



## *Chapter 1*

# **Replacing Myth with Math: Using Data to Design Shelter Overpopulation Programs**

Reducing the incidence of overpopulation in animal shelters critically depends on applying data about the magnitude, dynamics, and root causes of overpopulation in animal shelters; until recently, however, shelters have operated in a data-poor environment.<sup>1</sup>

In the 1970s, a surge of articles in both lay and scientific presses drew attention to the great number of pets being put to death in animal shelters in the United States.<sup>2</sup> More than a decade later, though, Dr. Andrew Rowan pointed to the lack of data about the causes of overpopulation and the effectiveness of programs to reduce it as a “statistical black hole,” lamenting in 1992 that:

“(g)iven that close to \$1 billion are spent by animal shelters every year to deal with unwanted companion animals, it is unfortunate that we have so little reliable data that could be used to plan more effective programs or even to evaluate where we are headed.”<sup>3</sup>

## GLOSSARY OF TERMS

Pet overpopulation was originally used to describe a situation in which the volume of kittens and puppies overwhelmed the capacity of pet owners and shelters to care for them all and the excess were humanely destroyed in shelters. Over time, as puppies and kittens came to make up an increasingly smaller share of shelter admissions, some continued to refer to the overpopulation of animal shelters as pet overpopulation even though many of the impounded animals were unsocialized cats that had never been kept as pets and the reasons for many impoundments arose from a characteristic of the animal or pet owner, not the overall size of the pet population. Although there continued to be overpopulation, it was in the sheltering system, not in the total pet population. For this reason, the term **shelter overpopulation** will be used to describe a situation in which the total number of animals impounded from all sources substantially exceeds the carrying capacity of shelters in a community and the rate at which sheltered animals can be placed in appropriate adoptive homes.

Euthanasia in its common usage refers to taking steps to end the life of a person suffering from a terminal illness or incurable condition. With reference to animal shelters, the term has been applied both to taking steps to end the life of an animal that is severely injured or dying and to taking the life of an animal that is healthy or suffers from a treatable condition in order to control the size of the shelter population. To differentiate between these two contexts, **medical euthanasia** will be used to refer to the former situation and **population control euthanasia** to the latter. This will allow the population control euthanasia rate to serve as a measure of shelter overpopulation. Shelter overpopulation will have been eliminated when the only euthanasias performed in shelters are medical euthanasias that have not been induced by conditions at the shelter.

The following year, a consortium of animal protection groups, veterinary organizations, animal control groups, and pet products manufacturers formed the National Council on Pet Population Study and Policy (National Council) with three goals: (1). to gather and analyze data regarding the number, origin, and disposition of cats and dogs in the United States; (2). to promote responsible stewardship of companion animals; and (3). based on the data gathered, to recommend programs to reduce the number of homeless pets in the United States.<sup>4</sup>

During the past 15 years, the National Council has sponsored several epidemiological studies about the magnitude and dynamics of companion animal populations in the United States and the risk factors for the relinquishment of pets to animal shelters. A Regional Shelter Relinquishment Survey (Shelter Survey) of 12 animal shelters in four regions of the United States was undertaken to compile data on the characteristics of relinquished animals and their owners, the relative frequency of selected behaviors of the relinquished animals, and the relinquishers' general animal husbandry knowledge.<sup>5</sup>

Data collected in the National Council's Shelter Survey were analyzed in several studies about the demographics and dynamics of pet relinquishment.<sup>6, 7, 8, 9, 10</sup> To secure a comparison group, in 1997 the National Council sponsored a national survey of households that owned at least one dog or cat to secure comparable data regarding the characteristics of all pet owners and their pets, the frequency of selected behaviors of the animals and their owners' animal-related knowledge. Together with data from the Shelter Survey, the National Pet-Ownning Household Survey (Household Survey) supplemented earlier research regarding relinquishment-related risk factors<sup>11, 12</sup> and provided insights for the development of interventions to reduce them.<sup>13</sup>

“The benefits of improving the current data collection process could be quite substantial. First, appropriate information could be used to develop targeted programs to combat overpopulation in a particular community. For instance, recognition of a sharp rise in the number of stray cats or excess kitten litters in a community may suggest the initiation, expansion or revamping of spay and neuter or Trap, Test, Vaccinate, Alter and Release Programs. Alternatively, an influx of young adult dogs into area shelters may indicate a need for behavioral training programs or owner education programs addressing the transition from puppy to adult.

Second, information could be employed to track the effectiveness of programs, compare seasonal trends, and alert the shelter to changes in underlying cat and dog population dynamics. Finally, the data could be shared in shelters across a community (or the nation, for that matter) to help understand the overall problem rather than merely the experiences of a lone shelter, which may be driven more by mission, policies, size, effectiveness, or affiliation than by underlying problems.”

Wenstrup J & Dowidchuk A (1999). Pet overpopulation: Data and measurement issues in shelters. *J. Appl. Animal Welfare Sci.* **2** (4), 304.

Data from the National Council's Household Survey were also used to estimate the size of the cat and dog populations in the United States, their sterilization status, birth and death rates, the frequency of planned and unplanned litters, the disposition of litters, and the frequency of and reasons for animals leaving households.<sup>14</sup>

In 1998, shortly after the Household Survey was completed, 186 animal shelters in 42 states were surveyed to collect demographic data regarding incoming animals and their disposition and information about the economics of sheltering (National Shelter Survey).<sup>15</sup> In addition to outlining a suggested community assessment and planning methodology, the researchers identified a set of criteria to assess the value of the data collected.

Advances in the collection and standardization of shelter data have enabled researchers to more accurately assess the impact and effectiveness of remedial programs. In recent years, a foundation that has sponsored pet sterilization and adoption programs in several states since 1999 has undertaken rigorous statistical analyses of the impact of its programs and the association between various human and pet demographics and shelter intake and euthanasia rates.<sup>16, 17</sup> The results of these studies—in addition to data collected in the National Council's Shelter Survey and the 1998 National Shelter Survey—broadened the scope of available data beyond relinquished pets to all sources of shelter admissions.

As part of its rabies control program, in 1970 the State of California began to require all public and private agencies that provided animal control services to collect and report basic intake and disposition data to the Department of Health Services.<sup>18</sup> In recent years, several other states have passed laws requiring public and private animal shelters to collect and report basic intake and exit demographic

#### THE IMPORTANCE OF GOOD DATA

In the late 1980s and early 1990s, Dr. Andrew Rowan highlighted the need for data regarding pet populations and their dynamics. Without such information, he questioned how the humane community could determine if it was allocating its resources wisely.

Since then, a growing body of epidemiological studies has provided some answers to the questions Dr. Rowan raised. These data can be used to develop coherent, effective companion animal welfare policy.

Scarlett JM (2008). Interface of epidemiology, pet population issues and policy. *Prev. Vet. Med.* **86**, 189-190.

data, such as species, age, sex, sterilization status, and method of disposition. In addition, beginning in 1997, the editor of a periodical that specializes in reporting animal-related news, *Animal People*, has collected and published annual summaries of statewide and local shelter exit data. It has employed the same statistical protocol over the years to estimate the national shelter euthanasia rate. All of these data can provide an increasingly reliable basis to assess trends in shelter intake, adoption, redemption and euthanasia rates.

