Companion Animal Overpopulation: Trends and Results of Major Efforts to Reach a "No-Kill" Nation

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Abstract: Human companion animal overpopulation is a problem of human creation, with significant human costs, and that can only be addressed through human action. Concern and awareness regarding the euthanasia of companion animals has grown dramatically in recent decades. Within the past five years in particular, a new "no-kill" philosophy has penetrated much of the animal welfare movement. Perhaps the largest development in this area has been the creation and actions of "Maddie's Fund", an organization offering unprecedented financial resources to fuel numerous animal welfare programs and with a commitment to move entire communities to "no-kill" status. This paper discusses recent companion animal overpopulation trends, and the results from Maddie's Fund Programs in particular.

~~Key words:~~

~~Outline: Intro to what is done with model. Methodology focusing on model only (include sensitivity analysis). Results (effect of various treatments), then synergy and scale effects. All focus on no-kill. Put details of model in an appendix~~

Introduction

Human companion animal overpopulation is a problem of human creation, with significant human costs, and that can only be addressed through human action. In many respects, companion animals lie in an unusual gray area between the human world and the natural environment. Legally and economically, these animals are property and a tradable "good" and therefore lie within the realm of industrialized human society.

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However, at the same time, companion animals are also a connection between human society and the natural environment. This paper will discuss the companion animal overpopulation and the controversy over the "No-Kill" movement. The paper will then go on to discuss results of several programs funded by Maddie's Fund, one of the leading organizations in the No-Kill movement.

Regardless of why humans choose to live with companion animals, it is clear that humans value their animal companions very highly. Studies repeatedly have shown that the vast majority of people consider their companion animals to be "family members" (Friedmann et al., 1984, Hirschman, 1994) and are very attached to their animal companions (Ory & Goldberg, 1984). Frank (2001) found that most dog owners stated they would not trade their companion animal even if offered sums of money of a million dollars or more and promised that the animal would be well cared for. Since these animals have a high value to many humans, their welfare is of significant human concern.

In addition, humans have a certain responsibility for the welfare of companion animals. Dogs, and cats to a lesser extent, have been bred for thousands of years to serve our needs. They have therefore ceased being truly "wild" animals and instead have become dependent on humans for survival. As the creators of a species dependent on humans, we have a certain responsibility for that specie's welfare. Humans also have a responsibility for addressing dog overpopulation since they are, in a sense, the perpetuators of the problem. Pet store suppliers, commercial breeders, and private owners (or "backyard breeders") intentionally produce millions of animals every year to meet public demand. Millions of consumers initially decide to purchase or adopt a dog, only to later abandon that animal because it is inconvenient or no longer suits their needs.

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Millions more choose not to spay or neuter their dog. Therefore, it is human actions and inaction that perpetuate dog overpopulation and creates the need for the human-made "solution" of euthanasia.

Millions of dogs and cats are euthanized every year in United States shelters. Mackie (1992) estimates 7 to 15 million animals are euthanized, Thornton (1991) estimates 16 million, and Carter (1990) estimates 13 to 17 million. Arkow (1994) extrapolated data from nine states to come up with a national estimate of 5.7 million animals euthanized every year. Of the animals entering shelters, the majority are euthanized rather than adopted or reclaimed by their owners. Arkow also concluded that the rate of animals sheltered is lower than that found in studies from the 1980's which report rates in the high double digits.

A more recent estimate of euthanasia of companion animals is 4.2 million dogs and cats euthanized a year or 14.8 animals per 1,000 Americans (Animal People, 2003). The annual survey uses rolling-three year data from various regions through 2002 and is based on jurisdictions that include about 30% of the U.S. population. The death rate continues a downward trend found in annual surveys by Animal People and is lower than that found by Arkow in 1994 and considerably lower than that found in prior decades.

Rowan (1992) has also reported that the number of animals being euthanized is significantly down from 13.5 million to between 5 and 6 million animals. Looking just at New York City data from the late 1800's on, Zawistowski, et al. (1998) indicate a peak in euthanasia rate per person at around the time of the depression, followed by a steep decline to about a tenth of the peak rate in the 1990's. The authors cite this as evidence of a general decline in euthanasia rates both per person and per animal sheltered. This

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conclusion is consistent with other studies, though the fact remains that millions of companion animals are still put to death in the U.S. each year.

These same authors also examined survey data on shelters nationwide. They identified 4,700 shelters in the United States which each take in 100 or more animals a year. For the 22% of shelters responding in the latest survey (1995), about 45% of dogs came from animal control officers, 27% came from guardian relinquishment, and the remainder came from other or unknown sources. Approximately 26% of dogs were adopted, 16% were reclaimed by guardians, 55% were euthanized, and the remainder had unknown or other dispositions.

Focusing specifically on dog overpopulation there are multiple costs to human society. According to Rowan (1992) shelters spend approximately $1 billion every year to deal with unwanted companion animals. Baetz (1992), estimates that $500 million is paid each year for animal control by United States cities and counties. Other costs include dog bites which result in the death of 20 Americans and 585,000 injuries a year (Pediatrics, 1994). According to Beck, Loring, & Lockwood (1975) the reported bite rate in urban areas from all dogs (strays and owned) is 0.45%. However, according to Jones & Beck (1984), a high percentage of animal bites go unreported to authorities. There are other unexpected costs. Carding (1969) found that 6 percent of all automobile accidents and 1.2% of accidents involving death or injury to humans involved dogs.

Beyond these physical costs there are the psychological costs suffered by humans sympathetic to the plight of animals. According to Jasper & Nelkin (1992), 20% of Americans have contributed money to an animal protection organization, and 10-15

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million Americans belong to at least one animal welfare group. Congress also receives more letters about animal welfare than any other topic (Fox, 1990).

But if animals are assumed to have interests independent of any human sympathy, the greatest cost is the impact on the animals themselves. This is a somewhat controversial assumption, but a growing number of philosophers and scientists are positing its validity including Singer (1975) and Regan (1986).

The rise of the "no-kill" movement

Much progress was made in reducing euthanasia rates in the 1970's and 1980's, with increased spay/neuter rates cited as at least one cause for the improvement (Rush, 1985, Arkow 1985). However, although imprecise and incomplete data makes the exact euthanasia trend over time difficult to determine, at some point the euthanasia rate appears to have leveled off.

Recently there has been a growing sentiment that allowing millions of animals to die every year is unacceptable and renewed efforts have been made to reduce euthanasia rates. In the 1990's, this resulted in the "no-kill" movement, which is committed to eliminating the practice of euthanizing healthy and treatable animals altogether. Shelters with a policy of not killing animals have existed for a number of years, mostly as smaller private organizations that do not have municipal contracts and therefore have the option of limiting intake to maintain their policy. However, the "no-kill" movement put a new emphasis on eliminating euthanasia as a goal not just for individual shelters, but for

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communities as a whole. In the last decade, large, high profile shelters such as the San Francisco SPCA have switched to a no-kill policy. More recently, even some animal control agencies such as Maricopa County, Arizona have started adopting no-kill type goals.

The "no-kill" concept has been the subject of much controversy. In part this controversy has been generated by misunderstanding. On the one hand, some no-kill shelter personnel and lay people sympathetic to animals have been too quick to blame animal control agencies and shelters with public contracts for a steady stream of euthanized animals. Limited intake shelters have sometimes also used their no-kill policy as a fundraising tool, implying they are taking the higher moral ground by not killing animals. In reality, many no-kill shelters have the option of limiting intake[1] while animal control departments and shelters with municipal contracts have few options to limit intake[2]. As long as the incoming flow of cats and dogs exceeds the number redeemed or adopted, from the perspective of many traditional shelter managers, their only humane option is to kill the excess. However, this is a matter of perspective rather than reality

Brestrup (1997), makes a strong case that shelters should not be committed to take in all excess animals from their community if it means killing healthy animals. By killing the excess, Brestrup argues, shelters send a strong message that pets are disposable even while they try in vain to convince the public that the opposite is true. By killing unwanted animals, shelters are in effect hiding people from the consequences of their irresponsibility. Quietly and efficiently killing animals enables the continuation of the problem. If shelters refused to kill, on the other hand, Brestrup argues that the public

[1] Some no-kill organizations do not have that option, such as the San Francisco SPCA.

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would be confronted with the moral outcomes of its actions and would take other means of preventing overpopulation (such as spay/neuter) more seriously.

According to Brestrup, traditional animal shelters have been co-opted. While seeking to alleviate the suffering of animals, these organizations with their open door policy and pride in not turning any animal away actually help perpetuate the continued disposability and commodification of pets. It is quite easy to drop off an animal at most traditional shelters, reinforcing the view that animals can be disposed of on a whim. Perversely, adopting an animal is typically more difficult.

Brestrup also brings out some other important points. In other helping fields, such as social work, the primary responsibility is to the existing client. It would be unacceptable in those fields to not give adequate care to existing clients simply because there are so many others in need of help. The same should be true in animal welfare work. Brestrup also argues against the "fates worse than death" implication on which the traditional shelter view relies. In killing healthy animals, traditional shelters assume that the fate of these animals would be worse if it were not brought in to the shelter and "euthanized". Brestrup argues that this is not necessarily the case.

An important distinction needs to be made between shelter policy and community goals. Animal control and traditional shelter personnel have often confused having a no-kill shelter policy with the general no-kill movement and have criticized "no-kill" as simply letting somebody else deal with excess animals. But in reality, the heart of the no-kill movement is not about individual shelter policy nor about blaming traditional shelters for euthanasia. The no-kill movement is about goals for entire communities and an

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[2] Except by controlling intake indirectly such as through spay/neuter programs, or by changing animal control policy (such as feral cat intake policy) or the amount of effort spent taking in stray animals.

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unwillingness to accept killing of homeless animals at any level[3]. While many traditional shelters and animal control agencies have always been committed to reducing euthanasia levels, others have accepted the killing as inevitable and have grown complacent. The no-kill philosophy is committed to continuous improvement in euthanasia rates until it is eliminated altogether for animals that could be adopted.

With these distinctions in mind, there is little that organizations in the no-kill movement and traditional shelters that are committed to reducing euthanasia have to disagree about. Nevertheless, misunderstandings persist and many no-kill organizations have backed away from the "no-kill" terminology while maintaining their commitment to their general goals.

Recently, great progress has been made in some communities towards improving euthanasia rates. Some communities have done this in partnership with Maddie's Fund, a relatively new organization that funds programs and collaborative efforts to reduce dog and cat euthanasia. Maddie's Fund is an organization of unprecedented resources, financially larger than any other organization in the history of animal welfare. Some communities such as Utah and Lodi, California have made important strides in reducing euthanasia in partnership with Maddie's Fund. Other communities are making important progress independent of Maddie's Fund such as New Hampshire, Tompkins County in New York State, Richmond Virginia, and San Francisco[4]. The results presented here will highlight the progress that is being made in general, but will primarily focus on the

[3] It should be noted that some animals may always have to be euthanized due to aggression or untreatable illness. The leading organizations in the no-kill movement acknowledge and accept this. However, the killing of animals for these reasons is distinguishable from the killing of healthy or treatable animals simply for lack of a home. For example, Maddie's Fund makes a category in their funded projects for tracking "non-rehabilitatable" animals.

[4] It is important to note that the organizations behind these various community efforts do not all necessarily associate themselves with the "no-kill" movement. Maricopa County is another program that made great progress towards

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results of Maddie's Fund programs. These programs have primarily focused on improving adoption and spay/neuter rates.

Results

The results shown here are for Maddie's Fund programs in Lodi, California, the state of Utah, and Dane County, Wisconsin. The first two programs involved both adoption and spay/neuter efforts and include two years of program data in addition to a baseline year. Dane County was a pilot, experimental program that only focused on feral cat spay/neuter and has 18 months of data. Unless otherwise noted, Lodi and Utah data is for cats and dogs while Dane County data is for cats only.

