection was performed on the full model. Forward,

backward, and mixed direction stepwise selection were performed using AICc, BIC, and a p-value threshold of 0.05 to ensure consistent results. All methods yielded the same final model, which included the age of the dog and its square term, whether they showed signs of aggression, length of time they stayed in the shelter prior to adoption, breed group, and outcome geography as predictors. Post-variable selection, there was no evidence of multicollinearity based on variance inflation factor (VIF) values (all VIF < 5). After stepwise selection was performed, two-way interactions of the remaining variables were added. No interaction was significant, so they were removed from the final model. Not all two-way interactions were tested originally because of issues with identifiability of the coefficients (insufficient degrees of freedom). The model assumptions were verified using graphical depictions using randomized quantile residuals.

Assumptions associated with our model include independence of errors, linearity in the logit for continuous variables, absence of multicollinearity, and lack of strongly influential outliers (Stoltzfus, 2011). To satisfy the assumption of independence of errors, we transferred our model to R statistical software, and plots of randomized quantile residuals (RQRs) (Dunn and Smyth, 1996) simulated from the model using the DHARMA package in R (Hartig, 2022) were evaluated. The DHARMA package also provides a test for outliers based on particularly large RQR values, and no evidence of extreme outliers was found. The absence of multicollinearity was confirmed using VIF as previously described, and the linearity assumption was evaluated using the RQR plots provided by the DHARMA package. These plots are what led to the inclusion of a quadratic age term in the model.

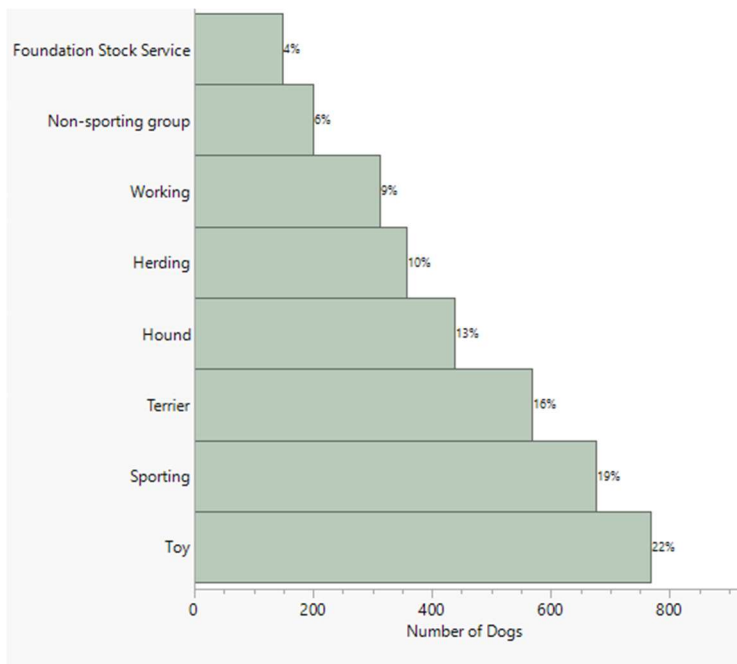
3. Results

3.1 Descriptive Statistics

Population Makeup: Age, Sex, Breed Grouping

The median age of dogs entering the shelters was 12.1 months at intake. Approximately 44% ($n=1,520$) of all dogs were ≤ 10 months of age at intake. More males (53%, $n=1861$) than female (46%, $n=1,612$) were represented in the data. Regarding breed grouping makeup, toy group was the largest at 22% of the population (Figure 1).

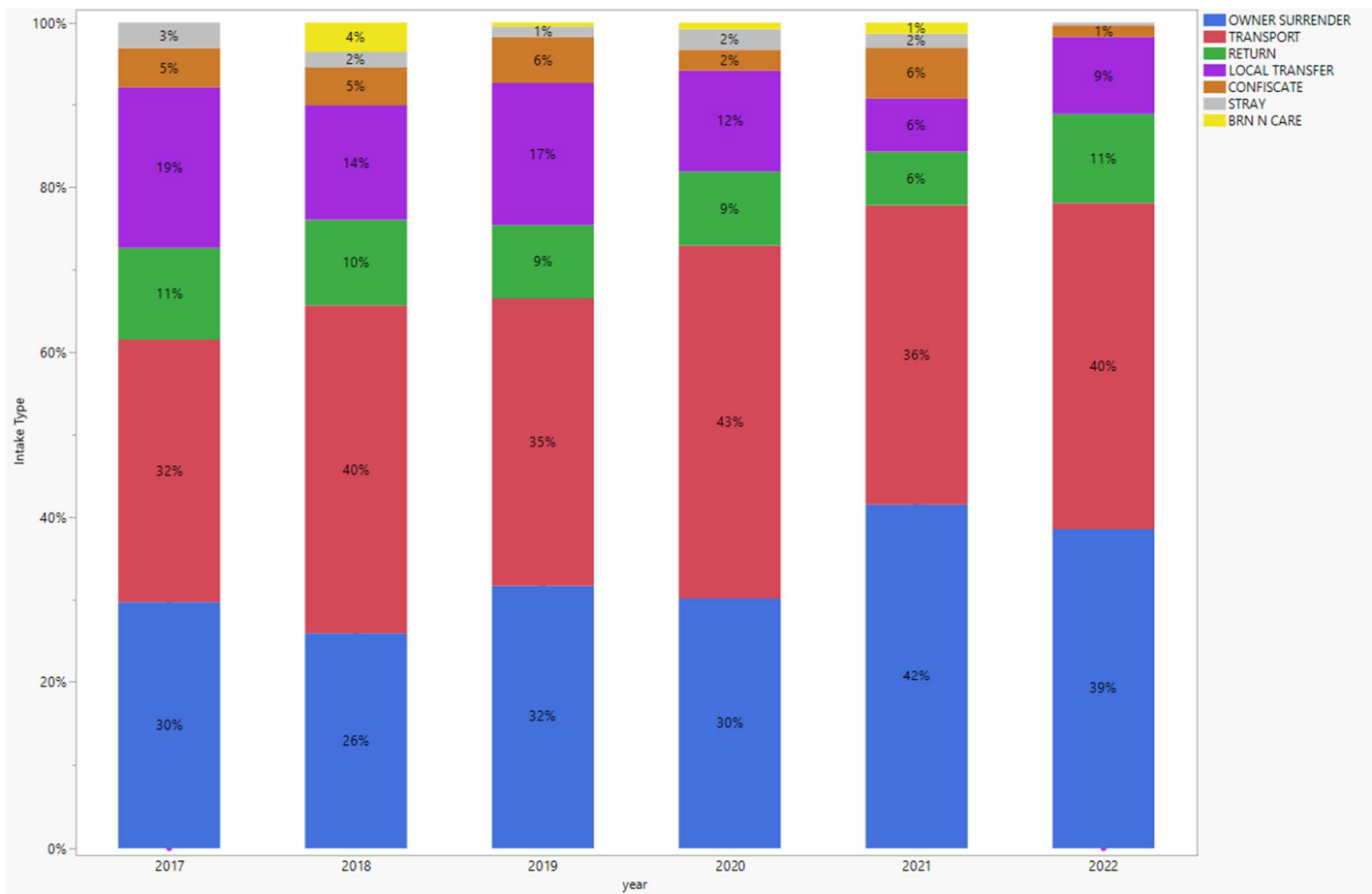
Figure 1. Breakdown of population makeup by breed grouping in full data set



Intake Type

Looking at intake types, transports made up 37% ($n=1,438$) of all intakes over the period analyzed, followed by owner-surrenders at 32% ($n=1,237$). Year-over-year data suggests that intake trends are consistent over time, with owner-surrender and transport population fluctuating in opposite directions (Figure 2).