The collection and analysis of data have confirmed some widely held impressions previously derived from anecdotal information, such as the finding of relinquishment studies that problem behaviors increase a pet's risk of being surrendered to a shelter.<sup>19</sup> At the same time, they have contradicted impressions long accepted as shelter dogma, such as the belief that animals given as gifts are at greater risk of relinquishment than those acquired in other ways.<sup>20,21</sup> Another study found that special adoption promotions and alternative adoption locations resulted in adoptive placements with retention rates comparable to traditional, in-shelter placement programs<sup>22</sup> And a study of subsidized pet sterilization programs found that increases in the number of subsidized surgeries not only were not associated with a drop in the volume of non-subsidized surgeries, but that the number of non-subsidized surgeries increased as well, perhaps as a result of the positive effects of social marketing campaigns undertaken in connection with the subsidy programs.<sup>23</sup>

Myth, in other words, has begun to be replaced with math. Although still far from sufficient, this growing body of data and analysis has provided some answers to the questions raised by Dr. Rowan,<sup>24</sup> as discussed below.

## **I. During the Past 30 Years, the Euthanasia Rate in U.S. Animal Shelters Has Been Greatly Reduced.**

The best longitudinal picture of shelter intake and exit trends is contained in data collected by the California Department of Health Services since 1970. Under California law,<sup>25</sup> all public and private agencies that perform animal care and control services in the state are required to report basic shelter admission and disposition data to the Department. In the early 1970s—when the number of cats and dogs put to death in the state's shelters reached its peak—21% of the state's entire populations of household cat and dogs were euthanized each year.<sup>26</sup> The shelter death toll was

similar in other states. In 1973, 21-22.5% of the national population of owned cats and dogs were euthanized in U.S. animal shelters.<sup>27</sup> By 1982, the shelter euthanasia rate had fallen to 8.2-10.9% of the household cat and dog populations.<sup>28</sup>

Additional progress has been made since then. By 1996, the statewide euthanasia rate in California shelters had dropped to 4.1% of the owned cat and dog populations.<sup>29</sup> In 2003, 2.6% of Michigan's estimated dog population were euthanized in the state's animal shelters and 3.1% of the owned cat population.<sup>30</sup> Euthanasias in Virginia shelters in 2002 included 3.9% of the state's estimated dog population and 4.1% of the owned cat population.<sup>31</sup> In 2007, 4.2 million cats and dogs were euthanized in American animal shelters,<sup>32</sup> about 2.6% of the owned cat and dog populations.<sup>33</sup>

TOTAL EUTHANASIAS (U.S.)		
YEAR	CATS & DOGS EUTHANIZED (MILLIONS)	EUTHANASIAS PER 1,000 AMERICANS
1970	23.4	115.0
1985	17.8	74.8
1997	4.9	21.1
1998	4.9	19.4
1999	4.5	16.6
2000	4.5	16.8
2001	4.4	15.7
2002	4.2	15.3
2003	4.5	14.8
2004	4.9	17.4
2005	4.4	14.8
2006	4.0	13.6
2007	4.2	13.8

SOURCE: July/August 2008 *Animal People*, 8.

## II. The Drop in Shelter Euthanasia Rates Over the Past 30 Years Has Been Produced Almost Exclusively by a Decline in Shelter Intake Rates.

Three changes can produce a drop in a shelter's euthanasia rate: a decline in the number of pets admitted to the shelter, an increase in the number that are reclaimed by their owners, or an increase in the number placed with new owners. Shelter data show that the substantial drop in the national shelter euthanasia rate over the past 30 years has been produced almost entirely by a drop in the number of pets that have been admitted to shelters. As the following comparison of canine shelter intake and euthanasia data from California animal care and control agencies reflects, these two variables rose and then fell in tandem between 1970 and 1995:

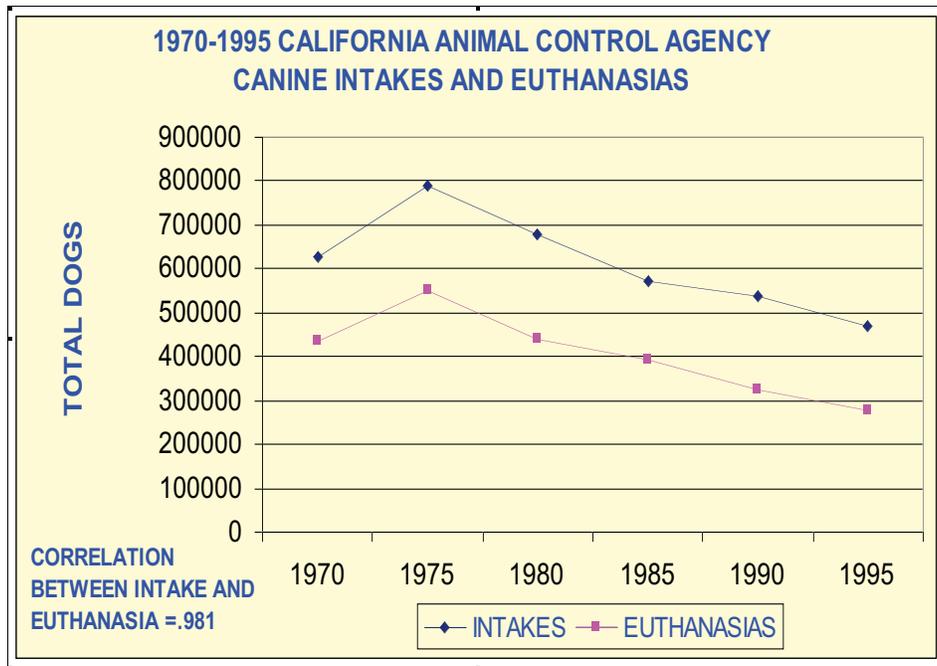


Figure 1.<sup>34</sup>

The strong correlation between shelter intake and euthanasia rates is also reflected in more recent data from Hillsborough County (Florida) Animal Services from 1997 to 2009:

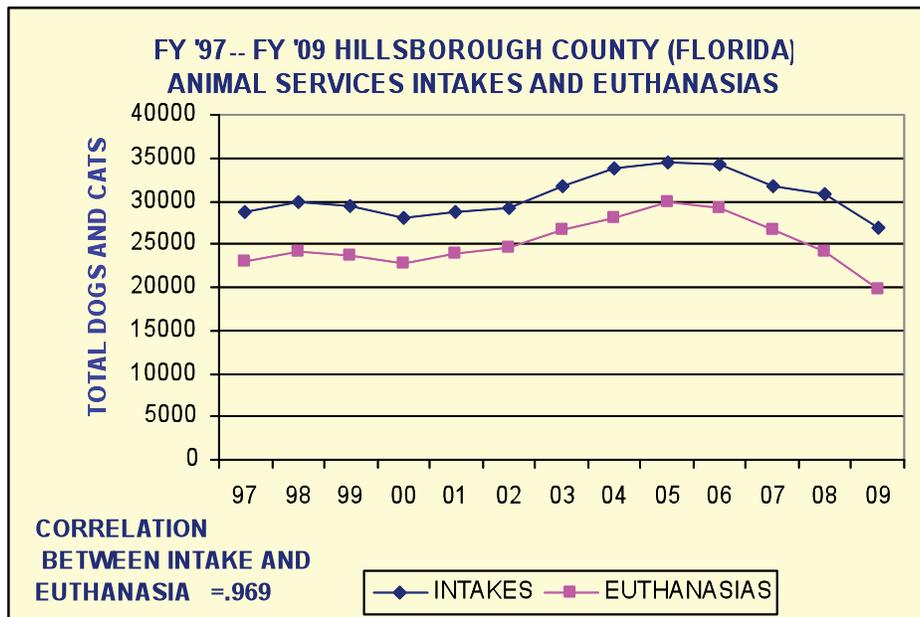


Figure 2.<sup>35</sup>

Despite substantial changes in the canine euthanasia rate in California animal care and control shelters between 1970 and 1995—in which it first rose by more than a quarter and then was cut in half—the adoption rate in these shelters remained relatively constant:

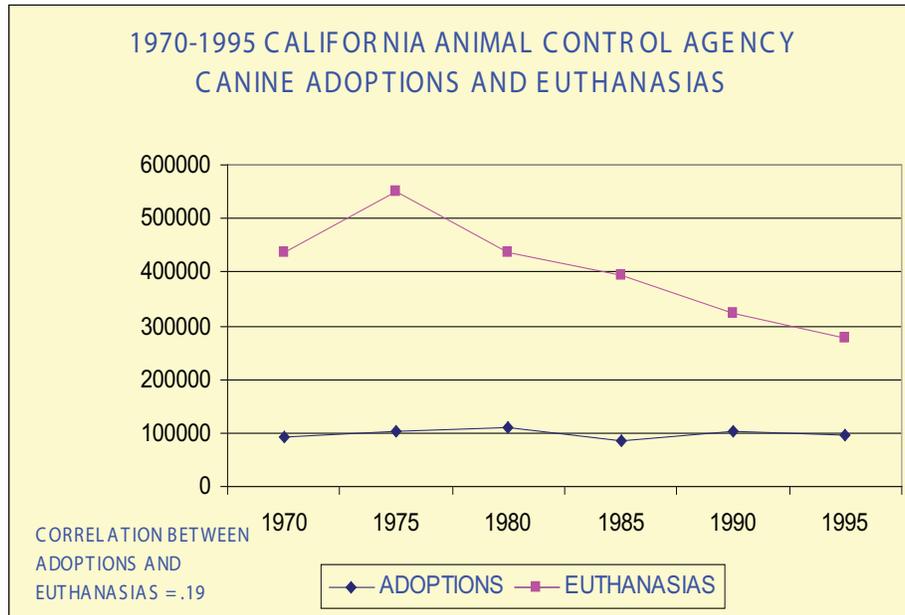


Figure 3.<sup>36</sup>

Shelter statistics from other states that have collected complete data for canine and feline intakes, adoptions, and euthanasias show the following, expressed in cats and dogs per 1,000 residents:

STATE	YEAR	ADOPTION RATE	INTAKE RATE	EUTHANASIA RATE
NH <sup>37</sup>	2007	9.4	12.6	2.1
MICHIGAN <sup>38</sup>	2003	7.2	24.2	13.2
OHIO <sup>39</sup>	2004	9.0	26.4	14.9
VIRGINIA <sup>40</sup>	2003	9.2	32.2	18.1
UTAH <sup>41</sup>	2007	9.1	29.2	12.9

Figure 4.

The correlation between intake and euthanasia rates in these five states was .964, while the correlation between adoption and euthanasia rates was -.215. As with

the county-by-county California data, adoption rates in these states vary within a relatively small range despite significant differences in shelter intake and euthanasia rates, suggesting that there is great potential to achieve a significant reduction in population control euthanasia through interventions to reduce intakes. As a result, the process of designing and implementing the most effective strategies to reduce population control euthanasia rates begins with identifying modifiable factors that are associated with reductions in shelter intake rates.

### **III. Communities with Low Pet Sterilization Rates Tend to Have Relatively High Shelter Intake Rates.**

As soon as surgical pet sterilization became widely available, evidence began accumulating that increased sterilization rates were associated with lower shelter intakes. In 1970, only 5% of licensed dogs in Los Angeles had been sterilized, and more than 144,000 dogs and cats were impounded in the city's shelters.<sup>42</sup> Twelve years later, 49% of licensed dogs had been sterilized, and the number of cats and dogs impounded had dropped to 72,454.<sup>43</sup> The trend of increases in canine sterilization rates accompanied by declines in impoundments has continued to the present. By 2006-2007, cat and dog impoundments had dropped to 45,016, despite substantial human population growth, and the sterilization rate of licensed dogs had increased to 89.5%.<sup>44</sup>

Animals impounded in U.S. animal shelters are almost evenly split between stray animals (including lost pets) and those relinquished by owners.<sup>45</sup> The demographic characteristics of relinquished animals have been more extensively studied than those of strays largely due to the Regional Shelter Relinquishment Survey sponsored by the National Council.

One study compared cats and dogs relinquished by their owners to the 12 animal shelters in the National Council's Shelter Survey with the national population

"To the knowledge of the ASPCA, the only method of population control that has demonstrated long-term efficacy in significantly reducing the number of animals entering animal shelters is the voluntary sterilization of owned pets."

*ASPCA Position Statement on Mandatory Spay/Neuter Laws*, <http://www.asPCA.org/about-us/policy-positions/mandatory-spay-neuter-laws.html>

of owned pets regarding several characteristics, including sterilization status. It was found that sexually intact dogs were twice as likely to have been relinquished as those that had been sterilized and that intact household cats were 3.3 times more likely to have been relinquished than their sterilized counterparts, both of these differences being statistically significant.<sup>46</sup> These findings were consistent with earlier studies indicating that intact dogs were 3.5 times more likely to be relinquished than sterilized ones<sup>47</sup> and that intact cats had a 4.8 times greater risk of relinquishment.<sup>48</sup>

Data from the 2003 Michigan shelter census suggest that the association between sterilization status and the risk of impoundment extends beyond relinquished pets to other sources of shelter intakes. Of the 92,714 adult dogs admitted to Michigan shelters during the census period, 74,609 (80.4%) were sexually intact, as were 79.8% of adult cats.<sup>49</sup> During this period, national surveys found that only 30% of all dogs and less than 20% of all household cats remained intact.<sup>50</sup> The reproductive status of cats and dogs admitted to 16 Texas animal shelters in 1997 was similar. Only 17.7% of dogs and 19.7% of cats admitted to these shelters had been sterilized.<sup>51, 52</sup>

#### **IV. Communities with Relatively High Poverty Rates Tend to Have Higher Shelter Intake Rates.**

In 2005, a foundation that had provided funding for several programs to reduce shelter euthanasia rates sponsored a study to identify the human and companion animal demographic factors associated with changes in shelter intake rates. The influence of several variables already known to affect pet ownership rates—and as a result, shelter intakes—such as local home ownership rates and educational levels, were controlled through a statistical regression analysis. Higher local poverty rates, as measured by the percentage of the population living below the federal poverty threshold, were found to be statistically associated with higher shelter intake rates.<sup>53</sup>

The link between poverty levels and shelter intake rates can be partly explained by the higher pet relinquishment rates of low-income households. In a case-control study of the rates at which pets were relinquished to an Indiana shelter, researchers found that 25.6% of all dogs relinquished to the shelter were from households with annual incomes of less than \$20,000.<sup>54</sup> At the time, households with incomes of less than \$20,000 made up only 12.3% of the dog-owning households in the county.<sup>55</sup> Dogs living in the households with the lowest incomes faced the greatest risk of

relinquishment: Those living in households with annual incomes of less than \$20,000 had the highest relinquishment rate of any income group and more than four times the risk of relinquishment of those living in households with incomes greater than \$75,000 a year.<sup>56</sup>

Cats living in low-income households also faced a greater risk of being relinquished to the shelter. In the Indiana study, 23.4% of cats relinquished to the shelter came from households with annual incomes of less than \$20,000, while only 12.4% of cats living in households in the county were from households of that income level.<sup>57</sup> Cats living in the lowest-income households also faced the greatest risk of relinquishment: Those living in households with incomes of less than \$20,000 a year had the highest relinquishment rate of any income group and more than four times the risk of relinquishment of those living in households with incomes higher than \$75,000 a year.