Euthanasia

As shown in Figures 1, 2, and 3, shelter euthanasia declined in all three programs. This occurred despite rapid population growth in the study regions, which probably would have led to a euthanasia increase if no new programs had been in place. Utah in particular has been experiencing extremely fast growth, with the population jumping 31% between the 1990 and 2000 census. Lodi had a particularly strong decline with total euthanasia being cut almost in half over the span of just two years.

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reducing euthanasia before getting a Maddie's Fund grant. The county is currently working in partnership with Maddie's Fund to make further progress.

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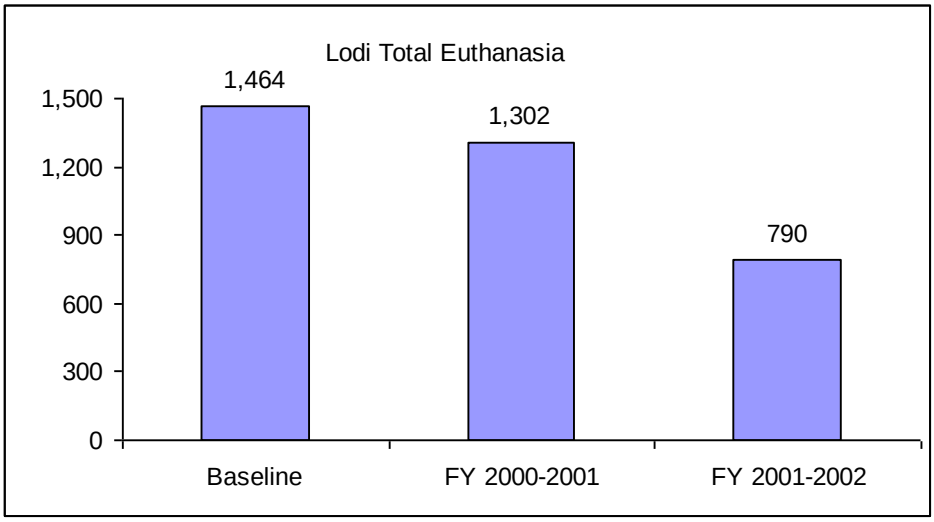

Figure 1

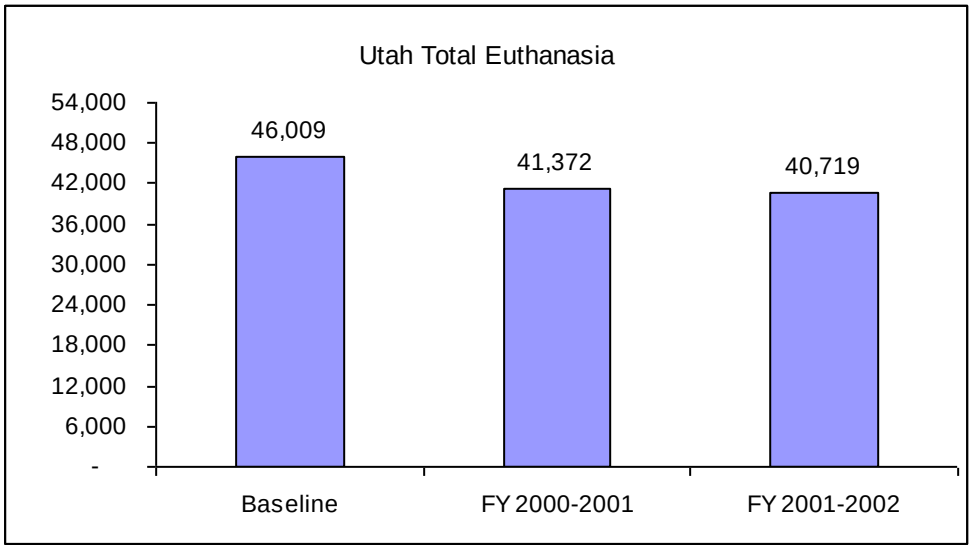

Figure 2

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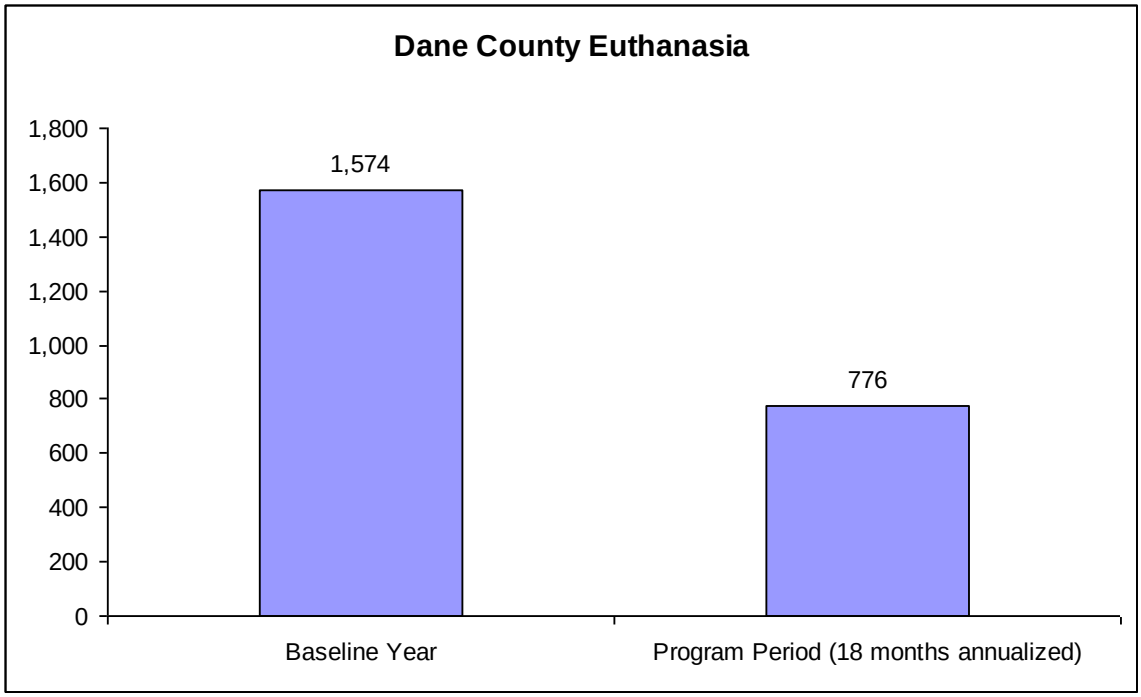

Figure 3

It should be noted that the No-Kill movement acknowledges that there are some animals who we may simply not be able to save. Maddie's Fund in particular splits animals into adoptable, treatable, and non-rehabilitatable categories. Although the ultimate goal is to save every possible animal, in defining program goals most Maddie's Fund programs place particular focus on adoptable animal euthanasia as step one before moving on to treatable animals. Both Lodi and Utah experienced declines in adoptable animal euthanasia as well as total euthanasia (see Figure 4). Similar data for Dane county broken down by subcategory of euthanasia is not available for the baseline period.

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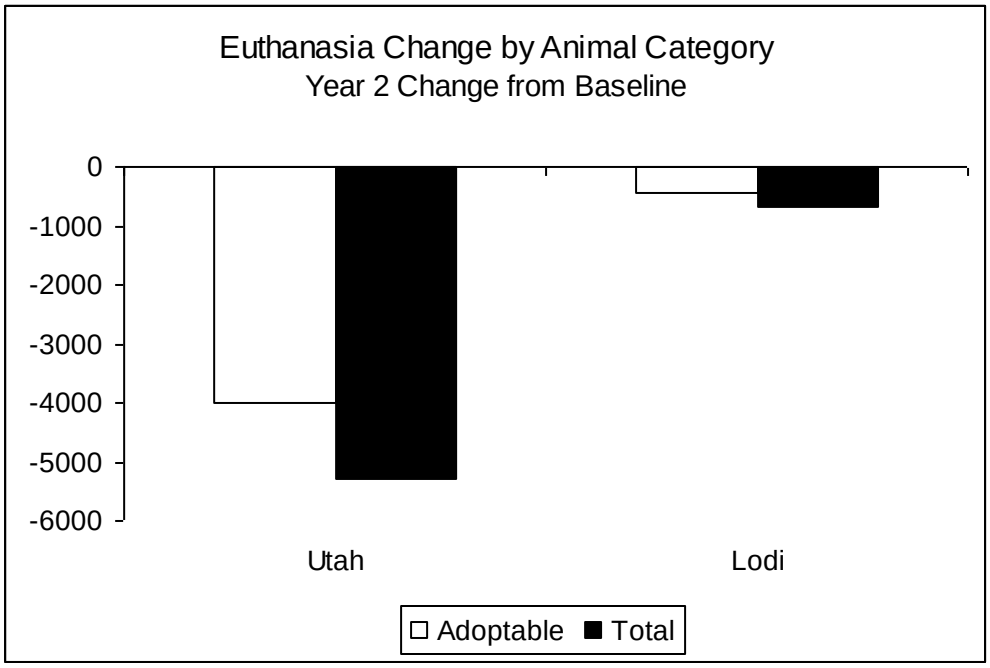

Figure 4

Adoptions

As shown in Figure 5, adoptions increased in all three program areas. The increases in Lodi and Utah were due to focused campaigns with multiple adoption efforts and events. The increase in Dane County, though smaller than in the other two regions, may appear surprising because the program in that region was purely a feral cat spay/neuter effort. However, a change in the nature on the euthanasia policy for feral cats was at least in part responsible for the increase in adoptions and the drop in euthanasia. Specifically, unadoptable feral cats that under the prior policy would have been euthanized were placed in barns after being spayed or neutered. In addition, some studies of feral cat programs have reported that colony size declined early in the program primarily through adoptions of cats and kittens rather than through reduced birth rates (Centonze & Levy,

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2002). It is possible that the additional cats and kittens made available to the public through the presence of the feral cat program led to higher adoption rates as well.

It is noteworthy that most of the improvements in both Lodi and Utah can be attributed to adoptions rather than spay/neuter procedures. If it is assumed that the adopted animals would otherwise have to be euthanized[5], over 100% of the euthanasia improvement in Utah and 78% of the improvement in Lodi can be traced to adoption gains.

The results here highlight the importance of adoption programs. In addition, animal control managers have sometimes expressed concern that no-kill adoption programs might come at the expense of some of their own adoptions. However, the results here suggest otherwise. In the Lodi program, animal control experienced adoption gains almost as large as the adoption increase for no-kill organizations. In Utah, most adoption gains were from no-kill organizations, but animal control adoptions went up at the same time (see Figure 6). These gains in adoptions at animal control occurred despite a large rise in the number of animals transferred from animal control to no-kill organizations. Thus, the fear sometimes expressed in animal control circles (outside of these programs) that no-kill organizations take away the most adoptable animals leaving animal control with a harder time adopting their own animals is not supported by these programs.

[5] Logically, this would seem to be the case, but adoption can also have indirect effects such as changing intake in other periods.