Figure 2. Intake type distribution year-over-year



Shelter geography, origin geography, and outcome geography

For the total period analyzed, the urban shelter location represented 39.8% of all intake records, followed by the suburban location (31.1%), and the rural location (29%). In terms of geographical shift of dogs coming into the shelter, of the total intake/outcome records analyzed, inclusive of all intake types, 41% ($n=1,553$) of dogs adopted were matched to the same geographical label as their origin, and 28% ($n=1,082$) of dogs adopted had a three-way match in which the shelter geography matched the geography of the dogs origin and outcome accordingly (Table 2). Year-over-year data suggests that more than 70% of the adoptable dog population came into the shelter(s) from urban and suburban geographies during the study timeframe and approximately half of the dogs adopted went to homes in urban environments (Figure 3). As to the relationship between geography and transports, our data showed that 86% of all transports came from suburban and rural geographies, 80% were processed through suburban and rural shelters, and 62% were adopted into urban outcomes. Only 14% of transports came from urban areas, while 37% of transport dogs were adopted into urban homes.

Table 2. Breakdown of population matches by geography.

Geography	Dog geography matches from origin to outcome	% of adoptions
Urban-Urban	767	20%
Rural-Rural	407	11%
Suburban-Suburban	379	10%
<i>Total Matches</i>	<i>1,553</i>	<i>41%</i>

Note. This table represents all records with “adopted” outcomes that correspond with a zip code (n=3,830). This includes dogs that were returned, readopted, and subsequently have more than one corresponding zip code. It does not include dogs that had an outcome without a corresponding zip code (e.g., dogs who were euthanized). A match indicates that the geography of a dog’s origin matches the geography of their outcome (e.g., urban to urban).

Figure 3. Population distribution by geography at origin, shelter location, and outcome – year-over year



Length of stay and outcomes

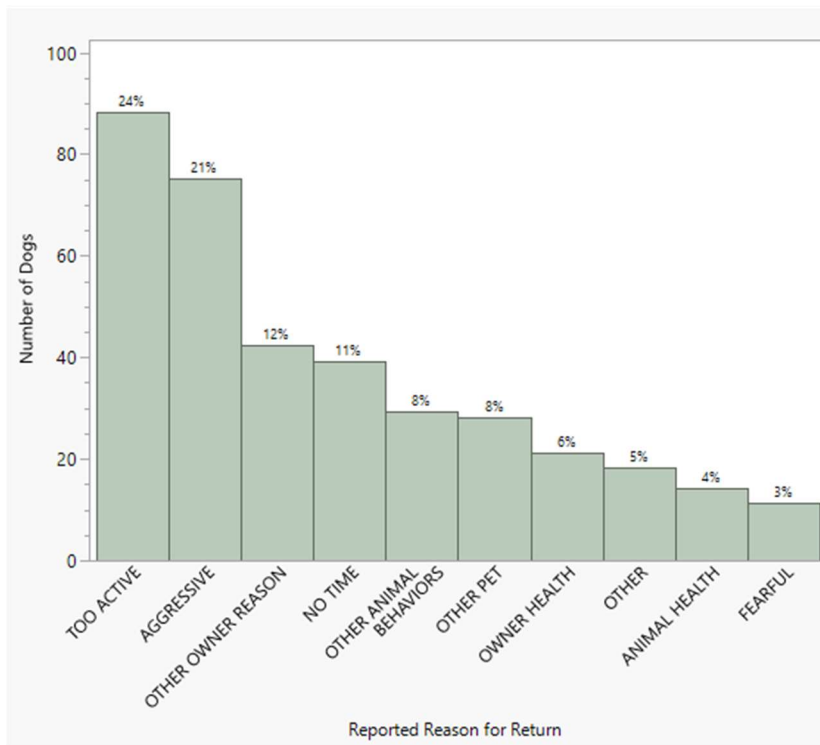
Length of stay had a mean \pm standard deviation of 24.8 ± 43.5 , and a median of 13 days, with a range of 0 to 668 days. Regarding outcomes, 87% dogs were adopted ($n=3,034$), 8% ($n=279$) of the population were euthanized for behavioral or medical reasons, 4% ($n=152$) were transferred to another shelter, rescue, or medical facility, and the remaining 1% died in care or went into a foster home.

Returns

Of the 3,895 records analyzed, 372 represented returns to the shelter ≤ 182 days post-adoption. Of those returns, 327 records were first returns, 40 were second returns, and five were

third returns. Year-over-year, returns held a steady approximate rate of 10%, with a shift in trend in 2020 (Figure 2.) Of the reasons for return reported by owners at surrender, more than half (56%) of the dogs were returned to the shelter for behavioral reasons (see Figure 4 for breakdown), followed by owner logistical reasons which include lack of time, landlord restrictions, insurance restrictions, cost, divorce, moving, or a new baby in the home (23%). Of the 327 first returns, 86% of the dogs were readopted, and 11% ($n=41$) were euthanized. Forty-eight dogs were relinquished after the time set as a return period, and therefore were not considered returns in the parameters set for this study.

Figure 4. Reason for return post-adoption

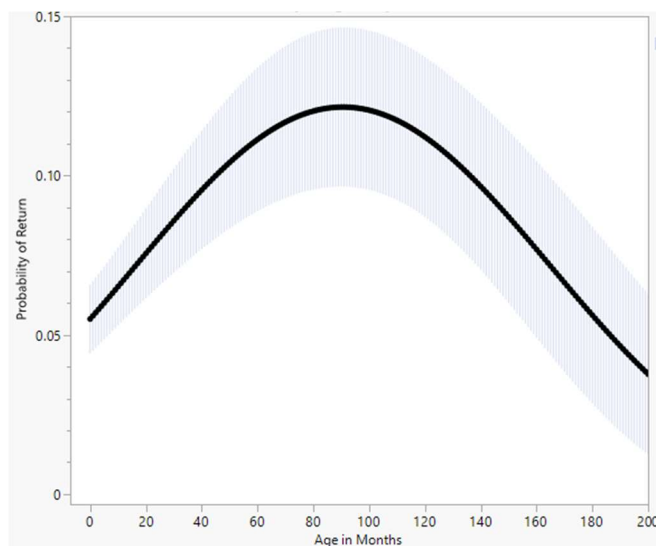


3.2 Predictors of Returns

We looked at origin, outcome, and shelter geographies (categorized by urban, rural, and suburban) in relation to returns, and only a dog's outcome geography was an important predictor of whether it would be returned post-adoption. Urban outcome regions had the highest probability of return (14.2%, $SE = 1.1\%$, $p < 0.05$). Suburban regions had the lowest (10.3%, $SE = 1.2\%$). Rural regions were intermediate (11%, $SE = 1.1\%$). In other words, a dog being adopted into an urban environment had a four percent higher probability of being returned to the shelter post-adoption than dogs being adopted into a suburban environment.