58

“Cost is one of the primary barriers to spay/neuter surgery in many communities. In fact, low household income and poverty are statistically associated with having a sexually intact cat, with relinquishment of pets to shelters, and with shelter intake. As a result, the proportion of pets from poor communities who are being euthanized in shelters remains high; shelter euthanasia rates in the poorest counties in states including California and New Jersey are several times higher than those in the most affluent counties.”  
(Reference citations omitted)

*ASPCA Position Statement on Mandatory Spay/Neuter Laws.*

Another factor is the lower sterilization rate of cats living in low-income households. As mentioned above, low pet sterilization rates in a population are associated with relatively high shelter intake rates. A 2007 national telephone survey found that cats living in U.S. households with annual family incomes of less than \$35,000 were significantly less likely to be sterilized than those living in households with annual incomes of between \$35,000 and \$75,000 or in households with annual incomes greater than \$75,000.<sup>59</sup> Only 51.4% of cats living in the low-income households surveyed were reported to have been sterilized, compared to 90.4% of cats living in the middle-income households and 96.2% of cats living in the upper-income households.<sup>60</sup> The survey results showed that cats living in the low-income households were 26 times more likely to be intact than those living in the upper-income households.<sup>61</sup>

Cats and dogs living in low-income households surveyed in 2008 for the 2009/2010 American Pet Products Association (APPA) National Pet Owners Survey were also less likely to be sterilized than those living in middle- and upper-income households, as shown below:

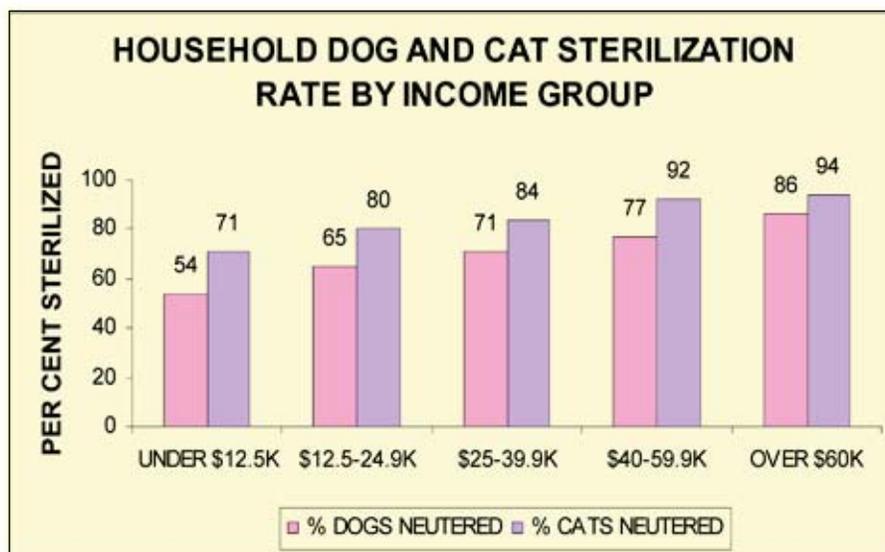


Figure 5.<sup>62</sup>

These data suggest that for a significant number of dog and cat owners, cost is a factor in pet sterilization decisions.

## V. Shelters That Sterilize Intact Pets Prior to Their Release Tend to Have Lower Future Intake Rates

Public and private animal sheltering policymakers have long recognized that it would greatly undermine attempts to curb pet overpopulation if the intact cats and dogs they placed back in their community were not sterilized by the people who adopted them. They were often instrumental in helping pass legislation intended to increase the rate at which the adopted animals were sterilized by requiring all adopters to post neutering deposits or sign contracts agreeing to comply with the pet sterilization requirement and threatening them with civil penalties for any failure to follow through. By 1998, 21 states had passed laws requiring animal shelters to take refundable neutering deposits when placing intact cats and dogs.<sup>63</sup>

California passed such a neutering deposit law in 1986. Twelve years later, legislators were concerned that the placement of intact cats and dogs by the state's animal shelters—despite the mandatory statewide neutering deposit and the threat

of a fine for noncompliance with the sterilization requirement—may actually have been contributing to pet overpopulation in the state<sup>64</sup> and amended the law to require all public and private shelters in counties with over 100,000 residents to sterilize all cats and dogs they placed unless a veterinarian certified that sterilization would be detrimental to the animal’s health.<sup>65</sup>

“There is evidence that sterilizing very specific, at-risk sub-populations of companion animals such as animals in shelters can contribute to reductions in overpopulation.”

*ASPCA Position Statement on Mandatory Spay/Neuter Laws.*

Because the neutering deposit mandate had been in effect for more than a decade before the pre-release sterilization law took effect, it is possible to compare intake rates in the same jurisdiction for periods in which a neutering deposit was required to those after pre-release sterilization was required. Total dog and cat intake rates in the six largest counties with complete animal control agency data dropped by 10% between 2000 and 2005, the first five years after the pre-release sterilization law took effect:

COUNTY	'00 INTAKE	'05 INTAKE	% CHANGE
LOS ANGELES	193,190	184,723	-4.4
ORANGE	44,200	41,081	-7.1
SAN DIEGO	50,798	43,078	-15.2
RIVERSIDE	55,947	42,794	-23.5
SANTA CLARA	30,114	22,910	-24.0
FRESNO	51,963	48,911	-5.9
TOTAL	426,212	383,497	-10.0

Source: California Department of Health Services. Veterinary Public Health Section, Annual Reports of Local Rabies Control Activities. 2000, 2005.

Figure 6.