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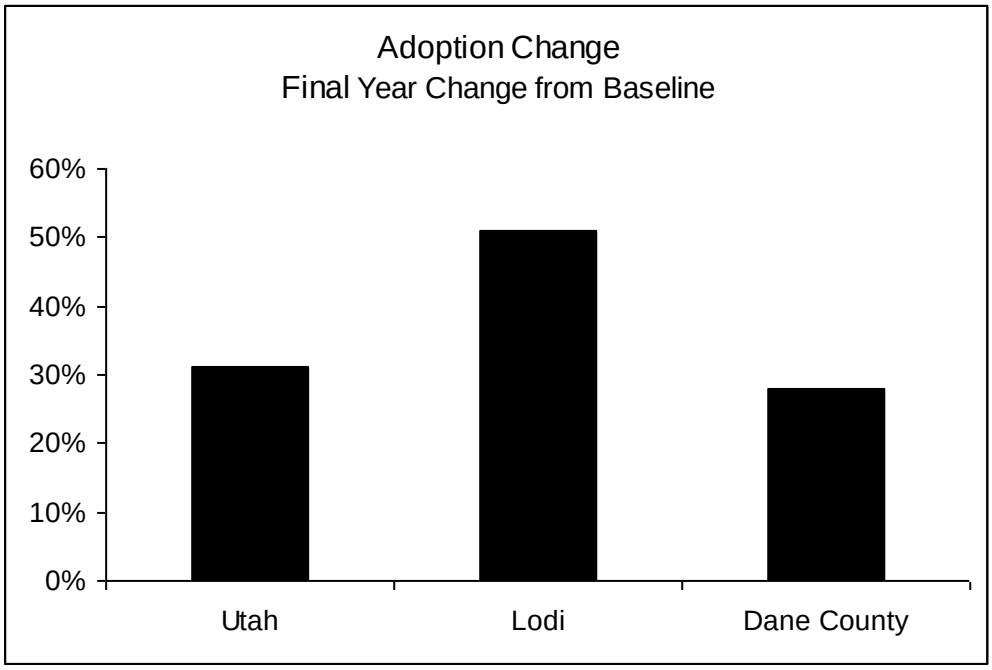

Figure 5

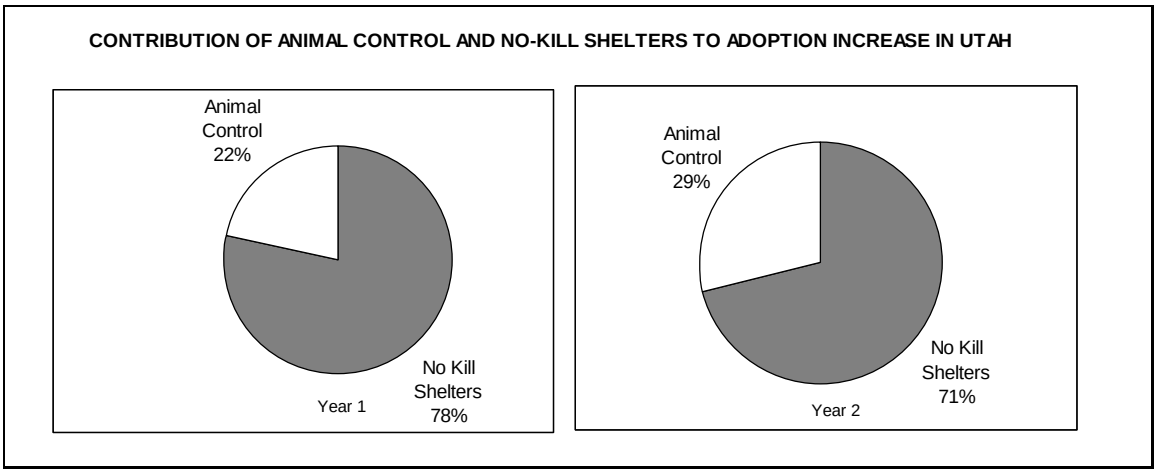

Figure 6

Results of Spay-Neuter Efforts

All three programs were quite successful at increasing the number of spay/neuter procedures performed. Lodi had an increase in both regular and discount procedures in

the first program year, followed by decreases in both types of procedures in Year 2 compared to Year 1 (see Figure 7). Although non-discount procedures were down slightly in Year 2 compared to the baseline, this decline is not significant given the variance in the monthly data, and when the two years are combined, regular procedures are up on average. Therefore, there is no evidence that the subsidized program caused people who would have spay/neutered their animal anyway ("bargain hunters") to exploit the program by taking advantage of the reduced rate.

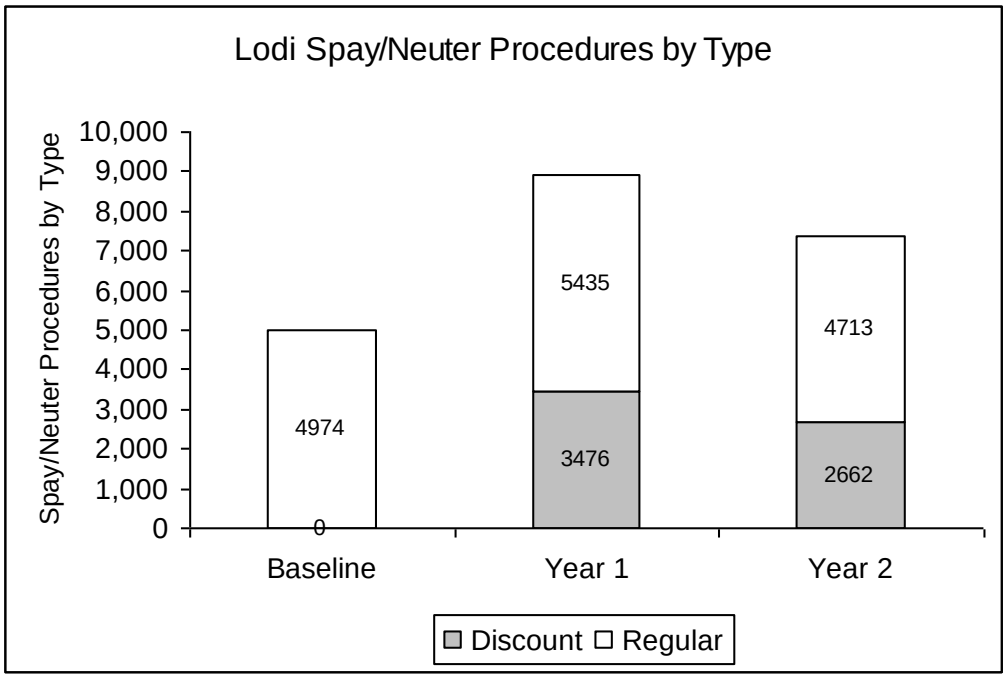

Figure 7

In terms of non-discount procedures Utah shows the reverse trend of Lodi, with regular procedures going down in the first year and then up in the second. In this case, the improvement in the second year is due to a program change that cut down on bargain hunters, so Year 2 is a better gauge of long-term program trends. Once again, the evidence suggests that subsidized spay/neuter programs do not have to reduce the number

of regular surgeries. As with Lodi, regular and discount procedures combined went up in both program years compared to the baseline period.

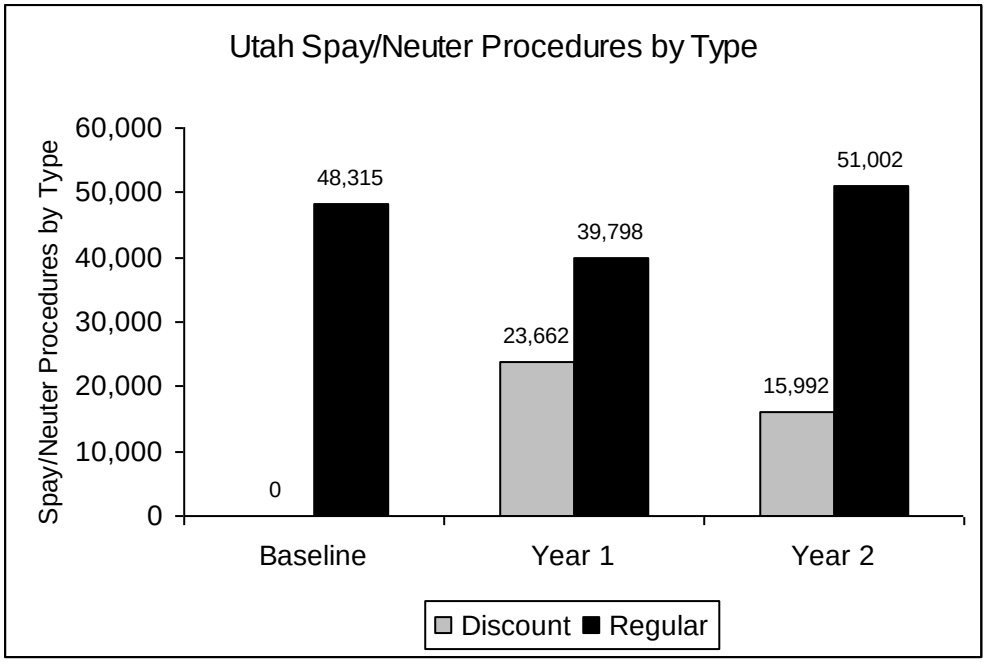

Figure 8

Regular procedure data is not available for Dane County, but the spay/neuter program was a success with over 2,000 feral cat procedures performed in an 18 month period.

Intake

Intake declined in Dane County but went up in Utah and Lodi (see Figure 9). Intake from the public in Utah is only directly available for animal control organizations since no-kill intake includes some animals already counted as intake for animal control. Therefore, intake change here is estimated based on transferred animals.

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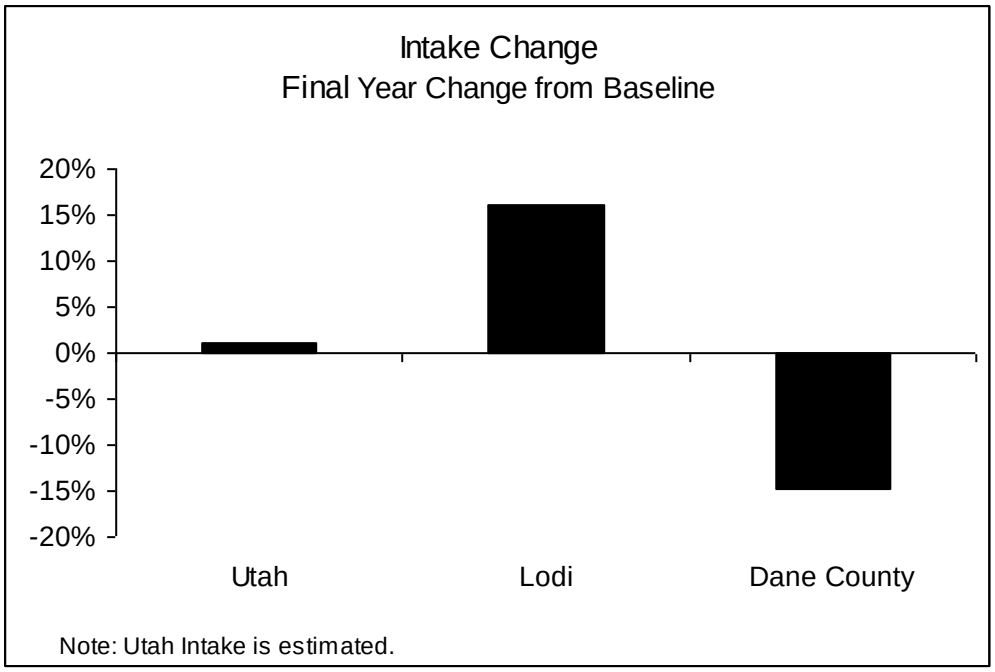

Figure 9

Data from both Utah and Lodi suggest that the entire increase in intake was from animals coming from the "counter" (i.e. individuals turning in animals at the shelter) rather than from the "field" (i.e. animal control officers finding strays or responding to calls).