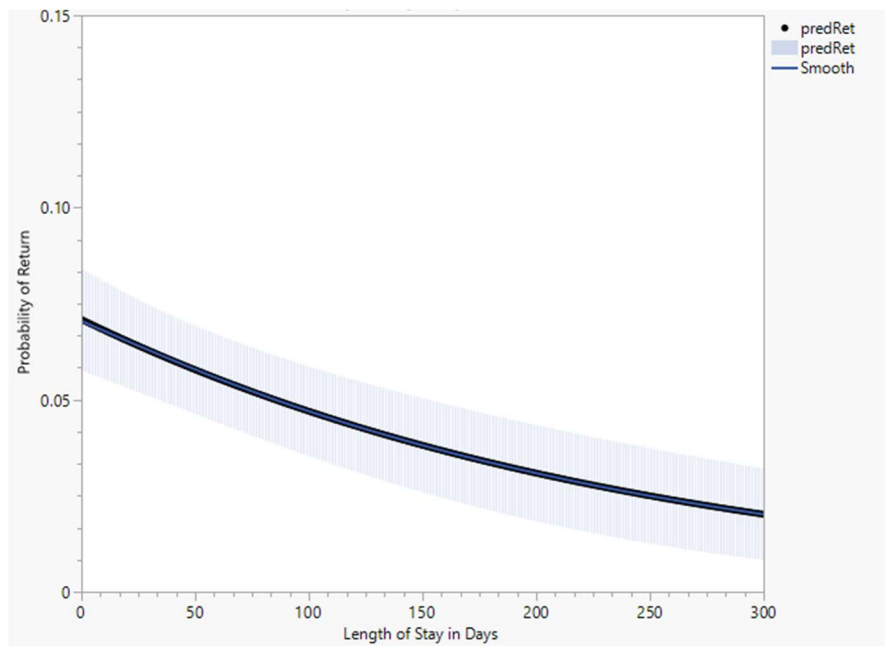
We calculated odds ratios (OR) for the continuous variables (i.e., age, length of stay) in addition to probabilities. The probability of return was dependent on age in a quadratic manner (OR for Age-squared = 0.99989, 95% CI = [0.99982, 0.99997]; OR for Age = 1.018, 95% CI = [1.008, 1.029]). Figure 5 shows that the probability of return peaks at approximately 8 years of age (100 months). In other words, the oldest and youngest dogs had the lowest probabilities and dogs of intermediate ages had higher probabilities.

Figure 5. Mean distribution of returns in relation to age



The probability of return was weakly dependent on dogs' length of stay in the shelter prior to adoption (OR = 0.996, 95% CI = [0.992, 1.000]), such that dogs who had longer lengths of stay had lower probabilities of return, on average (Figure 6). Nevertheless, due to the presence of outliers within this variable, we tested the effect of removing dogs with lengths of stay longer than 80 days and found no difference in the results.

Figure 6. Mean distribution of returns by length of stay



Regarding breed group – toy breeds had the lowest probability of being returned (7%, $SE = 0.97\%$, $p < 0.05$), and were the breed most often adopted into the same geography as they originated from (Table 3). Conversely, working dogs were twice as likely as toy breeds to be returned (probability = 15.7%, $SE = 2.3\%$), followed by foundation stock service (probability = 14.1%, $SE = 3.3\%$), sporting dogs (probability = 13.9%, $SE = 1.6\%$), and terriers (probability = 13.5%, $SE = 1.6\%$). All other breed groups were intermediate to these (Figure 7).

Figure 7. Mean probability of returns by breed grouping

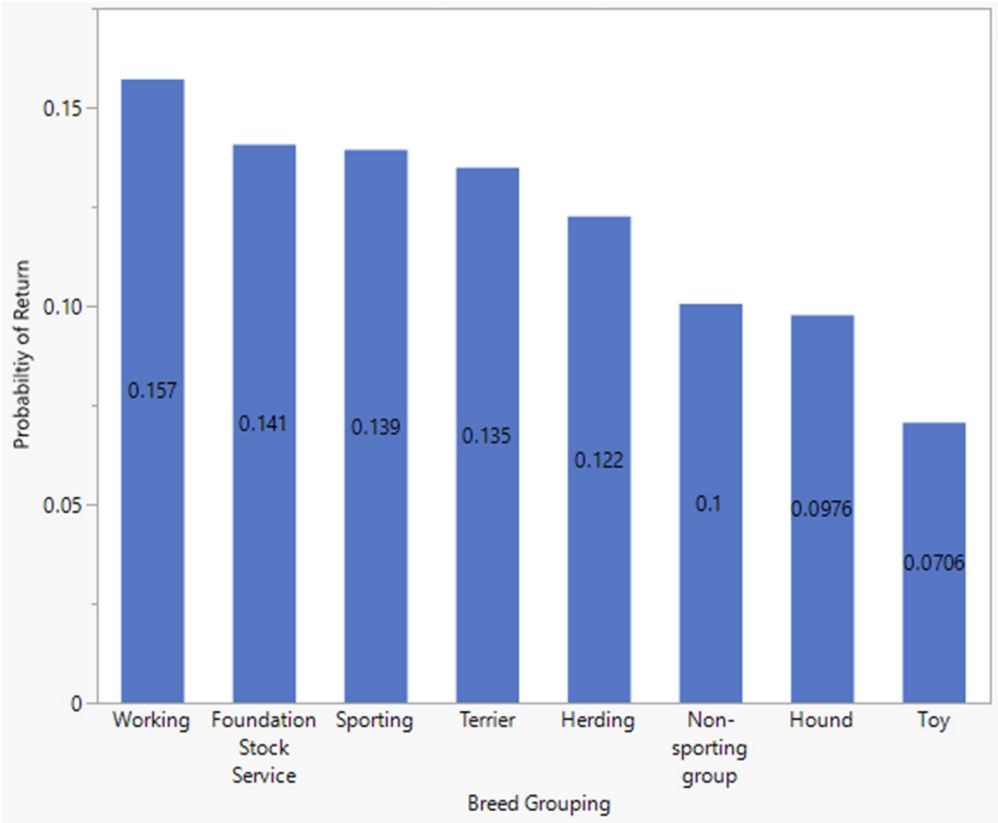


Table 3. Breakdown of geographical matches from origin to outcome by breed grouping

Breed Grouping	Dogs in breed group (n)	Dogs two-way matched within group (n)	% of total breed group	Dogs three- way matched within group (n)	% of total breed group
Foundation Stock Service	164	58	35%	33	20%
Herding	388	164	42%	115	30%
Hound	473	163	34%	107	23%
Non-Sporting Group	218	87	40%	53	24%
Sporting	752	261	35%	186	25%
Terrier	656	288	44%	219	33%
Toy	823	397	48%	285	35%
Working	356	135	38%	84	24%
	3,830	1,553	41%	1,082	28%

Note. This table represents all records with “adopted” outcomes that correspond with a zip code.

This includes dogs that were returned, readopted, and subsequently have more than one corresponding zip code. It does not include dogs that had an outcome without a corresponding zip code (e.g., dogs who were euthanized). A two-way match indicates that the geography of a dog’s origin matches the geography of their outcome (e.g., urban to urban). A three-way match

indicates that the geographies of origin, shelter, and outcome all match (e.g., urban, urban, and urban).