This drop in shelter intakes occurred during a period when the human population in these counties grew by 8.2%. In contrast, during the five-year period before the pre-release sterilization law took effect—that is, between 1995 and 2000—the total dog and cat intakes at animal control shelters in these six counties increased by 8.6%.<sup>66</sup>

## **VI. The Rate at Which the Sterilization of Female Cats and Dogs is Delayed Beyond the Optimal Age Greatly Affects the Reproductive Rate of the Household Pet Population in the United States.**

Based on the age-specific birth and survival rates of pet cats in a Kansas town, population ecologists estimated that when 76-88% of the females had been sterilized—depending on the percentage of the remaining intact animals that reproduced—the population would reach a state of zero population growth.<sup>67</sup> Using a similar methodology, they calculated that the sterilization of 66% of the female dogs in the population would result in reproduction at the replacement rate or less.<sup>68</sup>

About 87% of all owned cats and 75% of all owned dogs are now sterilized<sup>69</sup>—exceeding the level at which zero population growth should have been achieved in populations with the same birth and death rates as those of the Kansas studies—but more than 4 million cats and dogs are still euthanized in American shelters each year<sup>70</sup> and in recent years the household cat and dog populations have continued to grow at the rate of about one million dogs and two million cats per year.<sup>71</sup> The likely explanation for this discrepancy lies in an assumption upon which the estimates in the Kansas studies were made: Those estimates were based on an assumption that all the sterilized female pets had not reproduced before having been sterilized.<sup>72</sup>

Not only is it common in the United States for pets to have litters of kittens or puppies before sterilization, the number of these litters is substantial. A study of household pet populations in four Massachusetts towns found that female cats and dogs that had been sterilized were almost as productive before their sterilization (.313 litters per female) as those females that remained intact (.4 litters each), a difference that was not statistically significant.<sup>73</sup> This is consistent with other surveys, which found that 17% of intact female dogs had given birth, as had 16% of intact female cats,<sup>74</sup> a rate comparable to the pre-sterilization reproductivity of spayed dogs (21%) and cats (20%).<sup>75</sup>

Because female pets that have been sterilized now far outnumber their intact counterparts and their lifetime litter productivity approaches that of those that remain intact, they make a substantial contribution to the reproductive rate of the entire population. In the four towns included in the Massachusetts survey, female cats and dogs that had been sterilized after having had at least one litter accounted for 87% of all the litters of kittens and puppies born.<sup>76</sup>

Allowing pets to have a litter before being sterilized ignores the clinical evidence that the optimal age to sterilize female cats and dogs is before their first estrus.<sup>77</sup> Compared with its incidence in sexually intact dogs, those spayed before their first estrus have .5% of the risk of developing mammary gland cancer.<sup>78</sup> Cats spayed before their first estrus have 9% of the risk of developing mammary gland cancer of intact cats.<sup>79</sup> But the protective benefit of sterilization from mammary gland neoplasms dissipates quickly with delay: Cats spayed later than 24 months of age and dogs spayed after 30 months of age have the same or greater risk of developing mammary gland cancer as if they had remained intact.<sup>80, 81</sup>

The widespread delay in having female pets sterilized may arise in part from a significant knowledge deficit of cat and dog owners. Surveys consistently find that more than half of all dog and cat owners either do not know whether a pet would be better off by having a litter before being spayed or mistakenly believe that she would.<sup>82, 83</sup> The extent of this knowledge deficit was almost identical among owners who had visited a veterinarian within the past year and those who had not.<sup>84</sup> The mistaken belief that a female cat would benefit from having a

“When we examine the responses to general knowledge questions, it is disturbing to see that significantly more people relinquishing dogs and cats felt that the female animal would be better off if she had one litter before being spayed and that significantly fewer people relinquishing animals knew this was false.

Furthermore approximately half of the owners in the Household Survey (51.2% of the dog owners and 49.3% of the cat owners) wrongly felt this was a true statement or did not know the answer. Although scientific evidence does not support this belief, it might explain some of the difficulty experienced by many individuals and groups who try to encourage the spaying of family pets and documents a clear need for educational efforts aimed at this myth.”

New, JC, Jr., Salman MD, King M, Scarlett JM, Kass PH, & Hutchinson JM (2000). Characteristics of shelter-relinquished animals and their owners compared with animals and their owners in U.S. pet-owning households. *J. Appl. Animal Welfare Sci.* 3(3), 199.

litter before being sterilized is so widespread that it was the most common reason given by respondents in a 2007 national survey for not having had an intact cat sterilized.<sup>85</sup>

Reducing the age at which cats and dogs in a population are sterilized can have a substantial impact on its reproductive rate. Population modeling of the age-specific birth, death, and reproductive rates of owned dogs in an Italian province found that a sterilization rate of 55% of the female dogs would be necessary to reach the replacement fertility rate if the average age at which dogs were sterilized was three years old, but that it could be reduced to as low as 26% if the average age of spaying was reduced to one year or less.<sup>86</sup> Another population modeling study found that 71% of the females of reproductive age would have to be sterilized to halt the growth of a feral cat population but that if no females younger than a year old were sterilized, it would be necessary to sterilize 91% of those older than that to maintain a stable population.<sup>87</sup>

## **VII. The Optimal Allocation of Resources Depends on Developing Programs That Target the Specific Sources of Shelter Overpopulation in a Community.**

A key finding of the 1998 National Shelter Survey was that incoming animal demographics varied greatly from one sheltering system to another.<sup>88</sup> The county-by-county shelter statistics collected by the California Department of Health Services show the same variability in shelter animal demographics from one county to another.<sup>89</sup> In 2005, the shelter intake rate was as low as 12.48 cats and dogs per 1,000 residents in one county and as high as 60.52 in another. In addition to the great variation in the volume of incoming animals, there was substantial variation by species, too. In several counties, dogs made up more than two-thirds of the incoming animals; in several others, they made up less than 40%.<sup>90</sup>

The great variability in the demographics of homeless animal populations in different communities must be taken into account in the design of interventions. Different subsets of homeless animals are the product of different root causes that require different remedial programs.<sup>91, 92</sup> As a result, the effective allocation of resources requires that local intake demographics drive the planning process<sup>93</sup> and that communities use local statistics to identify, prioritize, and evaluate their programs.<sup>94, 95</sup>

“Each community is unique, however, in terms of the particular sources and causes of companion animal population and the primary barriers that exist to having pets altered. No one-size-fits-all solution is therefore possible. In examining communities around the country that are having significant success in reducing companion animal overpopulation, it appears that the common denominator is a multifaceted, targeted community program that:

- ◆ Is based on careful research to determine which segments of the animal population are actually significantly contributing to shelter intake and euthanasia and then targets efforts to those segments of the population;
- ◆ Focuses on the particular barriers to spay/neuter that are predominant and strives to overcome them;
- ◆ Is well-supported and well-funded; and
- ◆ Has an efficient voluntary spay/neuter infrastructure in place to service the populations it targets.”

*ASPCA Position Statement on Mandatory Spay/Neuter Laws.*

Researchers who conducted the 1998 National Shelter Survey identified four criteria to decide which types of data should be collected by local sheltering agencies: (1) The data must have a practical value for developing remedial interventions that exceeds the cost of collection; (2) They must be sufficiently specific to local conditions to allow planners to develop programs tailored to address the root causes of overpopulation in a community; (3) They must be adequately standardized to allow the consolidation of data from different communities; and (4) They must be scalable, so that local data can be compared to data from other communities.<sup>96</sup> Another analyst advises that despite its many benefits, consistent data collection is unlikely to be performed if it is overly burdensome or if those responsible for collecting the data never see the results of their work.<sup>97</sup>

Not all demographic data satisfy these criteria. Differentiation by species and gender does because it is easy to collect and composite data obscure important species- and gender-specific differences in neutering status, reproductive history, and annual turnover.<sup>98</sup>

It is also useful to differentiate animals that have entered a shelter as strays from those that have been relinquished by their owners, because the demographics of the two populations may differ significantly<sup>99</sup> and the underlying causes that led the animals to become homeless may require different strategies. For instance, programs to increase the rate at which owners provide their pets with adequate identification might substantially increase the rate at which stray animals are successfully returned to their owners, but would not affect relinquishment rates. On the other hand, obtaining information regarding the reasons for animals' relinquishment would be of great value in identifying major risk factors and designing programs to reduce them.<sup>100</sup>

"[I]ncoming animal demographics vary dramatically by shelter, implying high variance in localized problems, root causes, and efficacy of shelter activity to date. For instance, the average age of animals euthanized ranged from 6 months in one shelter to 6 years in another. As a result, any blanket policy or program recommendations may be of limited relevance to an increasingly large portion of shelters and, if followed, could result in a dramatic misallocation of funding to programs with less potential for a major impact."