The intake trend by region (at the county level), year, and animal species was analyzed statistically. A variety of models and variables were used in this analysis. In general, higher growth in adoption rates was associated with slightly higher growth in intake. It is important to note that this does not necessarily imply that increases in adoption caused increases in intake. Interestingly, no consistent trend was found between intake and spay/neuter programs. In other words, regions that had greater increases in spay/neuter rates did not necessarily show a better intake trend. Again, this lack of a statistical relationship should not be interpreted too strongly. It most likely is due to the presence of confounding variables, the length of time it takes spay/neuter programs to reach full effect, or limitations in the data (e.g. lack of full knowledge regarding

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where mobile spay/neuter procedures were performed or the activities of veterinarians who did not participate in the program).

Discussion of Results

In general, all three programs analyzed here showed strong success at reducing euthanasia. Success was also seen in raising adoptions and increasing spay/neuter rates.

The one surprise was the lack of a drop in intake for Lodi and Utah despite the success of the spay/neuter program. Although it is possible for higher adoptions to lead to higher intake through "returns", there are a number of other explanations, such as both adoption and intake being associated with a third factor. Given other findings regarding intake trends, it may be more reasonable to conclude that intake and adoption both increased in the same regions for reasons that are linked (e.g. rising numbers of animals in the region, increased shelter awareness, increased comfort with the care received by animals delivered to the shelter, increased animal control activity after adoption rises).

The fact that the rise is from people coming to the counter suggests that the rise in intake may be due to people being more willing to turn their animals in to the shelter due to publicity about the program. In other words, as people become aware of a "no-kill" goal and a lower kill rate at a shelter, they are more comfortable relinquishing their animal and are therefore more likely to bring their animal to the shelter. This is consistent with prior evidence that intake rises after a community becomes no-kill or publicly moves to a reduced killing rate because more people from the public at large are willing to turn their animal in to the no-kill or lower-kill shelter. This has occurred in San Francisco and Las Vegas among other places (Animal People, 1996).

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In addition, as no-kill organizations increase adoption rates, they are able to take in more animals from the public. Since there are some people who will only surrender their animal to a no-kill organization, this also leads to increased intake. This hypothesis is also consistent with the positive relationship found between adoption and intake.

The reduction in intake from the field suggests that there may be less stray animals in the region due to spay/neuter programs. However, these gains are partially being masked due to the public's increased willingness to take their animal to a shelter. If some of the increased counter intake would otherwise have gone into the stray population and died before being taken to a shelter, then this leads to a statistically deceptive result. The stray population is an uncounted population. The reduction in the suffering and death of this uncounted population is an important impact, but does not show up in statistics. In fact, this benefit to the stray population actually makes intake look worse. Because of the deceptive effects of this hidden population, the impact of the program on intake and total deaths may have been much stronger than the numbers show.

When considering the intake numbers it is important to note that these were regions with rapid population growth. In addition, other research suggests that spay/neuter programs may take more than a decade to show most of their impact on population size and euthanasia (Frank, 2001, 2003). Therefore, most of the benefits of these spay/neuter programs may come in the future.

Regardless of the intake question, the impact of all three programs were powerful where it ultimately counted: in reducing euthanasia rates. The results of these programs lend credibility to the No-Kill movement and the concept of a moving towards a "No-Kill nation". Although critics of the movement often label it as a public relations or fundraising strategy that simply shifts the burden of intake to traditional shelters, the

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evidence suggests that the efforts of this movement can make a real difference in improving the welfare of companion animals community-wide.

Aside from individual programs, probably the most important impact of this movement has been to end complacency. By starting from a moral position that it is never acceptable to kill an animal that can be adopted or rehabilitated, the movement pushes society to seek out creative solutions to overpopulation.

The results here suggest the importance of both promoting adoption and spay/neuter for other programs around the country. It is likely that publicity and increased community awareness were as important to the success of these programs as any spay/neuter discounts given or the convenience of specific adoption events.

While much has been made of the conflict between traditional animal welfarists and the no-kill movement, all of the programs discussed here involved coalitions of traditional shelters, no-kill organizations, and veterinarians. The results here emphasize the importance of putting aside differences and building coalitions. As long as all parties are committed to doing all they can to address companion animal overpopulation, cooperation can prevail over conflict.

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Model Components

P1 Pet Owners (Consumers)

This population is the end-market for companion animals. Change in the value of this stock at any given time is calculated as: $\Delta P1 = B1+S3+S4+S5-D1-A2-A3$

P2 Shelters (and rescuers)

Change in the number of animals in this stock is calculated as: $\Delta P2=A2+T32-S2-D2$

P3 Strays/Feral Population

The change in this population is defined as: $\Delta P3 = B3+A3-S3-T32$

P4 Breeders (Private)

This population includes animals owned by professional breeders. Amateur breeder animals should only be included in this population if the primary purpose for owning that particular animal is for breeding/selling purposes. The change is calculated as:

$\Delta P4=B4-S4-D4$

P5 Pet Shops/Farms

This population consists of animals owned by pet shops, and companies that supply animals to pet shops. The change is calculated as:

$\Delta P5=B5-S5-D5$

B1 Births-pet owners

~~Births in the general population are assumed to be a function of how many pets there are and what percentage of those pets are neutered. Specifically, it is estimated that:~~

~~B1 = P1 * (1-SN1) * BR1.~~

~~Where SN1 is the percentage of the general companion animal population that is spayed/neutered, and BR1 is a constant that represents the birth rate for the general population.~~

~~B3 Births-feral population~~

~~The number of births in the feral population is assumed to be:~~

~~B2 = P3 * (1-SN3) * BR3~~

~~Where SN3 is the percentage of the general companion animal population that is spayed/neutered, and BR3 is a constant that represents the birth rate for the general population.~~

~~B4 Births-breeders~~

~~Breeders are assumed to control the breeding of their animals to just meet the demand for their animals and to replace deaths in their population. Therefore it is assumed:~~

~~B4=S4+D4~~

~~B5 Births-pet farms~~

~~Pet farms (or "puppy mills") are assumed to control the breeding of their animals to just meet the demand for their animals and to replace deaths in their population. Therefore it is assumed:~~

~~B5=S5+D5~~

~~D1 Deaths-pet owners~~

~~Deaths in the P1 population are assumed to be: D1=DR * P1~~

~~Where DR, the death rate, is calculated as 1/average lifespan.~~

~~D2 Deaths-shelters (euthanized)~~

~~Deaths in shelters are assumed to be dictated by necessity, when animals in the population exceeds available space. Therefore, the death rate is assumed to be:~~

~~D2=A2+T32-S2-(Ssp-P2) Where Ssp represents shelter space. It should be noted that as long as at least some shelters euthanize animals, the presence of no-kill shelters does not alter the equation.~~

~~D3 Deaths-strays/feral population~~

~~If the number of strays is close to the environment's carrying capacity, the death rate among strays would tend to increase as the number of animals approached the environment's carrying capacity. However, due to animal control efforts and deaths from sources such as car accidents, the number of dogs in the United States is generally far below the environment's carrying capacity. Therefore, the death rate can simply estimated a 1/lifespan for feral animals.~~

~~D3= 1/(feral lifespan)~~

~~D4 Deaths-Breeders and D5 Deaths-Pet Shops~~

~~These variables are included for completeness. Generally, since breeders and Pet Shops/Farms will sell all except their reproductive population very early in the animal's life cycle, the death rate in these two populations is assumed to be negligible (0). Changing these parameters is not expected to significantly affect research results. However, the sensitivity of the model to changing these parameters will be tested.~~

S2 Adopted from shelters/rescuers, S4 Bought from breeders, and S5 Bought from pet shops

All three sources of purchased animals are assumed to be substitutes that follow the general principals of demand in economics. All three goods are assumed to be substitutes so the demand for any of the goods is a function of all three prices (Pr2, Pr4, Pr5). Demand is also a function of preferences. Demand for purchased animals will also be affected by the number of strays adopted (S3) which is another substitute. Income and population growth will also affect demand, but these factors will be assumed to be stable to simplify this analysis. Therefore, demand for any of the three pet "products": (S2, S4 and S5) = f(Pr2,Pr4,Pr5,preferences,S3)

Starting values for the demand levels will be estimated based on existing data on the number of pets from each source currently in the general population. Demand for new pets is assumed to initially equal the amount that it will take to maintain the current pet ownership rate. Based on the results of the survey, the level of demand will be altered to analyze the impact of changing prices or enacting other policy options.

S3 Adopted strays

Unlike other sources of animals, adoption of strays is assumed to be a function of opportunity and capacity. Certain people will adopt strays if they see the animal, bond with it, or sympathize with its plight. Therefore, the number of adoptions will go up linearly with the number of strays in the population since this improves the chance of a

beneficial interaction. Of course, if the stray population becomes high enough, there will be a saturation effect that will stop the relationship from being linear. However, the stray population in the United States is probably far from this point.

It is also assumed that the number of adoptions will be affected by the pet ownership status of the human population. The more animals people own already, the less willing they will be to take on an additional stray. This relationship is assumed to be linear, but less than one-to-one. In other words, one more animal in the "owned" population (P1) will reduce the number of pets adopted, but the reduction will be less than one for one. Or to formalize:

$A3=\alpha 3 * P3 - \beta 3 * P1$ (where $0 < \alpha 3, \beta 3 < 1$)

Different values for these parameters ($\alpha 3, \beta 3$) will be tested since the actual values cannot be easily determined.

A2 Animals abandoned to shelters

Animals abandoned to shelters are assumed to be a function of both the population size (P1) and the birth rate (B1). People abandon animals for a variety of reasons. If it is generally assumed that there is a fixed abandonment rate, then the number of additional abandonments is a linear function of the number of pets in the population. However, pets are also specifically abandoned to a shelter many times because of the birth of a new litter. Therefore, the abandonment rate is also a linear function of the number of births. In addition, shelters that euthanize animals will take as many pets as needed. However, a certain segment of the population may only abandon an animal to no-kill shelters, who

generally stop taking animals when they reach capacity. Therefore, the number of animals abandoned is also a function of the space available in no-kill shelters. Or:

$A2 = \alpha 2 * P1 + \beta 2 * B1 + \chi 2 * Ssp * NK$

(Where NK is the percentage of shelters that are no-kill and $0 < \alpha 2, \beta 2, \chi 2 < 1$)

Actual values for the first two parameters can be estimated from existing shelter data. These two parameters are also assumed to be affected by treatments that change consumer behavior. Different values for the final parameter will be tested, though it is expected to be low (closer to zero than one).

A3 Abandoned/lost to wild population

There are two distinct channels for animals that end up in the stray population. The first is animals that are intentionally abandoned by people. Certain people instead of bringing an animal to a shelter prefer to release the animal to the wild. The dynamics of this channel will be similar to A2 above.

However, there are a certain number of animals that are lost and that fail to be recovered, even though the owner wants to retain the animal. The chance that an animal will end up as a stray through this channel is a function of the population size and a parameter that reflects consumer behavior or carelessness (ε). Together then:

$A3 = (\chi 3 * P1 + \delta 3 * B1) + (\varepsilon 3 * P1)$

(Where $0 < \chi 2, \delta 2, \varepsilon 2 < 1$)

There is enough data available to roughly estimate abandonment rates to the wild relative to the number of animals turned in to shelters. These parameters are also assumed to be subject to change if preference/behavior of consumers can be affected by treatments.

T11 Transfers between consumers

This transfer represents exchanges of animals between consumers. It is shown for completeness of the model. Since it is a transfer internal to one population, it does not affect the model results and therefore it will be assumed to take a value of zero for simplicity.

T32 Strays put in shelters

This transfer represents stray animals brought in to shelters by animal control officer or private citizens. It is a linear function of the stray population size and also a function of the level of animal control efforts (AC). Specifically:

T32 = P3 * AC / (1 + AC) (Where 0<AC)

The way this equation is structured, if AC = 0, there is no animal control activity, if AC = 1 then animal control officers turn in the same number of stray animals as private citizens, and if AC > 1 (which is probably the case in most scenarios), most strays turned in come from animal control officers. This parameter is one form of treatment, so the effect of varying this parameter will be tested in any event.