In terms of behavioral assessments, dogs' records were reviewed, and a formula provided a true or false value if the assessment results included the word "aggression". We found that the probability of return was higher for dogs that had documented aggression versus dogs with no documented aggression (mean^{aggressive} = 15.1%, *SE* = 1.3%; mean^{non-aggressive} = 9.1%, *SE* = 0.67%, $p < 0.05$).

3.3 When returns are most likely to occur

For dogs that were returned ≤ 182 days post-adoption, we found that the time in the adoptive home before being returned had a mean \pm standard deviation of 27.62 ± 42.46 days. As for when returns are likely to occur, the quantiles of the exponential distribution fitted to the data suggest the probability of returns occurring within the first ten days post-adoption at approximately 30%, increasing to 51% by the 20-day mark, and to 66% at the 30-day mark (see Table 4 for distribution).

Table 4. Time to return probability post adoption

Days to Return	Probability of Return
1	.035
5	.165
10	.304
15	.419
20	.515
25	.595
30	.662
40	.765
50	.836
60	.886
70	.920
80	.945
90	.962
100	.973

4. Discussion

4.1 General Overview

This study analyzed five years' worth of dog intake records from three related animal shelters in Massachusetts to gain a better understanding of the population demographics and to investigate what factors influenced a dog being returned to the shelter post-adoption. Our study had three lines of inquiry. We investigated: 1) the relationship between dogs' origin geographies (i.e., out-of-state transports) and their probability of return, 2) what variables or combination of variables predicted the return of adopted dogs, and 3) following adoption, how many days post-adoption were dogs more likely to be returned to the shelter.

In order to answer these questions, we analyzed dogs' intake type, approximate age, length of stay, breed grouping, documented aggression, return reason, outcome, and geographical location (i.e., rural, urban, suburban) of their origin, shelter, and adoptive outcome. Our data set included 3,895 intake records from 3,475 individual dogs. We found that dogs were, on average, one year old at intake with over one-fifth of dogs categorized as a toy breed (22%), representing the largest breed group. For the period analyzed, approximately 10% of dogs were returned to the shelter, which coincides with previous research that found average shelter dog return rates to be between 7% and 15% (Diesel et al., 2008; Powell et al., 2021).

4.2 Intake Type and Geography Relationship to Returns

Due to the increase in relocation programs over the last several years and the expectation for that trend to continue (ASPCA, n.d.), we had a particular interest in transported dogs. As such, we anticipated that the proportion of transported dogs would steadily increase over time

relative to other intake types at the shelter, but year-over-year data showed that intake trends stayed consistent, with owner-surrender and transport intake percentages fluctuating in opposite directions. One possible explanation for this fluctuation is that the shelter relied on transports less often when owner-surrender intakes were increased to maintain a manageable population within the shelter.

Of the total records analyzed, 37% of dogs arrived at the shelter via out-of-state transports. Initially, we presumed that transported dogs might have a higher probability of returns, however our analysis did not find any significant correlation between any intake type (e.g., transport, owner surrender) and return rates. Other studies looking at variables that predict returns have either not included intake type in their analysis or have not reported a relationship between intake type and returns, but this might be a variable of interest due to the increase in animal relocation programs and their potential influence on shelter demographics (Diesel et al., 2008; Hawes et al., 2020; Powell et al., 2021; Powell et al., 2022).

Although there was a geographical shift from origin to adoption for approximately 20% of the transported dogs in our study, the impact of this shift on post-adoption returns was not as prevalent as we originally anticipated. Of the total dogs transported from out-of-state, 86% of the dogs originated from suburban and rural geographies, and 62% of those dogs were adopted into rural or suburban locations. Additionally, transported dogs only originated from urban locations 14% of the time, yet were adopted into urban homes 37% of the time.

Regardless of intake type, we wanted to investigate how often dogs entered the shelters from one geography (e.g. rural) and were adopted into homes in another geography (e.g. urban), and if that shift in geography had any influence on whether the dog was returned. Our analysis suggested a significant relationship between outcome geography and returns. Specifically, we

found that dogs adopted into urban locations were statistically more likely (14.2% probability of return) to be returned than dogs adopted into suburban areas (10.3% probability of return). It is possible that pet owners living in urban areas might encounter stimuli such as other dogs, people, and vehicles more frequently which might contribute to increased occurrences of leash reactivity or aggression. Similarly, barking and vocalizations related to separation distress might be less tolerable for neighbors or landlords in multi-unit apartment buildings. Research has shown that dog behaviors such as aggression, separation anxiety, and house soiling, are among the top reasons for returning a pet (Diesel et al., 2008, Friend & Bench, 2020; Hawes et al., 2020; Powell et al., 2021;).

While returns from urban locations were more probable in this study, additional research would be required to determine the practical implications of the significance. For example, it would be useful to understand the shelter cost implications that coincide with a 1.38 times higher risk of return (relative risk ratio), and if strategies such as allocating extra resources to support urban adopters or making modifications to the adoption matching criteria for urban adopters would be effective in reducing the likelihood of returns. One study in which researchers surveyed owners relinquishing large dogs in urban areas, found that more than half of the respondents reported that having some assistance (e.g., low-cost training support, day care, veterinary care, etc.) might have helped them avoid relinquishing their dog (Weiss et al., 2014). Organizations that offer free pet behavior helplines or have partnerships with low-cost veterinary or behavioral service providers might consider a more tailored approach to the marketing of such services towards the urban adopter so as to not be overlooked or underutilized.

4.3 Dog Related Factors that Influence Returns

Our analysis identified several variables as predictors of a dog's return to the shelter, including their age, length of stay in the shelter, breed grouping, and whether aggression was indicated in the dog's record. The relationship to age and probability of returns suggests that middle-aged dogs (approximately 100 months, or eight years of age) are more likely to be returned than puppies or older dogs. This differs from other studies that suggest dogs under two years of age were the most likely to be relinquished (Mondelli et al., 2004; Shore, 2005). However, our findings are more in line with the Powell et al. (2021) study that found a higher probability of returns for dogs between the ages of two and eight years. It is possible that owner expectations of behavior might influence adult dogs being returned. For example, adopters of puppies might be more tolerant of destructiveness or house soiling knowing the puppy might outgrow those behaviors, leading to lower instances of relinquishment in younger dogs. On the other hand, some research has suggested that the older a dog is at the time of adoption, their risk for exhibiting undesirable behaviors (e.g. resource guarding) increases, which might be an explanation for a higher probability of returns for adult dogs in our study (McGreevy & Masters, 2008; Powell et al., 2021).

In our study, the shelter length of stay was also associated with return. Specifically, dogs that spent more time in the shelter, prior to adoption, had lower probabilities of return by their adopters. However, this relationship was weak, meaning that for each one day increase in length of stay, there was only a 1.0001-fold decrease in the odds of return. One possible explanation for longer lengths of stay having lower probabilities of return could be due to special adoption requirements. Shelter policies for dogs who have medical or behavioral considerations often require adopters to participate in mandatory counseling and/or training sessions prior to the

adoption process, in some cases taking place over multiple days. It is possible that mandatory counseling might deter some adopters, making the pool of potential adopters smaller, thus taking more time to find an ideal match for the dog. However, for those who adopt these dogs, counseling might help to set realistic expectations and provide resources for management in the home, potentially reducing the likelihood of relinquishment. Previous studies from Herron et al. (2007) suggest pre-adoption counseling can be beneficial to adopters with common behavior concerns such as housetraining, although not effective in preventing more serious behaviors such as separation anxiety (2014). It might be worth examining special adoptions in a secondary study to investigate specific behavior concerns in relation to returns. We are not aware of other research reporting shelter length of stay as a predictor of returns outside of this study, and future research might consider including this as a variable of interest.