Wenstrup J & Dowidchuk A (1999). Pet overpopulation: Data and measurement issues in shelters. *J. Appl. Animal Welfare Sci.* **2**(4), 308.

Information about the age of incoming animals can help differentiate pet overpopulation—which can be effectively addressed by programs to increase the community's pet sterilization rate—from shelter overpopulation, which comes from a diverse array of sources and requires complex and manifold solutions beyond simply decreasing the number of animals born.

Information about the sterilization status of incoming animals can help determine the relative value of pet sterilization programs compared to other possible interventions. As long as intact household animals make up a significantly greater percentage of shelter admissions than that of the overall household population, pet sterilization programs will continue to be of value and the magnitude of difference in sterilization rates between the two populations should provide a sound basis for planners to determine whether sterilization programs should continue to be prioritized.

## VIII. Because It Is an Aggregate Problem, Shelter Overpopulation Requires Aggregate Solutions.

Almost all animals entering shelters come from one of two sources: Either their owners have relinquished them or they are stray, lost, or free-roaming animals that have been impounded.<sup>101</sup> Neither source, though, is monolithic with respect to the root causes that resulted in the animals entering a shelter. Some relinquished animals are from litters of kittens or puppies that have been brought to the shelter; others are healthy adolescent or adult animals that have been returned to a shelter after an unsuccessful placement; and still others have been surrendered because of an owner's health or housing or financial issues or issues related to the animal's health or behavior.

Stray animals are similarly diverse. Some have been abandoned by their owners; others have wandered from home and become lost; and others have migrated from homes to join free-roaming colonies. Even the subsets of stray animals are diverse: Cats in free-roaming colonies include some that are fully or partially socialized and others that are unsocialized.

While no single source of incoming animals may outstrip a community's sheltering capacity, the total from all sources can. And it often does. Shelter overpopulation is an aggregate problem.

No single strategy addresses all of the major causes of companion animal homelessness; eradicating it requires aggregate solutions. Pet sterilization programs can reduce the number of kittens and puppies that are relinquished to shelters. Problem behaviors of reproductively intact animals are responsible for nearly a third of all adult dog and cat relinquishments,<sup>102, 103</sup> so sterilization programs can help with that, too.

"[T]he animal shelter population is actually very heterogeneous, with no single cause or source. Many social, cultural and economic factors as well as animal health and behavioral issues contribute to shelter intake; therefore, no single program or law can be relied upon to solve the problem." (Reference citations omitted).

*ASPCA Position Statement on Mandatory Spay/Neuter Laws.*

Pet sterilization is not a remedy for many of the factors that are associated with an increased risk of relinquishment, however. Approximately 40% of all relinquished

dogs and 28% of relinquished cats have an unwanted behavior cited as a reason for their relinquishment, such as aggression toward people or animals, destructive behavior, or inappropriate elimination in the house.<sup>104</sup> Other major risk factors—such as lack of participation in a dog obedience class, lack of frequent veterinary care, and owners' inappropriate expectations<sup>105</sup>—require veterinary care and counseling and access to dog training classes. Subsidies to bring the necessary services within the economic reach of indigent pet owners may be needed to remediate the disproportionate risk of relinquishment faced by pets living in low-income households.<sup>106, 107</sup>

Sterilization is associated with a reduced tendency to roam, at least for male dogs,<sup>108</sup> and can help reduce stray populations. More than 97% of all free-roaming cats are intact,<sup>109</sup> suggesting that sterilization programs deserve to be a primary strategy to manage feral cat populations and reduce the migration of household cats to free-roaming status.<sup>110</sup> But sterilization programs are not the only interventions needed to reduce stray and free-roaming populations. Increased rates of pet identification can help increase the number of impounded stray and lost pets successfully returned to their owners.<sup>111</sup> And veterinary counseling about the protective benefits of maintaining a cat indoors can also reduce the rate at which cats become lost or stray from home.<sup>112</sup>

As the above discussion makes clear, no one group is in a position to provide the array of services and programs needed to eradicate companion animal homelessness in a community. Different groups and agencies serve the different subsets of animals that become or are at risk of becoming homeless. Public and private animal shelters provide care to animals that have entered their shelters. Veterinary practitioners serve animals owned by their clients. And local advocacy groups can provide needed services to homeless animals living in the community and those pets whose owners cannot afford veterinary care.

As a result, the contributions of veterinarians, animal care and control agencies, humane organizations, and advocacy groups are all necessary. As set forth in the following chapters, each group—because of its unique resources, mission, and authority—must play a role that cannot be filled by any other.

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- <sup>1</sup> Wenstrup J & Dowidchuk A (1999). Pet overpopulation: data and measurement issues in shelters. *J. Appl. Animal Welfare Sci.* **2** (4): 304.
  - <sup>2</sup> Rowan AN & Williams J (1989). The success of companion animal management programs: A review. *Anthrozoos* **1** (2): 110.
  - <sup>3</sup> Rowan AN (1992). Shelters and pet overpopulation: a statistical black hole. *Anthrozoos* **5** (3): 143
  - <sup>4</sup> National Council on Pet Population Study and Policy. <http://www.petpopulation.org>.
  - <sup>5</sup> Salman MD, New, Jr. JC, Scarlett JM, Kass P, Ruch-Gallie R, & Hetts S (1998). Human and animal factors related to the relinquishment of dogs and cats in 12 selected animal shelters in the U.S. *J. Appl. Animal Welfare Sci.* **1** (3): 207-226.
  - <sup>6</sup> New Jr., JC, Salman MD, King M, Scarlett JM, Kass PH, & Hutchinson JM (2000). Characteristics of shelter-relinquished animals and their owners compared with animals and their owners in U.S. pet-owning households. *J. Appl. Animal Welfare Sci.* **3** (3): 179-201.
  - <sup>7</sup> Salman et al., Human and animal factors, 207-226.
  - <sup>8</sup> New, Jr. JC, Salman MD, Scarlett JM, Kass PH, Vaughn JA, Scherr S & Kelch WJ (1999). Moving: characteristics of dogs and cats and those relinquishing them to 12 U.S. animal shelters. *J. Appl. Animal Welfare Sci.* **2** (2): 83-95.
  - <sup>9</sup> Salman MD, Hutchinson J, Ruch-Gallie R, Kogan L, New, Jr. JC, Kass PH, & Scarlett JM (2000). Behavioral reasons for relinquishment of dogs and cats to 12 shelters. *J. Appl. Animal Welfare Sci.* **3** (2): 93-106.
  - <sup>10</sup> Scarlett JM, Salman MD, New, Jr. JC, & Kass PH (1999). Reasons for relinquishment of companion animals in U.S. animal shelters: Selected health and personal issues. *J. Appl. Animal Welfare Sci.* **2** (1): 41-57.
  - <sup>11</sup> Patronek GJ, Glickman LT, Beck AM, McCabe GP, & Ecker C (1996). Risk factors for relinquishment of dogs to an animal shelter. *J. Am. Vet. Med. Assoc.* **209** (3): 572-581.
  - <sup>12</sup> Patronek GJ, Glickman LT, Beck AM, McCabe GP, & Ecker C (1996). Risk factors for relinquishment of cats to an animal shelter. *J. Am. Vet. Med. Assoc.* **209** (3): 582-588.
  - <sup>13</sup> Patronek G & Zawistowski S (2002). The value of data. *J. Appl. Animal Welfare. Sci.* **5** (3): 171.
  - <sup>14</sup> New, Jr JC, Kelch WJ, Hutchinson JM, Salman MD, King M, Scarlett JM, & Kass PH (2004). Birth and death rate estimates of cats and dogs in U.S. households and related factors. *J. Appl. Animal Welfare Sci.* **7** (4): 229-241.
  - <sup>15</sup> Wenstrup & Dowidchuk. Pet overpopulation: data and measurement issues, 303-319.
  - <sup>16</sup> Frank J (2005) Cross program statistical analysis of Maddie's Fund programs. [http://www.maddiesfund.org/organizations/org\\_pdf/firepaw\\_program\\_analysis.pdf](http://www.maddiesfund.org/organizations/org_pdf/firepaw_program_analysis.pdf).