Note regarding goals...one of the advantages of this type of model....

7. RESULTS

7.1 Results of Survey

7.1.2 Inputs to model

One purpose of the survey data was to get information needed to calibrate the mathematical model used in this dissertation. The size of several populations and variables defining the flow between populations are estimated based on the survey results as described in the Model Methodology section.

One key population is P1, the number of owned companion animals in Rensselaer and Albany Counties. The most straightforward way to estimate this (and in fact the method originally planned) would be to take the number of registered companion animals from state data for the region and multiply by a factor to account for the percentage of animals that are not registered. There are 27,989 registered dogs in the region, and if the survey results are taken at face value, 72% of dog owners are registered. This would imply that P1 = 27,989/0.72= 38,874. However, as discussed in the results section, the dog registration rate quite likely is overstated which would mean that P1 would be higher than 38,874.

Another simple method for estimating P1 is to use the random survey result indicating that 70% of randomly selected households responding to the survey have registered a dog and assume this statistic is representative of the total population. If we assume from the census that there are 173,436 households and from the random population survey that the average regional dog owner has 1.12 dogs, this would indicate that P1 = 173,436 * 0.70 * 1.12 = 135,974. However, dog owners probably responded at a higher rate than non-dog owners so this would mean P1 is less than 135,974.

This leaves us with a population range between 38,874 and 135,974 but we can reduce this range. As discussed in the survey methodology section, we can probably assume that

registered dog owners responded to the random survey at about a 40% rate, similar to the survey mailed directly to registered dog owners. Since it is estimated that 10% of households are registered dog owners and since the random mailing got a 27% response rate, we can assume that of 27 respondents, about four were registered dog owners. We can also estimate the range of the response rate of non-registered dog owners. On the high end, it is possible non-registered dog owners respond as well as registered dog owners (there is no convincing reason to expect them to respond more often than registered dog owners). On the low end, they may respond at the same rate as non-dog owners. If n = the percentage of households that are non-registered dog owners and r = the response rate of non-dog owners we can set up simultaneous equations for the total random population response rate (27%) and the percentage of respondents who are dog owners (70%):

Case 1 (Non-registered respond at 40%):

$0.4 * (0.1 + n) + r * (1-(0.1+n)) = 0.27$

$0.4 * (0.1 + n)/0.27 = 0.7$

$n = 0.3725$

$r = 0.1536$

Case 2 (Non-registered respond at same rate as non-owners):

$0.4 * (0.1) + r * (.9)) = 0.27$

$(0.4 * 0.1 + r * n) / 0.27 = 0.7$

$n = 0.5830$

~~r = 0.2556~~

~~According to these results, if the above assumptions are correct, between 37.25% and 58.3% of the population are non-registered dog owners. Or put another way, between 14% and 21% of the dog-owning population registers their dog. This implies the dog population is between:~~

~~$P1_{low} = 173,436 * (0.3725 + 0.10) * 1.12 = 91,782$~~

~~$P1_{high} = 173,436 * (0.583 + 0.10) * 1.12 = 113,247$~~

~~Although various sensitivities will be tested in the model, the core model will use the midpoint this range or: $(P1_{low} + P1_{high}) / 2 = 102,515$.~~

~~The surveys were also used to estimate the percentage of the owned dog population that was spayed/neutered. For the random population, 10.7% of owned dogs were not spayed/neutered.~~

~~The birth rate of dogs was also estimated based on the survey results. For all populations, there were 0.0779 litters per dog in the owned population and 0.115 litters per household.~~

~~The survey was also used to estimate how many dogs enter the owned population from each source every year. The distribution of dogs by source for the random and total survey population is shown below.~~

Table 7.1: Source of dogs for random and total population

These results shown above are reported after consolidating sources reported on the survey into the categories used in the model. Codes in parentheses are the flow labels used in the model.

Other significant results from the survey that will be used in the model are the average age of the animals (5.1 years for both the random and total populations). Information on lost animals for the model was also obtained from the survey. There were 0.16 incidents per household for all respondents and 0.09 incidents per household for random respondents where an animal was picked up by animal control. For both random respondents and all respondents, there were 0.05 incidents per household where a dog was lost and never found.

7.2 Results of Simulation Model

7.2.1 Base Model

Most of the information needed for the quantitative ecological-economic companion animal model has already been discussed. However, in addition to the survey results and equations previously mentioned, some shelter data is also needed for this model. In Albany and Rensselaer Counties, a total of five shelters were found. The Mohawk Hudson Humane Society is the official public shelter for the region, contracting with

~~local communities in the two counties to take possession of stray animals picked up by animal control officers in the region. Mohawk Hudson euthanizes excess animals. No-kill operations in the area include the Capital District Humane Association, Animal Lovers, the Companion Animal Placement Program, and Peppertree Rescue. There is an additional group called Whiskers that specializes primarily in rescuing cats. Most of the no-kill groups listed above do not rely on shelter-space to keep their animals, instead usually fostering animals in the homes of volunteers. Based on information from these organizations, there are about 110 dogs being sheltered in the New York State Capital Region at any given time, with all of the above shelters/groups normally filled to capacity. About 40% of these dogs are typically in the public shelter. In addition to the groups listed above, several individual "rescuers" have been found in the region who at least on occasion take in animals they feel are being treated cruelly, are strayed, or are scheduled to be killed at a shelter. These rescuers either place their animals through their network of contacts or advertise in local papers. Unfortunately, the exact size of this network is difficult to determine. Based on preliminary conversations with some rescuers and their personal knowledge of others doing the same work, it is estimated here that the independent rescuers house and place about half the number of dogs as other no-kill groups. This number is only an estimate, however it is felt that if anything this estimate is on the low side. This gives a total number of dogs at shelters and with private rescuers of 141.~~

~~It is estimated that about 5,500 dogs enter all of these regional shelters per year (including no-kill groups and independents). About 80% of this amount is through the Mohawk Hudson Humane Society. About 2600 dogs are placed from these shelters a~~

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year, with approximately 60% coming from the Mohawk Hudson Humane Society. About 1800 dogs going into Mohawk Hudson are strays picked up by animal control officers. And about 20% of the dogs going to Mohawk Hudson are puppies.

Using the inputs described above, a base case model was created. The graph below shows the population over time for the base model.

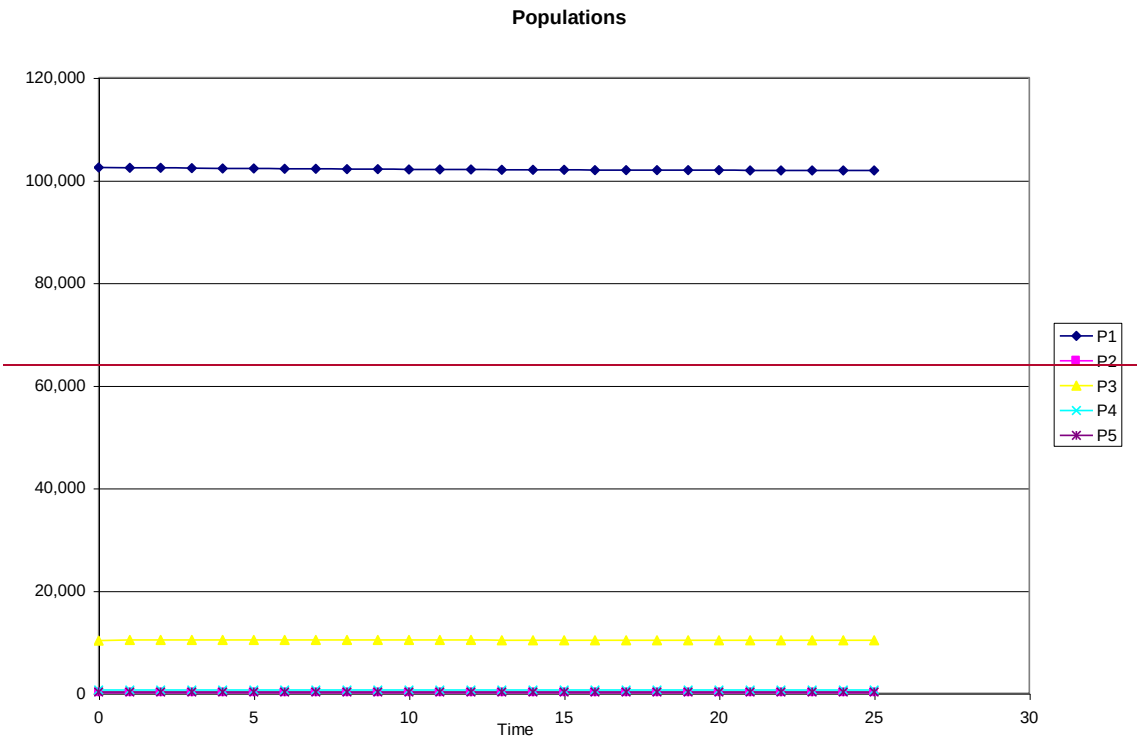

Figure 7.5: Population over time for base model

As shown, the population sizes are stable over time. The graph below shows the flows into and out of P1, the population of "owned" animals for the base model. These flows are also stable in the base model. It should be noted that not only is the population size set to be approximately the estimated size from the survey, but also the flows approximate the levels found in the data. Approximately 5500 dogs go to shelters each year in the model. The size of each supply source (S2-S5) is also based on the survey findings. Fortunately, the estimated shelter adoption rate (S2) from the survey (about

2900) is close to the amount estimated from surveying local shelters (2600). S2 in the model is between these two estimates.

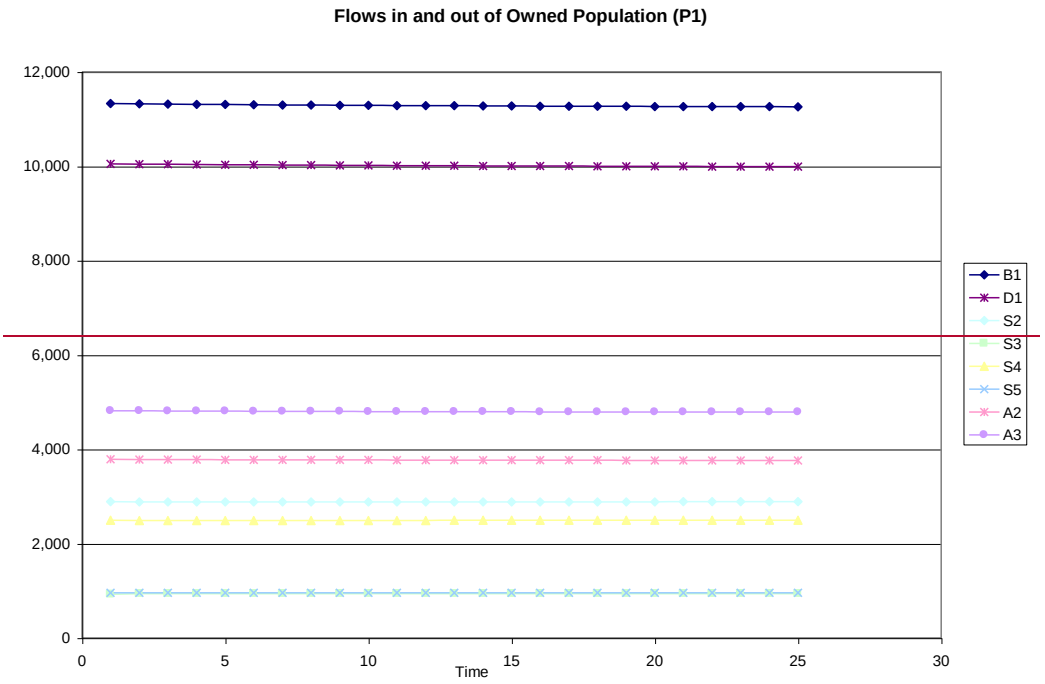

Table 7.6: Flows into and out of owned population (P1) in base model

P3 is the population of stray/abandoned dogs. The graph below shows the flows into and out of this population.