Breed grouping was also a predictor of return, such that toy breed dogs had the lowest probability of being returned (7%) which is consistent with other findings on breed groups and relinquishments (Powell et al., 2021). Interestingly, toy breeds comprised the largest percentage of owner-surrenders to the shelter (32%), which might explain their over-representation in our sample (22% of total breed groups). On the other hand, working dogs had the highest distribution of returns (16%). In our study, the top owner-reported reason for returning a dog post-adoption was because the dog was too active. Working dog breeds are historically categorized as being selected for active or energetic tendencies compared to non-working breeds (Ekin et al., 2015; Serpell & Duffy, 2014). As such, it might be possible that adopters of working dogs are not equipped to manage higher activity levels of dogs which might be further influenced by the geography an owner resides in.

We were also interested to know how often each breed group remained in the same geography from their origin to their adoption outcome (e.g. urban to urban), a scenario we denoted as a “match”. We found that toy breeds, which had the lowest rate of return, also had the highest percentage of matches. More specifically, 65% of geography matches for toy breeds dogs were dogs coming from urban geographies and then adopted into urban homes, which suggests that pet owners in urban geographies might gravitate towards having smaller pet dogs, potentially due to the spatial or landlord limitations that accompany urban living. Hound dogs were the breed group most often transported (33% of transports) and had the lowest percentage of geography matches from origin to outcome (34%), but interestingly were among the lowest return rates of breed groups (9.7%).

Although the statistical model did not find any statistically significant relationships between breed grouping and geographies in this data set, the lack of significant relationship could be due to inaccurate breed identification and labeling. Dog breeds in this study were estimated by shelter staff based on visual identification of physical characteristics and not confirmed by DNA. Research has shown that there is often disparity between visual dog breed identification and their genetic heritage as confirmed by DNA (Gunter et al., 2018; Olsen et al., 2015; Voith et al., 2013). Gunter and colleagues (2018) found that shelter staff were successful in visually identifying one breed in the genetic heritage of 384 dogs approximately two-thirds (67%) of the time, but that number went down to 10% accuracy when asked to identify a second breed in the dog heritage. The number of pure breed dogs available for adoption in animal shelters is thought to be low, approximately 5% (National Animal Interest Alliance, 2015; Gunter et al., 2018), so we might consider the possibility that some of the dogs in our study have not been completely or accurately identified according to their primary breed.

Our analysis also suggested a relationship between documented aggression and returns. Specifically, dogs with intake records that included the word “aggression” in their behavioral assessment had a significantly higher probability of being returned than dogs without reported aggression (+6%). Similarly, Bollen & Horowitz (2008) found that dogs who displayed mild aggression in shelter behavior assessments (e.g., stiffening, slight growling) were twice as likely to be returned than dogs who displayed no aggressive behaviors in their assessments. However, the absence of documented aggression in the intake records analyzed in our study did not necessarily indicate the absence in a dog’s behavioral repertoire; it simply means it was not reported. Additionally, when we looked at the reported reasons for return by owners at surrender, descriptive statistics showed that 21% of dogs were returned for aggression related behaviors (including aggression to children, adults, and/or to other animals).

Overall, dog behavior was the top reason for return (56%), compared to 29% of returns attributed to owner-reported reasons. These figures align with current research in which dog behavior, specifically aggression, is among the primary reasons for return (Hawes et al., 2020; Powell et al., 2021). One recent study investigated whether offering free behavior advice to adopters who were considering relinquishment would influence their decision to either retain or relinquish their dog. The researchers found that adopters were six times more likely to accept advice when their dog’s undesirable behaviors were not related to aggression (Powdrill-Wells et al., 2021). It is possible that aggressive behaviors might be perceived by adopters as more complex and time-consuming to modify, leading to relinquishment more often. Additionally, training methods that rely on punishment or aversive techniques might contribute to worsening aggressive behaviors that lead to relinquishment. (Arhant et al., 2010; Blackwell et al., 2008; Powdrill-Wells et al., 2021).

Interestingly, the top reason for reported returns in our data (24%) was for dogs being “too active”. However, the “too active” data included the sub-categories of “too big” and “too strong”, so the percentage of returns for dogs that only qualified as “too active” was potentially smaller. Being too active or too excitable are common characteristics reported as behaviors related to returns in other studies (Friend & Bench., 2020; Powell et al., 2021; Powell et al., 2022). It is possible that active dogs are returned more often in urban areas due to the spatial limitations related to apartment-living and lack of off-leash spaces, that might make meeting the exercise needs of some dog breeds more challenging compared to other geographic areas. Some research suggests that low-cost services such as day care, boarding, or dog walking might provide additional support to adopters of active dogs in urban areas, potentially alleviating their need to relinquish (Weiss et al., 2014).

4.4 When are Returns More Likely to Occur?

We also investigated when dogs were more likely to be returned to the shelter after adoption. Our findings suggest that returned dogs have a 66% likelihood of being relinquished by their adopters within the first 30 days following placement. It should be noted that the shelters in this study have a 30-day return policy in which the adoption fee is refunded if the dog is returned within this window. Dog adoption fees for the shelter represented in this study range from \$300 for senior dogs (aged > 9 years), \$480 for adult dogs (aged 1-9 years), to \$580 for dogs under 1 year of age (Animal Rescue League of Boston, n.d.). Other studies have reported return rates to be the highest within the first 14 days following adoption (Shore, 2005; Thumpkin et al., 2022), thus, it is possible the present data are impacted by monetary considerations by the adopter.

The shelter represented in this study offers post-adoption support in the way of phone check-ins for all specialty adoptions (dogs that require pre-adoption counseling for behavioral or medical reasons) around the three-day, three-week, and three-month mark. Additionally, the shelter operates a free behavior helpline service for adopters as well as within the community, regardless of where the pet was obtained. Hawes et al. (2020) suggest that post adoption programs might improve retention rates, but it is also possible that such support may be simply prolonging the time to return. Interestingly, much of the published literature on relinquishments focuses on the reasons for relinquishment rather than the influence of interventions (Coe, 2014; Protopopova & Gunter, 2017), suggesting the need for future studies to investigate novel interventions and their impact on adoption success.

4.5 Limitations

Regarding the limitations inherent in our current study, the response variable (return) is censored in that, for dogs that were not returned, we only know that they were not returned to the same shelter system during the time in which this data set represents. Additionally, the origin zip codes in our data only inform us about where the dog came from directly before intake into the shelter and are not necessarily representative of where they were born or where critical life experiences (socialization) took place.