- <sup>17</sup> Frank JM & Carlisle-Frank PL (2007). Analysis of programs to reduce overpopulation of companion animals: Do adoption and low-cost spay/neuter programs merely cause substitution of sources? *Ecol. Econ.* **62**: 740-746.
- <sup>18</sup> California Code of Regulations, Title 17, Section 2606.4 (a) (4).
- <sup>19</sup> Scarlett JM (2008), The interface of epidemiology, pet population issues and public policy. *Prev. Vet. Med.* **86**: 193.
- <sup>20</sup> Ibid.
- <sup>21</sup> New, Jr. et al., Characteristics of shelter-relinquished animals, 188.
- <sup>22</sup> Neidhart L & Boyd R (2002). Companion animal adoption study. *J. Appl. Animal Welfare Sci.* **5** (3): 180.
- <sup>23</sup> Frank & Carlisle Frank, Analysis of programs to reduce overpopulation, 745.
- <sup>24</sup> Scarlett, The interface of epidemiology, pet population issues and policy, 190.
- <sup>25</sup> California Code of Regulations, Title 17, Section 2606.4 (a) (4).
- <sup>26</sup> Christiansen, B (1998). Save Our Strays: How We Can End Pet Overpopulation and Stop Killing Healthy Dogs and Cats. Napa, CA: CLC Publishing, 12.
- <sup>27</sup> Rowan & Williams. The success of companion animal management programs, 112.
- <sup>28</sup> Ibid.
- <sup>29</sup> Christiansen, Save Our Strays, 12.
- <sup>30</sup> Bartlett PC, Bartlett A, Walshaw S, & Halstead S (2005). Rates of euthanasia and adoption for dogs and cats in Michigan animal shelters. *J. Appl. Animal Welfare Sci.* **8** (2): 100.
- <sup>31</sup> Bartlett et al., Rates of euthanasia and adoption, 100.
- <sup>32</sup> Clifton M (2008). U.S. shelters killed 2.3 million cats and 1.9 million dogs last year. Nearly half of the dogs were pit bulls. *Animal People 2008: July/Aug: 8*.
- <sup>33</sup> 2007-2008 National Pet Owners Survey, Greenwich, CT: American Pet Products Manufacturers Association (APPMA).
- <sup>34</sup> Christiansen, Save Our Strays, 12.
- <sup>35</sup> Hillsborough County Animal Services Shelter Statistics, 1997-2005 (unpublished).
- <sup>36</sup> Christiansen, Save Our Strays, 12.
- <sup>37</sup> NH Federation of Humane Organizations, Consolidated 2007 Shelter Statistics (unpublished).
- <sup>38</sup> Bartlett et al., Rates of adoption and euthanasia, 101.
- <sup>39</sup> Lord LK, Wittum TE, & Ferketich AK (2006). Demographic trends for animal care and control agencies in Ohio from 1996 to 2004. *J Am Vet Med Assoc* **229** (1): 50.

- <sup>40</sup> <http://vdacs.state.va.us/animals/pdf/allentities.pdf>
- <sup>41</sup> No More Homeless Pets in Utah, 2007 Utah shelter statistics (unpublished).
- <sup>42</sup> Rowan & Williams, The success of companion animal management programs, 119.
- <sup>43</sup> Ibid.
- <sup>44</sup> Los Angeles Animal Services 2007 Statistical Report (unpublished).
- <sup>45</sup> Wenstrup & Dowidchuk. Pet overpopulation: data and measurement issues, 307.
- <sup>46</sup> New, Jr. et al., Characteristics of shelter-relinquished animals, 185.
- <sup>47</sup> Patronek et al., Risk factors for relinquishment of dogs, 574.
- <sup>48</sup> Ibid., 583.
- <sup>49</sup> Bartlett et al., Rates of adoption and euthanasia, 100.
- <sup>50</sup> 2003/2004 National Pet Owners Survey. Greenwich, CT: American Pet Products Manufacturers Association (APPMA); 2002 U.S. Pet Ownership and Demographic Source Book. Schaumburg, IL: American Veterinary Medical Association (AVMA).
- <sup>51</sup> Mahlow J (1999). Estimation of the proportions of dogs and cats that are surgically sterilized. *J. Am. Vet. Med. Assoc.* **215** (5): 641.
- <sup>52</sup> These data are similar to those from a 2001-2002 survey of three shelters in Melbourne, Australia, in which 23.8% of impounded dogs had been sterilized at a time when an estimated 61% of the owned dogs in the country had been sterilized. Marston LC, Bennett PC, & Coleman GJ (2004). What happens to shelter dogs? An analysis of data for 1 year from three Australian shelters. *J. Appl. Animal Welfare Sci.* **7** (1): 32.
- <sup>53</sup> Frank, Cross program statistical analysis of Maddie's Fund programs, 8.
- <sup>54</sup> Patronek et al. Risk factors for relinquishment of dogs, 578.
- <sup>55</sup> Ibid.
- <sup>56</sup> Ibid.
- <sup>57</sup> Patronek et al. Risk factors for the relinquishment of cats, 586.
- <sup>58</sup> Ibid.
- <sup>59</sup> Chu K, Anderson WM, & Rieser MY (2009). Population characteristics and neuter status of cats living in households in the United States. *J. Am. Vet. Med. Assoc.* **234** (8): 1029.
- <sup>60</sup> Chu et al., Population characteristics and neuter status of cats, 1026.
- <sup>61</sup> Ibid.
- <sup>62</sup> Data collected for the 2009-2010 National Pet Owners Survey (APPA) but not included in the report.