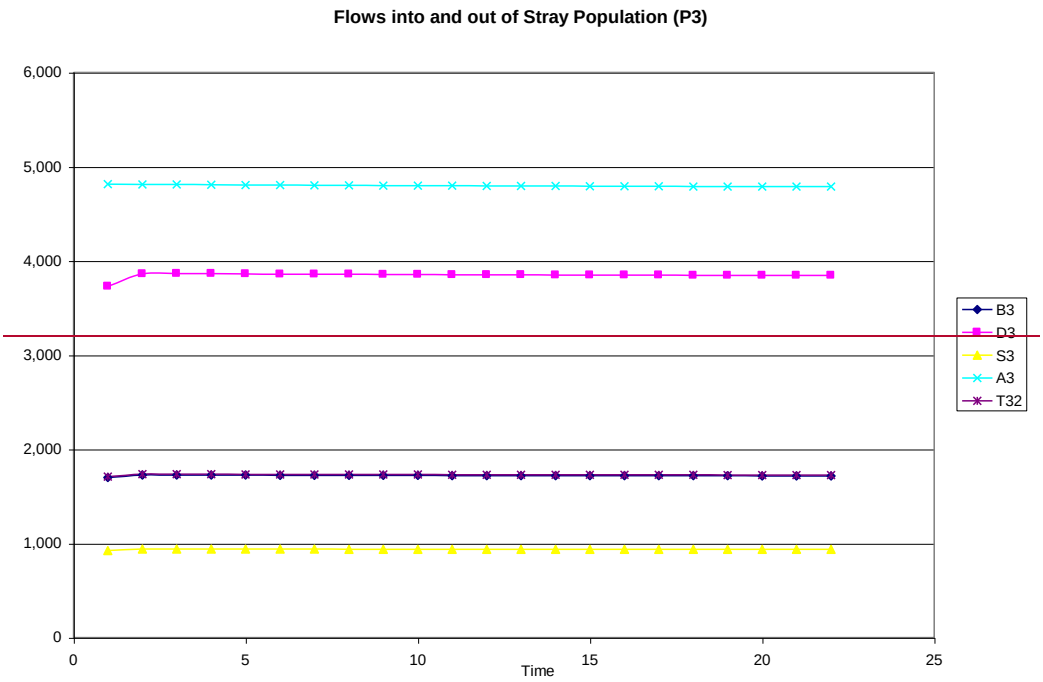

Table 7.7: Flows into and out of stray population (P3) in base model

The final graph below for the base model shows the death rates for the owned (D1), shelter (D2), and wild/stray (D3) populations. As indicated, the model shows a death rate for the region close to 10,000 dogs a year in the owned population. These deaths are presumed to normally occur as a natural consequence of having companion animal dogs in the population. In other words, even if the flow of unwanted companion animal problem were completely eliminated, there would still be around this number of deaths a year. The unnecessary dog deaths caused by an excess of unwanted companion animals is shown by the lines designated as "D2" (deaths at shelters) and "D3" (deaths in the stray population). From one perspective, it could be argued that the problem is not so bad, since most deaths in the regional dog population are not due to unwanted animals. This probably was not the case as recently as a couple decades ago. However, the model also makes it clear (assuming the numbers are consistent with reality) that the number of dog

deaths is increased by as much as 60% due to the flow of unwanted companion animals. This is a substantial death toll among mostly young, healthy animals, and quite possibly an unnecessary one.

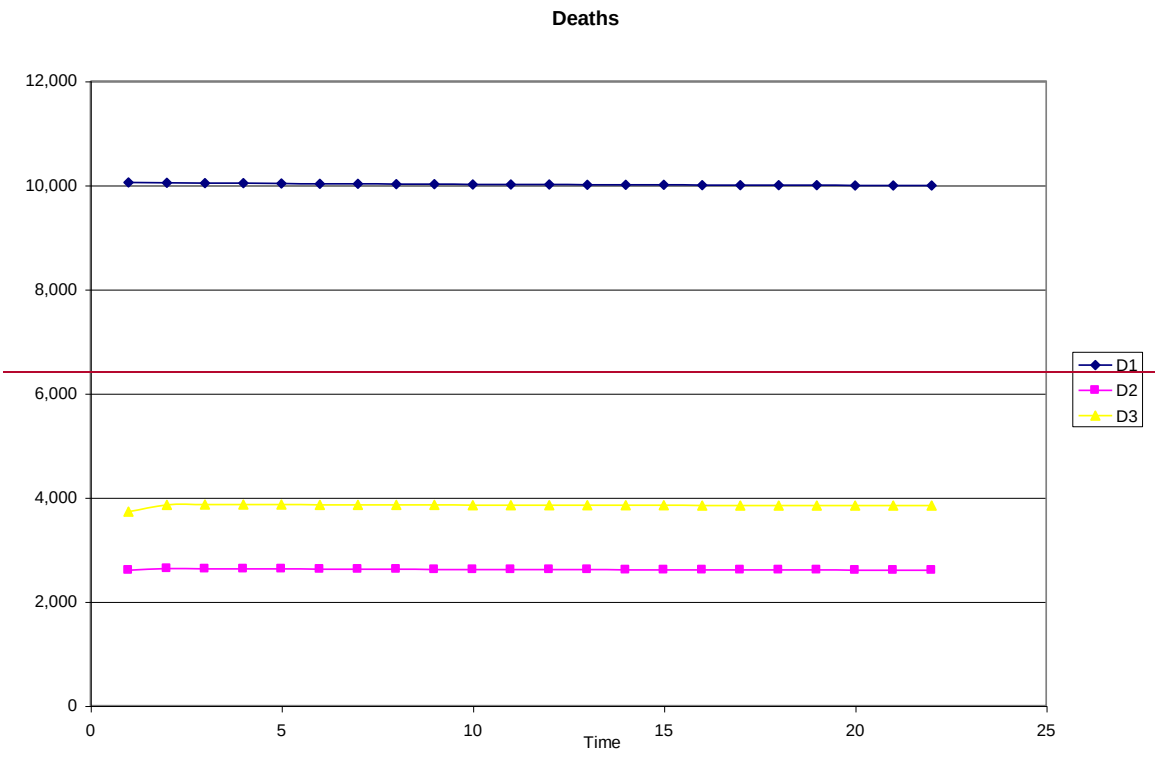

Figure 7.8: Death rates over time in base model

An extensive sensitivity analysis was performed on each parameter in the model. The results of the sensitivity analysis are shown in Appendix E. This appendix contains 38 tables showing all of the welfare measures given above after a change up or down in a given parameter. In every case, the parameter was changed by 10%. For the first ten appendices a chart showing the change in population sizes over time after a factor is increased or decreased is also included. The charts for the remaining tables were not

~~included because they follow patterns very similar to the first ten and do not add any additional useful information.~~

~~The table below summarizes some of the elasticities from Appendix E. It should be noted that the way the welfare measures are defined, any positive elasticity is a welfare improvement, while any negative elasticity is a welfare decline from a positive change in a model parameter. There are several noteworthy observations from the table. First, it should be noted that in general most parameters tend to be inelastic, with only 19 of 209 numbers in the table (or about 9%) greater than 1 in absolute value. Since some of the parameters in the model are particularly difficult to pin down accurately, this is good news since it means that the model is robust to moderate errors in specifying these parameters. In fact, many of the most difficult numbers to pinpoint have to do with the dynamics of the stray population, since this population is hard to collect data on directly. Fortunately, the elasticities for these parameters (such as the birth rate in strays and the dynamics of stray adoption) are generally very low, indicating that an error in the estimate here is unlikely to throw the model off to a significant degree. The most sensitive parameter in the model is the percentage of the owned population (P1) that is spayed/neutered, with the absolute value of the elasticity of this parameter reaching as high as 14.25. In other words, a 1% change in the spay/neuter percentage of the population would result in a 14.25% change in welfare. This is an important finding that will be discussed more in the portion of this section dealing with treatments. The second most elastic parameter is the birth rate in the owned population (B1). Fortunately, although neither of these two parameters are known with perfect accuracy, due to the~~

~~survey results, the accuracy of these two elastic parameters are known with a high degree of certainty relative to some of the other model parameters.~~

	Death 10 year	Death 100 year	Euthanasia 10 year	Life 10 year	Life 100 year	Welfare C 10 year	Welfare C 100 year	Welfare G 10 year	Welfare G 100 year	Welfare H 10 year	Welfare H 100 year
P1	-0.849	-0.179	-1.584	0.693	0.140	-0.738	-0.149	0.693	0.139	0.703	0.142
Shelter Capacity	0.000	0.000	0.000	0.001	0.001	-0.008	-0.007	-0.002	-0.001	-0.001	-0.001
P3	-0.072	-0.008	-0.088	0.005	0.001	-0.007	-0.001	-0.001	0.001	-0.004	0.001
Birth rate in P1	-0.500	-1.707	-1.211	0.438	1.343	-0.608	-1.588	0.402	1.295	0.444	1.351
Percent spay/neutered (P1)	-4.174	-14.249	-10.109	3.656	11.210	-5.075	-13.255	3.356	10.810	3.706	11.277
Birth rate in P3	-0.106	-0.129	-0.127	0.020	0.029	-0.099	-0.109	-0.024	-0.016	0.008	0.016
Percent spay/neutered (P3)	0.214	0.258	0.256	-0.040	-0.058	0.200	0.219	0.049	0.033	-0.017	0.031
~~Death rate in P1~~	~~-0.282~~	~~0.772~~	~~0.735~~	~~-0.420~~	~~-1.113~~	~~0.356~~	~~1.103~~	~~-0.445~~	~~-1.129~~	~~-0.433~~	~~-1.126~~
Death rate in P3	0.001	-0.136	-0.750	0.117	0.173	-0.587	-0.657	-0.087	-0.040	0.142	0.191
Gross adopted demand	0.060	-0.275	0.997	0.133	0.387	-0.113	-0.384	0.141	0.393	0.137	0.392
Breeder supply (S4)	-0.100	-0.390	-0.17	0.115	0.334	-0.097	-0.331	0.122	0.339	0.118	0.339
Pet Store supply (S5)	-0.038	-0.150	-0.065	0.044	0.128	-0.037	-0.127	0.047	0.130	0.045	0.130
Stray adoption population factor (X3)	0.031	-0.016	-0.058	0.012	0.052	0.044	0.001	0.041	0.083	0.019	0.062
Stray adoption P1 factor	-0.006	0.002	0.011	-0.002	-0.009	-0.008	0.000	-0.008	-0.015	-0.004	-0.011
Stray adoption effect on subst. supply	0.005	0.055	-0.046	-0.020	-0.058	0.017	0.058	-0.021	-0.059	-0.021	-0.058
P1 factor affecting # to shelter	-0.063	0.249	-0.906	-0.128	-0.340	-0.047	0.206	-0.135	-0.365	-0.132	-0.364
B1 factor affecting # to shelter	-0.017	0.066	-0.239	-0.033	-0.096	-0.013	0.055	-0.036	-0.098	-0.035	-0.097
P1 factor affecting # to wild	-0.064	0.175	-0.209	-0.061	-0.266	-0.385	-0.156	-0.202	-0.406	-0.078	-0.287
B1 factor affecting # to wild	-0.028	0.076	-0.090	-0.026	-0.116	-0.166	-0.068	-0.087	-0.177	-0.034	-0.125