Our data set only includes intake records through June 2022, therefore any dogs that were returned after this time were included in our data set. It is also worth noting that our data set includes the timeframe of the Covid 19 pandemic, which had a notable impact on trends pertaining to adoption and relinquishment (Ho et al., 2021; Hoffman et al., 2021; Morgan et al.,

2020). In March 2020, in accordance with the restrictions corresponding to the declared state of emergency (Mass.gov), ARL closed the animal adoption centers to the public, and adoptions were permitted by appointment only. In our study, there was a significant decrease in the number of intake records from 2019 (n=800) to 2020 (n=500), and a 3% decrease in return rate from 2020 to 2021. The decrease in intake numbers aligns with the operational slowdown seen in shelters across the country due to pandemic related restrictions and changed the way in which people acquired their pets during the pandemic, with an increase in utilizing breeders and pet stores and a decrease obtaining pets from animal rescues and shelters (Hoffman et al., 2021).

4.6 Future Directions and Considerations

Identifying and understanding the factors that contribute to successful adoption requires a multifaceted approach. It is also important to consider that returns are not the only way to assess whether an adoption match is successful. The analysis in this study focused on specific geographic and dog-related variables of interest in relation to returns, but other variables are likely influential. For example, future studies could investigate data obtained from post-adoption counseling, dog training programs, or organization's behavior helplines to understand what commonly reported behaviors adopters seek help for and what strategies are effective in preventing return. One recent example of this is a study from Bohland et al. (2023) in which researchers used the Canine Behavioral Assessment & Research Questionnaire (C-BARQ) to track behavior changes of 90 dogs in the home for six months following adoption. Studies such as these continue to shed light on whether shelter behavior evaluations have predictive value in the home following adoption, informing shelter practices and adoption matchmaking.

For this study, we investigated geography in terms of urban, rural, and suburban origins and outcomes. However, further examining exact zip codes could offer insights into additional geographical disparities, including the variations in regional pet ownership and the influence of socioeconomic status. Ly and colleagues (2021) utilized zip codes in their research to track the movement of surrendered animals from origin to outcome and found that a disproportionate number of animals were being surrendered from vulnerable communities, particularly in urban environments. Rather than using broad geographic categorizations, future research could benefit from utilizing the exact zip codes to better understand the relationship between socioeconomic status and companion animal returns.

5. Conclusion

There are many factors that contribute to an animal being relinquished to shelter post-adoption. While having many variables can be challenging to investigate, the studies that start to explore this multifactorial system are incredibly important in the quest to tease apart the variables and their interactions. Our results support the findings of prior research that dog breed groupings, reports of aggressive behavior, and age are predictive variables when it comes to returns. On the other hand, while we expected to detect associations between dogs' originating and outcome geographies, we only found that a dogs' outcome geography predicted their return to the shelter. Considering the paucity of studies investigating geographical influence on relinquishment and adoption success of shelter dogs, we would encourage future research to include geography as a variable of interest in experimental or longitudinal studies. We also identified the number of days following adoption in which returns were more likely to occur. While this could be related to the organization's policies on adoption fees, it might be beneficial for shelters to examine their post-adoption follow-up programs and provide support prior to these points of surrender, in hopes of improving owner retention rates and reducing returns.

6. References

- American Kennel Club. (n.d.). Dog breeds sorted by groups. Retrieved on March 28, 2024, from <https://www.akc.org/public-education/resources/general-tips-information/dog-breeds-sorted-groups/>
- Animal Rescue League of Boston. (n.d.). Adopt a pet. Retrieved on April 19, 2024, from <https://www.arlboston.org/adopt/adopt-a-pet/>
- Arhant, C., Bubna-Littitz, H., Bartels, A., Futschik, A., & Troxler, J. (2010). Behaviour of smaller and larger dogs: Effects of training methods, inconsistency of owner behaviour and level of engagement in activities with the dog. *Applied Animal Behaviour Science*, 123(3–4), 131–142. <https://doi.org/10.1016/j.applanim.2010.01.003>
- The Association for Animal Welfare Advancement. (n.d.). Home. Retrieved on March 28, 2024, from <https://theaawa.org/>
- ASPCA. (n.d.). *Pet statistics*. Retrieved March 2, 2022, from <https://www.asPCA.org/helping-people-pets/shelter-intake-and-surrender/pet-statistics>
- ASPCA. (n.d.). *Animal relocation*. Retrieved March 2, 2022, from <https://www.asPCA.org/helping-people-pets/animal-relocation>
- ASPCA. (n.d.). *Position Statement on Shelter Dog Behavior Assessments*. Retrieved January 24, 2024, from <https://www.asPCA.org/about-us/asPCA-policy-and-position-statements/position-statement-shelter-dog-behavior-assessments>

ASPCA Pro (2010). *SAFER Manual and training guide – ASPCA PRO*.

<https://www.aspcapro.org/sites/default/files/safer-guide-and-forms.pdf>

AVMA. (n.d.). *Non-emergency relocation of dogs and cats for adoption within the United States Best practices*. Retrieved February 1, 2024 from

<https://www.avma.org/sites/default/files/2020-03/AWF-transportAdoptionBestPractices.pdf>

Bergeron, R., Scott, S. L., Emond, J. P., Mercier, F., Cook, N. J., & Schaefer, A. L. (2002).

Physiology and behavior of dogs during air transport. *Canadian Journal of Veterinary Research = Revue Canadienne de Recherche Veterinaire*, 66(3), 211–216.

Blackwell, E. J., Twells, C., Seawright, A., & Casey, R. A. (2008). The relationship between training methods and the occurrence of behavior problems, as reported by owners, in a population of domestic dogs. *Journal of Veterinary Behavior*, 3(5), 207–217.

<https://doi.org/10.1016/j.jveb.2007.10.008>

Bohland KR, Lilly ML, Herron ME, Arruda AG, O’Quin JM (2023) Shelter dog behavior after adoption: Using the C-BARQ to track dog behavior changes through the first six months after adoption. *PLoS ONE* 18(8): <https://doi.org/10.1371/journal.pone.0289356>

Bollen, K. S., & Horowitz, J. (2008). Behavioral Evaluation and demographic information in the assessment of aggressiveness in Shelter Dogs. *Applied Animal Behaviour Science*, 112(1–2), 120–135. <https://doi.org/10.1016/j.applanim.2007.07.007>

Cannas, S., Rampini, F., Levi, D., Costa, E. D., Talamonti, Z., Minero, M., & Palestrini, C. (2014). Shelter Dogs and their destiny a retrospective analysis to identify predictive factors: A pilot study. *Macedonian Veterinary Review*, 37(2), 151–156. <https://doi.org/10.14432/j.macvetrev.2014.07.018>

Center for Shelter Dogs. (n.d.). *Match-up II manual - Center for Shelter Dogs*. Retrieved February 5, 2024, from <https://www.yumpu.com/en/document/view/38799339/match-up-ii-manual-center-for-shelter-dogs>

Clay, L., Paterson, M., Bennett, P., Perry, G., Rohlf, V., & Phillips, C. J. C. (2020). In defense of canine behavioral assessments in shelters: Outlining their positive applications. *Journal of Veterinary Behavior*, 38, 74–81. <https://doi.org/10.1016/j.jveb.2020.03.005>

Coe, J. B., Young, I., Lambert, K., Dysart, L., Nogueira Borden, L., & Rajić, A. (2014). A scoping review of published research on the relinquishment of Companion Animals. *Journal of Applied Animal Welfare Science*, 17(3), 253–273. <https://doi.org/10.1080/10888705.2014.899910>

The Demographic Statistical Atlas of the United States - Statistical Atlas. (n.d.). Retrieved April 7, 2022, from <https://statisticalatlas.com/United-States/Population#figure/region>

Diesel, G., Pfeiffer, D. U., & Brodbelt, D. (2008). Factors affecting the success of rehoming dogs in the UK during 2005. *Preventive Veterinary Medicine*, 84(3–4), 228–241.