- <sup>63</sup> Huss RJ (2007). Rescue me: Legislating cooperation between animal control authorities and rescue organizations. *Conn. L. Rev.* **39**: 2097.
- <sup>64</sup> California State Senate Committee on Business & Professions, April 12, 2004 Report on Senate Bill 1301 (repealing the five-year sunset provision contained in the original pre-release sterilization law).
- <sup>65</sup> Chapter 747, California Statutes of 1998, codified at California Food & Agriculture Code § 31751.3.
- <sup>66</sup> California Department of Health Services, Annual Reports of Local Rabies Control Activities, 1995; 2000.
- <sup>67</sup> Nassar R & Mosier JE (1982). Feline population dynamics: A study of the Manhattan, Kansas feline population. *Am. J. Vet. Res.* **43** (1), 169.
- <sup>68</sup> Nassar R Mosier JE (1980). Canine population dynamics: A study of the Manhattan, Kansas canine population. *Am. J. Vet. Res.* **41** (11): 1800.
- <sup>69</sup> 2007-2008 National Pet Owners Survey (APPMA).
- <sup>70</sup> Clifton M (2008). U.S. shelters killed 2.3 million cats and 1.9 million dogs last year. *Animal People*, **Jul/Aug** 2008: 8.
- <sup>71</sup> 2001/2002 National Pet Owners Survey (APPMA); 2007/2008 National Pet Owner's Survey (APPMA); 2002 U.S. Pet Ownership and Demographics Sourcebook (AVMA); 2007 U.S. Pet Ownership and Demographics Sourcebook (AVMA).
- <sup>72</sup> Manning MM & Rowan AN (1992). Companion animal demographics and sterilization status: Results from a survey in four Massachusetts towns. *Anthrozoos* **5** (3): 197.
- <sup>73</sup> Ibid.
- <sup>74</sup> Nassar R, Mosier JE, & Williams LW (1984). Study of the feline and canine populations in the greater Las Vegas area. *Am. J. Vet. Res.* **45** (2): 286.
- <sup>75</sup> Dorr Research Corporation (1991). Massachusetts Public Opinion Study on Spaying and Neutering of Pets Summary, 2.
- <sup>76</sup> Manning & Rowan, Companion animal demographics, 200.
- <sup>77</sup> Kustritz, MVR (2007). Determining the optimal age for gonadectomy of dogs and cats. *J. Am. Vet. Med. Assoc.* **231** (11): 1665.
- <sup>78</sup> Schneider R, Dorn CR, & Taylor DON (1969). Factors influencing canine mammary gland cancer development and post-surgical survival. *J. Nat'l Cancer Inst.* **43**, 1255.
- <sup>79</sup> Overly B, Shofer FS, Goldschmidt DS & Sorenino KU (2005). Association between ovariohysterectomy and feline mammary carcinoma. *J. Vet. Internal Med.* **19**: 561.
- <sup>80</sup> Schneider et al., Factors influencing canine mammary gland cancer development, 1256.
- <sup>81</sup> Overly et al., Association between ovariohysterectomy and feline mammary carcinoma, 562.
- <sup>82</sup> New, Jr. et al. Characteristics of shelter relinquished animals, 193.

- <sup>83</sup> Salman et al. Human and animal factors related to the relinquishment of cats and dogs, 220.
- <sup>84</sup> Scarlett JM, Salman MD, New, Jr. JC, & Kass PH (2002). The role of veterinary practitioners in reducing dog and cat relinquishments and euthanasias. *J. Am. Vet. Med. Assoc.* **220** (3): 309.
- <sup>85</sup> Chu et al., Population characteristics and neuter status of cats, 1026.
- <sup>86</sup> DiNardo A, Candelaro L, Budke CM, & Slater MR (2007). Modeling the effect of sterilization rate on owned dog population size in central Italy. *Prev. Vet. Med.* **82**: 311-312.
- <sup>87</sup> Budke CM & Slater MR (2009). Utilization of matrix population models to assess a 3-year single treatment nonsurgical contraception program versus surgical sterilization in feral cat populations. *Appl. Animal Welfare Sci.* **12** (4): 272-292.
- <sup>88</sup> Wenstrup & Dowidchuk, Pet overpopulation: Data and measurement issues, 308.
- <sup>89</sup> California Department of Health Services, Annual Reports, 2005.
- <sup>90</sup> *Ibid.*
- <sup>91</sup> Wenstrup & Dowidchuk, Pet overpopulation: data and measurement issues, 308.
- <sup>92</sup> Hurley K (2004). Implementing a population health plan in an animal shelter. Shelter Medicine for Veterinarians and Staff, L. Miller and S. Zawistowski (eds.) Ames, Iowa: Blackwell Publishing, 213.
- <sup>93</sup> Wenstrup & Dowidchuk, Pet overpopulation: data and measurement issues, 308.
- <sup>94</sup> Scarlett J (2004). Pet population dynamics and animal shelter issues. Shelter Medicine for Veterinarians and Staff, L. Miller and S. Zawistowski (eds.) Ames, Iowa: Blackwell Publishing, 22.
- <sup>95</sup> Materials that describe the step-by-step process in which shelter statistics can be used to design a localized community assessment are referenced in the Section B of the Appendix.
- <sup>96</sup> Wenstrup & Dowidchuk, Pet overpopulation: data and measurement issues, 314.
- <sup>97</sup> Hurley, Implementing a population health plan in an animal shelter, 215.
- <sup>98</sup> Patronek GJ, Beck AM, & Glickman LT (1997). Dynamics of cat and dog populations in a community. *J. Am. Vet. Med. Assoc.* **210** (5): 641
- <sup>99</sup> Patronek GJ, Glickman LT, & Moyer MR (1995). Population dynamics and the risk of euthanasia for dogs in an animal shelter. *Anthrozoos* **8** (1), 37.
- <sup>100</sup> Patronek et al., Risk factors for the relinquishment of dogs, 579.
- <sup>101</sup> Shelter admissions from other sources, such as those seized in connection with animal cruelty cases, appear to make up less than 5% of all shelter admissions. Wenstrup & Dowidchuk, Pet overpopulation: data and measurement issues, 307.
- <sup>102</sup> Patronek et al., Risk factors for the relinquishment of dogs, 579.

- <sup>103</sup> Patronek et al., Risk factors for the relinquishment of cats, 586.
- <sup>104</sup> Scarlett, Interface of epidemiology, pet population issues and policy, 193.
- <sup>105</sup> Patronek et al., Risk factors for the relinquishment of dogs, 579.
- <sup>106</sup> Patronek et al., Risk factors for the relinquishment of cats, 586.
- <sup>107</sup> Patronek et al., Risk factors for the relinquishment of dogs, 578.
- <sup>108</sup> Neilson JC, Eckstein RA, & Hart BL (1997). Effect of castration on problem behaviors in male dogs with reference to age and duration of behavior. *J. Am. Vet. Med. Assoc.* **211** (2): 182.
- <sup>109</sup> Wallace JL & Levy JK (2006). Population characteristics of feral cats admitted to seven trap-neuter-return programs in the United States. *J. Fel. Med. & Surgery* **8**: 282.
- <sup>110</sup> Patronek GJ (1998). Free-roaming and feral cats—their impact on wildlife and human beings. *J. Am. Vet. Med. Assoc.* **212** (2): 224.
- <sup>111</sup> Lord LK, Wittum TE, Ferketich AK, Funk JA, & Rajala-Schultz PJ (2007). Search and identification methods that owners use to find a lost dog, *J. Am. Vet. Med. Assoc.* **230** (2): 215.
- <sup>112</sup> Scarlett, Interface of epidemiology, pet population issues and policy, 192.