~~Table 7.20: Elasticities of selected welfare measures~~

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~~Another striking observation from these elasticity figures is that the signs on the elasticity measures change frequently for any given parameter depending on the welfare measure. In fact, there is not a single parameter on the table in which the elasticity results are consistent in sign across all welfare measures. In other words, no parameter change gives unequivocally higher or lower welfare results across all measure. The affect of a parameter change on "welfare" is completely dependent on how welfare is defined. The sensitivity of model results to welfare definitions will be discussed in more detail later in this dissertation.~~

~~Another interesting finding is that sign changes also occur occasionally as the time period under consideration changes. In other words, a change in a parameter may hurt welfare short term, but may improve welfare longer term even when the same measure is used in both cases. For example, when welfare is simply defined as the average number of dogs dying per year (with higher deaths indicating a more negative welfare score), reducing the death rate in the owned-dog population (P1) initially causes an improvement in welfare due to the obvious connection between death rate and number of deaths. However, over very long time periods (such as 100 years), P1 goes up due to the lower death rate, leading to more stray and shelter deaths and ultimately more total deaths and a lower welfare score using this simple measure. The results in the table make it clear that welfare results can be very sensitive to the time horizon under consideration. Policy decision-makers must have a clear idea what time period they wish to consider. What is true over 5 years or 10 years is not necessarily true over 30 years or 100 years.~~

~~*7.2.2 Treatments*~~

~~The primary purpose of the model is to test the effects of various potential "treatments" on welfare. Possible treatments that can be used to improve the welfare of dogs include low cost spay/neuter programs, public relations programs to encourage spay/neuter behavior, public relations programs to encourage consumers to adopt animals rather than buying animals from sources that increase supply, financial incentives for adopting/taxes on purchases from other dog sources, improved marketing to increase shelter adoptions, public relations programs to encourage "responsible" ownership (i.e. discouraging abandonment and animal abuse/neglect even if it means discouraging some of these people from owning pets), and increasing shelter space.~~

~~7.2.2.1 Low Cost Spay/Neuter Programs~~

~~As stated in a prior section, 27% of those respondents who did not spay/neuter their animal indicated that they would spay/neuter their animal at a lower price. Since only about 10.7% of the population does not spay/neuter their animal, 27% of this sub-population is only 2.89% of the total population. As stated in a prior section, the use of low cost spay/neuter programs has been subject to some controversy. It is sometimes argued (often by the veterinary community) that these programs have little impact since a low percentage of the population uses these programs and these users are often people who would spay/neuter their animal anyway rather than the consumers who would otherwise not spay/neuter their animal. On the surface, the survey results seem to support this claim since only 2.89% of the population could potentially be swayed by such a program. However, plugging this amount of change into the model gives a dramatically different impact.~~

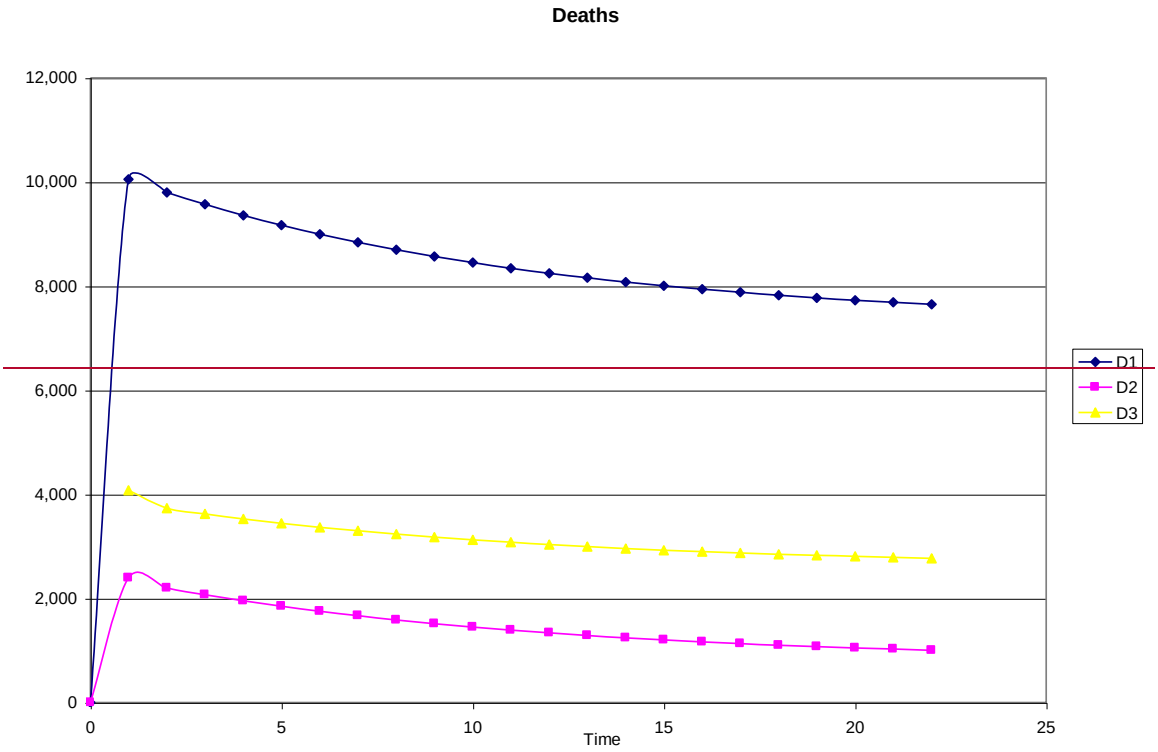

Figure 7.9: Death rates over time with low-cost spay/neuter program

The above chart shows the effect of getting this marginal population to spay/neuter their animal on death rates in the owned population (D1), the stray population (D3), and animals euthanized at shelters (D2). As indicated, this relatively small change in the spay/neuter rate can have a dramatic impact on the death rate and the euthanasia rate in particular. If the data in this graph is extended to a steady-state point, the equilibrium number of animals euthanized in the model eventually changes from 2,400 dogs a year down to about 800 dogs a year with the higher spay/neuter rate. This is a potential two-thirds reduction in the number of animals euthanized from a program giving financial incentives to spay/neuter dogs.

The table below gives the various welfare measures scores if this 2.89% of the dog-owning population adjusts its spay/neuter behavior.

Welfare Measure	Normalized 10 year	Normalized 30 year	Normalized 100 year	Average 10 year	Average 30 year	Average 100 year
Death	-87.63	-76.57	-68.76	14,458	12,606	11,294
Euthanasia	-70.34	-51.02	-37.25	1,844	1,332	968
Life	89.24	81.16	75.42	101,502	92,119	85,430
Measure	**10 year**	**30 year**	**100 year**	**Discounted 6%**	**Discounted 12%**	
Welfare A	89.54	81.41	75.63	82.73	86.91	
Welfare B	89.35	81.2	75.41	82.82	86.93	
Welfare C	-85.18	-76.87	-70.97	-78.22	-82.5	
Welfare D	-86.32	-76.73	-69.94	-85.21	-89.38	
Welfare E	-86.59	-77.12	-70.44	-82.33	-87.03	
Welfare F	89.56	81.49	75.74	82.8	86.95	
Welfare G	90.09	82.03	76.3	83.54	88.01	
Welfare H	89.09	81.03	75.29	82.17	86.04	
Welfare I	87.98	79.76	73.92	81.1	85.34	

~~Table 7.21: The impact of a low-cost spay/neuter program on various welfare measures~~

~~Two cost efficiency measures are calculated in the table below. The "minimum" measure gives the welfare improvement per thousand dollars spent per year assuming the cost of the program is at its minimum. The minimum cost assumes that the number of people using the spay/neuter program is exactly equal to the number of households in the marginal spay/neuter population. The "maximum" measure assumes that all consumers who have the option switch to the low-cost program increasing the financial burden on that program. Actual data on spay/neuter programs discussed in the literature review section indicates that most people still prefer to go to traditional full-cost veterinarians for their spay/neuter procedure even when subsidized spay/neuter programs are available. Therefore, the actual cost of these programs may be closer to the minimum value. Testing how many consumers who already spay/neuter their dog are actually price-sensitive and switch sources is an important question, but one beyond the scope of this research.~~

	Welfare Measure	Change/$1,000 (minimum)	Change/$1,000 (maximum)
10 year horizon	Death	0.213	0.015
	Euthanasia	0.511	0.036
	Life	-0.185	-0.013
	Welfare A	-0.18	-0.013
	Welfare B	-0.183	-0.013
	Welfare C	0.255	0.018
	Welfare D	0.236	0.017
	Welfare E	0.231	0.016
	Welfare F	-0.18	-0.013
	Welfare G	-0.171	-0.012
	Welfare H	-0.188	-0.013
	Welfare I	-0.207	-0.015
30 year horizon	Death	0.403	0.028
	Euthanasia	0.843	0.059
	Life	-0.324	-0.023
	Welfare A	-0.32	-0.022
	Welfare B	-0.324	-0.023
	Welfare C	0.398	0.028
	Welfare D	0.401	0.028
	Welfare E	0.394	0.028
	Welfare F	-0.319	-0.022
	Welfare G	-0.309	-0.022
	Welfare H	-0.327	-0.023
	Welfare I	-0.348	-0.024
100 year horizon	Death	0.538	0.038
	Euthanasia	1.08	0.076
	Life	-0.423	-0.03
	Welfare A	-0.419	-0.029
	Welfare B	-0.423	-0.03
	Welfare C	0.5	0.035
	Welfare D	0.517	0.036
	Welfare E	0.509	0.036
	Welfare F	-0.418	-0.029
	Welfare G	-0.408	-0.029
	Welfare H	-0.425	-0.03
	Welfare I	-0.449	-0.031

Table 7.22: The efficiency of a low-cost spay/neuter program using various welfare measures

Of course, it should be kept in mind throughout this analysis that it is assumed that the actual number of consumers who would switch is similar to the number who report that they would switch behaviors. The actual amount could be more or less. The results also assume a full subsidy (i.e. a zero-cost spay/neuter program). The results may be different

for different subsidy amounts. There are two ways the results could vary be subsidy amount. First, the slope of the demand curve could change at different subsidy amounts. However, as indicated in the survey results, the curve appears close to linear. This is verified quantitatively in the table below.

Table 7.23: Slope of spay/neuter quantity vs. price relationship at different subsidies

As the table indicates, there is approximately a 0.27% reduction in the number of people not spaying/neutering their animal per dollar reduction in the spay/neuter price. Given the sub-sample size in the survey of people indicating they would change behavior if price were reduced, this percentage is surprisingly stable over different price reduction amounts.

The other factor that could influence the cost efficiency of low-cost spay-neuter programs at different price levels is nonlinearities in how spay/neuter levels impacts welfare. The tables below are similar to the ones previously shown except that they show the welfare impact and impact per thousand dollars spent for a subsidized spay/neuter program priced at $50 that has half the impact on spay/neuter behavior.