<https://doi.org/10.1016/j.prevetmed.2007.12.004>

DiGangi, B. A., Craver, C., & Dolan, E. D. (2021). Incidence and predictors of canine parvovirus diagnoses in puppies relocated for adoption. *Animals*, 11(4), 1064.

<https://doi.org/10.3390/ani11041064>

Dunn, K. P., and Smyth, G. K. (1996). Randomized quantile residuals. *Journal of Computational and Graphical Statistics* 5, 1-10.

Eken Asp, Helena; Fikse, Willem Freddy; Nilsson, Katja; Strandberg, Erling (2015). *Breed differences in everyday behaviour of dogs. Applied Animal Behaviour Science*, 169(), 69–

77. <https://doi:10.1016/j.applanim.2015.04.010>

Foraita, M., Howell, T. & Bennett, P. Environmental influences on development of executive functions in dogs. *Anim Cogn* 24, 655–675 (2021). [https://doi.org/10.1007/s10071-021-](https://doi.org/10.1007/s10071-021-01489-1)

[01489-1](https://doi.org/10.1007/s10071-021-01489-1)

Friend, J., & Bench, C. (2020). Evaluating factors influencing dog post-adoptive return in a canadian animal shelter. *Animal Welfare*, 29(4), 399–410.

<https://doi.org/10.7120/09627286.29.4.399>

Garrison, L., & Weiss, E. (2014). What do people want? factors people consider when acquiring dogs, the complexity of the choices they make, and implications for nonhuman animal relocation programs. *Journal of Applied Animal Welfare Science*, 18(1), 57–73.

<https://doi.org/10.1080/10888705.2014.943836>

Great Data. (n.d.). Retrieved March 17, 2023, from <https://greatdata.com/product/urban-vs-rural>

Gunter, L. M., Barber, R. T., & Wynne, C. D. L. (2018). A canine identity crisis: Genetic breed heritage testing of shelter dogs. *PLOS ONE*, 13(8), e0202633.

<https://doi.org/10.1371/journal.pone.0202633>

Hartig F (2022). `_DHARMa: Residual Diagnostics for Hierarchical (Multi-Level / Mixed) Regression Models_`. R package version 0.4.6, <<https://CRAN.R-project.org/package=DHARMa>>.

Hawes, S. M., Kerrigan, J. M., Hupe, T., & Morris, K. N. (2020). Factors informing the return of adopted dogs and cats to an animal shelter. *Animals*, 10(9), 1573.

<https://doi.org/10.3390/ani10091573>

Herron, M. E., Lord, L. K., Hill, L. N., & Reisner, I. R. (2007). Effects of preadoption counseling for owners on house-training success among dogs acquired from shelters. *Journal of the American Veterinary Medical Association*, 231(4):558-62.

<https://doi.org/10.2460/javma.231.4.558>

Herron, M. E., Lord, L. K., & Husseini, S. E. (2014). Effects of preadoption counseling on the prevention of separation anxiety in newly adopted shelter dogs. *Journal of Veterinary Behavior*, 9(1), 13-21. <https://doi.org/10.1016/j.jveb.2013.09.003>

Hoffman, C. L., Thibault, M., & Hong, J. (2021). Characterizing pet acquisition and retention during the COVID-19 pandemic. *Frontiers in Veterinary Science*, 8. <https://doi.org/10.3389/fvets.2021.781403>

Ho, J., Hussain, S., & Sparagano, O. (2021). Did the COVID-19 pandemic spark a public interest in pet adoption? *Frontiers in Veterinary Science*, 8. <https://doi.org/10.3389/fvets.2021.647308>

Ly, L. H., Gordon, E., & Protopopova, A. (2021, October 19). Inequitable flow of animals in and out of shelters: Comparison of community-level vulnerability for owner-surrendered and subsequently adopted animals. *Frontiers*. <https://www.frontiersin.org/articles/10.3389/fvets.2021.784389/full>

Marder, A. R., Shabelansky, A., Patronek, G. J., Dowling-Guyer, S., & D'Arpino, S. S. (2013). Food-related aggression in Shelter Dogs: A comparison of behavior identified by a behavior evaluation in the shelter and owner reports after adoption. *Applied Animal Behaviour Science*, 148(1–2), 150–156. <https://doi.org/10.1016/j.applanim.2013.07.007>

Martinez, E., Cesário, C. S., Ferraz, F., Repolês, R., Silva, I. O., & Boere, V. (2022). Behavior of rural and urban free-ranging dogs in Viçosa, Minas Gerais, Brazil. *Journal of Veterinary Behavior*, 48, 68–73. <https://doi.org/10.1016/j.jveb.2021.09.004>

Mass.gov. (n.d.). *Covid-19 state of emergency*. <https://www.mass.gov/info-details/covid-19-state-of-emergency>

McGreevy, P. D., & Masters, A. M. (2008). Risk factors for separation-related distress and feed-related aggression in dogs: Additional findings from a survey of Australian dog owners. *Applied Animal Behaviour Science*, 109(2–4), 320–328. <https://doi.org/10.1016/j.applanim.2007.04.001>

McGuire, B., Orantes, D., Xue, S., & Parry, S. (2020). Abilities of canine shelter behavioral evaluations and owner surrender profiles to predict resource guarding in adoptive homes. *Animals*, 10(9), 1702. <https://doi.org/10.3390/ani10091702>

Mondelli, F., Prato Previde, E., Verga, M., Levi, D., Magistrelli, S., & Valsecchi, P. (2004). The bond that never developed: Adoption and relinquishment of dogs in a rescue shelter. *Journal of Applied Animal Welfare Science*, 7(4), 253–266. https://doi.org/10.1207/s15327604jaws0704_3

- Morgan, L., Protopopova, A., Birkler, R. I., Itin-Shwartz, B., Sutton, G. A., Gamliel, A., Yakobson, B., & Raz, T. (2020). Human–dog relationships during the COVID-19 pandemic: Booming dog adoption during social isolation. *Humanities and Social Sciences Communications*, 7(1). <https://doi.org/10.1057/s41599-020-00649-x>
- National Animal Interest Alliance. (n.d.). Shelter Project: Purebred Dogs in Shelters. Retrieved on March 25, 2024, from <https://shelterproject.naiaonline.org/purebred/>
- Newbury, S., Blinn, M. K., Bushby, P. A., Cox, C. B., Dinnage, J. D., Griffen, B., Hurley, K. F., Isaza, N., Jones, W., Miller, L., O'Quin, J., Patronek, G. J., Smith-Blackmore, M., & Spindel, M. (2010). Guidelines for standards of care in animal shelters. In *Association of Shelter Veterinarians*. Pages 45–47.
- Olson, K. R., Levy, J. K., Norby, B., Crandall, M. M., Broadhurst, J. E., Jacks, S., Barton, R. C., & Zimmerman, M. S. (2015). Inconsistent identification of pit bull-type dogs by shelter staff. *The Veterinary Journal*, 206(2), 197-202. <https://doi.org/10.1016/j.tvjl.2015.07.019>
- Patronek, G. J., & Bradley, J. (2016). No better than flipping a coin: Reconsidering canine behavior evaluations in animal shelters. *Journal of Veterinary Behavior*, 15, 66–77. <https://doi.org/10.1016/j.jveb.2016.08.001>
- Patronek, G., & Crowe, A. (2018). Factors associated with high live release for dogs at a large, open-admission, Municipal Shelter. *Animals*, 8(4), 45. <https://doi.org/10.3390/ani8040045>

- Patronek, G. J., Bradley, J., & Arps, E. (2019). What is the evidence for reliability and validity of behavior evaluations for Shelter Dogs? A prequel to “No better than flipping a coin.” *Journal of Veterinary Behavior*, 31, 43–58. <https://doi.org/10.1016/j.jveb.2019.03.001>
- Powdrill-Wells, N., Taylor, S., & Melfi, V. (2021). Reducing Dog Relinquishment to Rescue Centres Due to Behaviour Problems: Identifying Cases to Target with an Advice Intervention at the Point of Relinquishment Request. *Animals*, 11(10), 2766. <https://doi.org/10.3390/ani11102766>
- Powell, L., Lee, B., Reinhard, C. L., Morris, M., Satriale, D., Serpell, J., & Watson, B. (2022). Returning a shelter dog: The role of owner expectations and dog behavior. *Animals*, 12(9), 1053. <https://doi.org/10.3390/ani12091053>
- Powell, L., Reinhard, C., Satriale, D., Morris, M., Serpell, J., & Watson, B. (2021). Characterizing unsuccessful animal adoptions: Age and breed predict the likelihood of return, reasons for return and post-return outcomes. *Scientific Reports*, 11(1). <https://doi.org/10.1038/s41598-021-87649-2>
- Protopopova, A., & Gunter, L. (2017). Adoption and relinquishment interventions at the animal shelter: A review. *Animal Welfare*, 26, 35-48. <https://doi.org/10.7120/09627286.26.1.03535-48>. [10.7120/09627286.26.1.035](https://doi.org/10.7120/09627286.26.1.035).
- Romaniuk, A. C., Diana, A., Barnard, S., Weller, J. E., Espinosa, U. B., Dangoudoubiyam, S., Shreyer, T., Arnott, G., & Croney, C. (2022). The Effect of Transportation on Puppy Welfare from Commercial Breeding Kennels to a Distributor. *Animals : an open access journal from MDPI*, 12(23), 3379. <https://doi.org/10.3390/ani12233379>

Rowan, A., & Kartal, T. (2018). Dog Population & Dog Sheltering Trends in the United States of America. *Animals*, 8(5), 68. <https://doi.org/10.3390/ani8050068>

SAS Institute Inc. (2021). JMP Pro 16 [Computer software]. Retrieved from https://www.jmp.com/en_us/home.html

Serpell, J.A., Duffy, D.L. (2014). Dog Breeds and Their Behavior. In: Horowitz, A. (eds) Domestic Dog Cognition and Behavior. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-53994-7_2

Shelter Animals Count. (2021). *Q1-Q4 Analysis 2019-2021*. https://www.shelteranimalscount.org/wp-content/uploads/2022/03/SACAnalysis_Q1Q4_031122.pdf

Shore, E. R. (2005). Returning a recently adopted companion animal: Adopters' reasons for and reactions to the failed adoption experience. *Journal of Applied Animal Welfare Science*, 8(3), 187–198. https://doi.org/10.1207/s15327604jaws0803_3

Simmons, K., & Hoffman, C. (2016). Dogs on the move: Factors impacting animal shelter and rescue organizations' decisions to accept dogs from distant locations. *Animals*, 6(2), 11. <https://doi.org/10.3390/ani6020011>

Sternberg, S. *Assess-A-Pet: The Manual*; Assess-A-Pet: New York, NY, USA, 2006; p. 51.

Stoltzfus J. C. (2011). Logistic regression: a brief primer. *Academic emergency medicine : official journal of the Society for Academic Emergency Medicine*, 18(10), 1099–1104. <https://doi.org/10.1111/j.1553-2712.2011.01185.x>

Taylor, K.D.; Mills, D.S. The effect of the kennel environment on canine welfare: A critical review of experimental studies. *Anim. Welf.* **2007**, *16*, 435–447.

<https://doi:10.1017/S0962728600027378>

Tateo, A., Costa, L. N., & Padalino, B. (2022). The welfare of dogs and cats during transport in Europe: a literature review. *Italian Journal of Animal Science*, *21*(1), 539-550.

<https://doi.org/10.1080/1828051X.2022.2043194>

Thumpkin, E.; Paterson, M.B.A.; Morton, J.M.; Pachana, N.A. Adoption Can Be a Risky Business: Risk Factors Predictive of Dogs Adopted from RSPCA Queensland Being Returned. *Animals* *2022*, *12*, 2568. <https://doi.org/10.3390/ani12192568>

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. (n.d.). Animal movement. Retrieved March, 28, 2024, from

<https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/nvap/NVAP-Reference-Guide/Animal-Movement>

Villatoro, F. J., Sepúlveda, M. A., Stowhas, P., & Silva-Rodríguez, E. A. (2016). Urban Dogs in rural areas: Human-mediated movement defines dog populations in southern Chile.

Preventive Veterinary Medicine, *135*, 59–66.

<https://doi.org/10.1016/j.prevetmed.2016.11.004>

- Voith, V. L., Trevejo, R., Dowling-Guyer, S., Chadik, C., Marder, A., Johnson, V., & Irizarry, K. (2013). Comparison of visual and DNA breed identification of dogs and inter-observer reliability. *American Journal of Sociological Research*, 3(2), 17-29. <https://doi.org/10.5923/j.sociology.20130302.02>
- von Rentzell, K. A., van Haaften, K., Morris, A., & Protopopova, A. (2022). Investigation into owner-reported differences between dogs born in versus imported into Canada. *PLOS ONE*, 17(6). <https://doi.org/10.1371/journal.pone.0268885>
- Weiss, E., Slater, M., Garrison, L., Drain, N., Dolan, E., Scarlett, J. M., & Zawistowski, S. L. (2014). Large Dog Relinquishment to Two Municipal Facilities in New York City and Washington, D.C.: Identifying Targets for Intervention. *Animals: an open access journal from MDPI*, 4(3), 409–433. <https://doi.org/10.3390/ani4030409>
- Wright, I., Jongejan, F., Marcondes, M., Peregrine, A., Baneth, G., Bourdeau, P., Bowman, D. D., Breitschwerdt, E. B., Capelli, G., Cardoso, L., Dantas-Torres, F., Day, M. J., Dobler, G., Ferrer, L., Gradoni, L., Irwin, P., Kempf, V. A., Kohn, B., Krämer, F., ... Little, S. (2020). Parasites and vector-borne diseases disseminated by Rehomed Dogs. *Parasites & Vectors*, 13(1). <https://doi.org/10.1186/s13071-020-04407-5>