Welfare Measure	Normalized 10 year	Normalized 30 year	Normalized 100 year	Average 10 year	Average 30 year	Average 100 year
Death	-93.62	-87.31	-82.29	15,446	14,375	13,515
Euthanasia	-84.64	-73.42	-64.4	2,219	1,917	1,674
Life	94.44	89.79	86.06	107,409	101,906	97,480
Measure	**10 year**	**30 year**	**100 year**	**Discounted 6%**	**Discounted 12%**	
Welfare A	94.59	89.92	86.18	90.6	93.05	
Welfare B	94.49	89.81	86.05	90.66	93.06	
Welfare C	-92.32	-87.44	-83.53	-88.15	-90.71	
Welfare D	-92.92	-87.38	-82.95	-92.2	-94.51	
Welfare E	-93.07	-87.59	-83.24	-90.51	-93.2	
Welfare F	94.6	89.97	86.24	90.64	93.07	
Welfare G	94.88	90.26	86.56	91.05	93.65	
Welfare H	94.35	89.72	85.99	90.29	92.58	
Welfare I	93.78	89.02	85.21	89.71	92.22	

Table 7.24: The impact of a 50% reduction in spay/neuter cost on various welfare measures

~~As shown, there is some evidence of nonlinearity, with most welfare measures showing more impact per dollar spent for the first $50 in price reduction than for the second $50 in price reduction even though the effect on number of people spaying/neutering their animal is linear. A partially subsidized program has the added advantage that it may attract a smaller percentage of consumers who would spay/neuter their dog anyway.~~

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	Welfare Measure	Change/$1,000 (minimum)	Change/$1,000 (maximum)
10 year horizon	Death	0.22	0.015
	Euthanasia	0.529	0.037
	Life	-0.192	-0.013
	Welfare A	-0.186	-0.013
	Welfare B	-0.19	-0.013
	Welfare C	0.265	0.019
	Welfare D	0.244	0.017
	Welfare E	0.239	0.017
	Welfare F	-0.186	-0.013
	Welfare G	-0.176	-0.012
	Welfare H	-0.194	-0.014
	Welfare I	-0.214	-0.015
30 year horizon	Death	0.437	0.031
	Euthanasia	0.915	0.064
	Life	-0.352	-0.025
	Welfare A	-0.347	-0.024
	Welfare B	-0.351	-0.025
	Welfare C	0.432	0.03
	Welfare D	0.434	0.03
	Welfare E	0.427	0.03
	Welfare F	-0.345	-0.024
	Welfare G	-0.335	-0.024
	Welfare H	-0.354	-0.025
	Welfare I	-0.378	-0.027
100 year horizon	Death	0.61	0.043
	Euthanasia	1.226	0.086
	Life	-0.48	-0.034
	Welfare A	-0.476	-0.033
	Welfare B	-0.48	-0.034
	Welfare C	0.567	0.04
	Welfare D	0.587	0.041
	Welfare E	0.577	0.04
	Welfare F	-0.474	-0.033
	Welfare G	-0.463	-0.032
	Welfare H	-0.482	-0.034
	Welfare I	-0.509	-0.036

~~Table 7.25: The impact of a 50% reduction in spay/neuter cost on cost efficiency measures~~

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7.2.2.2 Publication relations program to encourage spay/neuter

An alternative method of increasing the spay/neuter rate in the regional population is to conduct public relations/advertising campaigns that encourage spaying/neutering owned animals. Media campaigns for similar causes have been very effective on other issues. One obvious example of a successful public relations effort is the campaign by animal rights organizations to discourage the public from wearing clothing made with animal fur.

The results of the survey clearly indicate that the public at least can be influenced in what they say they will do regarding spaying/neutering their animal. Biasing language strongly affected both the percentage of people who said they would definitely not spay/neuter their animal in the future and the number who might be willing to spay/neuter their animal if the price was right. However, there are still two problems with translating this into actual behavior. The first is that neither of these numbers indicate how many people would definitely change even their reported behavior. The second is that reported behavior does not necessarily correlate in all cases with actual behavior. The latter problem is inherent in any survey research, however, the former problem is specific to this research topic. Questions about changing *current* spay/neuter behavior were not asked intentionally. It is one thing to ask a "what-if" question regarding a price change or a hypothetical question regarding future animals owned, it is quite another to tell somebody who reports not spaying/neutering their dog that this may be bad behavior and ask "*now* will you spay/neuter your dog?"

Unfortunately, this still leaves open the question of how many people would actually respond to a public relations campaign. Some insight can be gained on this question from

looking at the reasons given for not spaying/neutering an animal. These reasons include: "may use dog for breeding", "cost of procedure", "wanted dog the way God made him"/"did not want dog mutilated"/"simply did not want to", "too young", "not necessary/indoor dog", "show dog", "would give puppies to good home", "health reasons", and "no reason given". Although some categories are probably more easily influenced than others, it appears that some people in each of these categories could be influenced to some extent with the possible exception of owners of show dogs (6% of these respondents). Probably the most likely respondents to be influenced (without a change in cost) are people who do not spay/neuter for perceived health reasons, people who "...simply did not want to", people who "would give puppies to a good home", and people who gave no reason. Combined, these categories make up about 30% of the respondents who did not spay/neuter their animal. As a very rough initial estimate, we could work under the assumption that this is the size of the market who could be influenced by a public relations campaign. Of course, not every individual in these categories may be willing to reconsider their position, but there may be dog owners who can be convinced to spay/neuter their animal from the other categories to compensate for this loss.

The next question then becomes how much does it take in advertising costs to change the spay/neuter behavior of a group this size. Of course, there are many variables that this would depend on. To precisely measure the impact and cost of a marketing campaign is beyond the scope of this research and probably beyond the scope of any research that does not involve actually conducted at least a pilot campaign to test how responsive people are to the message across various advertising media. However, a

rough estimate can be achieved based on adding information on average marketing costs to the information already learned from the survey and model. The information on the first three lines of the table below is adopted from Ad Resource (2000).

Table 7.26: Cost of various advertising media (Source: Ad Resource, 2000. Final row calculated by Frank, J.)

In actuality, the most cost-effective way to reach an audience in this type of campaign would probably not be through focusing exclusively on the New York State Capital Region, rather it would be through a larger national public relations effort where economies of scale can reduce the per unit fixed costs of creating, managing and producing the advertisements and other efforts. However, for purposes of this research, we will focus on the cost of the portion of a campaign that would target the New York State Capital Region. As indicated earlier, there are approximately 173,000 households in the two counties studied here. The fourth line of the table gives the cost of making an average of one impression per household. Based on the survey results about 91,531 of the 173,000 households own dogs, with about 10.3% of dogs not spayed/neutered. Assuming that a good marketing campaign would reach 30% of these households, this comes out to a goal of getting a response from approximately 2,828 households. Based on the cost per impression and the response rate for each media, the final line in the chart above gives the cost of achieving this goal.

Of course, these costs are based on average costs and response rates. Actual cost will vary a great deal based on the nature of the marketing campaign. These figures also assume that residents are reached by the campaign completely at random. A well-targeted marketing campaign (i.e. one that focuses on sources that have a high frequency

~~of pet owners and in particular those who do not spay/neuter their dogs) could reduce these costs significantly. However, to be conservative, we will assume that these are the appropriate costs. Again to be conservative, rather than taking the lowest cost above, it will be assumed that a mixed media campaign will be used and take an average cost for all media to estimate the cost of this campaign. The average of these costs is $602,431. Since the net effect of this campaign will be to encourage spay/neuter behavior (just like a subsidized spay-neuter program), the impact of a certain amount of increased spay/neutering behavior on the welfare goals is identical to the pattern already presented. The only difference is that here we are discussing a 30% decrease in the number of dogs not spayed/neutered while in the prior section a 27% decrease was used as the maximum amount attainable. Also, for the subsidized program, the total cost was between $58,092 and $828,361 depending on buyer behavior. The cost for a marketing campaign affecting 27% (rather than 30%) of the relevant population is:~~

~~$602,431 * .27/.30 = $542,188~~

~~Interestingly, the cost of the marketing campaign ($542,188) appears to be in the high-middle of the cost range for the subsidized spay/neuter program, however, these costs are not yet directly comparable. This is because the subsidized spay/neuter program must be paid for every year to maintain effectiveness while the public education/marketing campaign can be conducted much less often. The exact length of time between marketing efforts is difficult to say. In the case of fur, a single extended campaign by organizations seems to have created a permanent cultural shift (though fur use is on the rise, it quite likely will not again return to the popularity it enjoyed twenty to thirty years ago). However, in most cases, repeated public relations campaigns will probably be~~

required from time to time. If we assume here that the campaigns will need to be repeated every five to ten years, this results in a long-term annualized cost of the public education campaign of between $54,219 and $108,438 which is still within the range of the subsidized spay/neuter cost, but now at the low-end of this range. Of course, both of these cost figures could differ significantly based on altered assumptions, though it generally appears that these two methods of increasing spay/neuter rates are somewhat comparable in efficiency.

It should be noted that a third method of increasing spay/neuter rates is not discussed here because it is already in effect in the New York State Capital Region. This is requiring that all animals adopted from shelters be spayed/neutered. All known shelters in the region have adopted this policy. This change in policy can make a substantial difference in the percentage of spayed/neutered animals and is a policy focus among some national animal welfare organizations.

A mixed strategy using both subsidized spay/neuter programs and a public relations campaign stressing spaying/neutering animals may be more effective than either program individually. This possibility gets some support from the responses to the biased survey. All of the respondents (100%) to the biased spay/neuter survey who did not spay/neuter their animal said they would be willing to spay/neuter their animal at a lower cost while only 17.7% of the control group indicated a willingness to spay/neuter if the cost of the procedure was lowered. Assume, for example, a mixed program was conducted with 50% of the money spent on a spay/neuter media campaign that did not change any behavior in itself but simply made the respondents willing to spay/neuter at a lower cost (as suggested by the survey), and the other 50% was spent on subsidized spay/neuter.

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~~Assume this was done rather than spending the same amount of money on a fully-subsidized spay/neuter campaign. Using the same data as before, the fully subsidized program would change behavior for 27% of households who do not spay/neuter their dog while the mixed program could change behavior for 50% of the target population.~~

~~7.2.2.3 Marketing/Public Relations Campaign to Encourage Adoption~~

~~A second direction a public relations/marketing campaign could take is to encourage adopting animals rather than purchasing animals from for-profit sources. Aside from the survey results, it anecdotally appears that this type of program might have the potential to be even more effective than a spay/neuter campaign in changing behavior since most people appear to be aware of the significance of spaying/neutering their animal in controlling dog populations. However, it seems that a sizable percentage of the dog-owning population does not adopt simply because they never consider the indirect influence dog purchases from other sources have on encouraging dog production and overpopulation.~~

~~The results of the survey tend to support this observation. For example, close to a third of respondents combined did not purchase from a shelter simply because it was an impulse decision, they did not think about purchasing from a shelter, or for convenience reasons. Many of these purchasers quite possibly could be impacted by an increased awareness of the influence their purchase behavior has on the surplus dog population.~~

~~The clearest indication of the influence a public education campaign could have is the results of the adoption-biased survey. As previously discussed, respondents to the adoption-biased survey were twice as likely to say they will probably go to a shelter next~~

~~time, and were less than one third as likely to say they would definitely not purchase from a shelter next time.~~

~~To estimate how many people may respond to a public education campaign, it is assumed here that 80% of the respondents who say they will "probably" buy from a shelter next time actually do so. In addition, it is assumed that if we take the remaining relevant population and remove those who say they will definitely **not** go to a shelter next time (i.e. looking at the group who did not indicate either extreme regarding their next dog purchase) that 20% of these respondents will purchase from a shelter next time. We then have for the number purchasing from a shelter next time:~~

~~Control group: (8.6% * 80%) + {(1-30%-8.6%) * 20% = 19.2%~~

~~Marketed group: (17.1% * 80%) + {(1-8.6%-17.1%)}* 20% = 28.5%~~

~~The above figures imply a potential increase within the relevant population in the number of households adopting dogs of 28.5%-19.2%= 9.3%. The relevant population is defined here to be people who do not adopt dogs either from shelters or as strays already. According to the survey results, this group makes up 71.4% of the total dog owning population. This implies a total responsive population of approximately 6,078 households.~~

~~Based on these figures, and using the same methodology as the spay/neuter public education campaign, a very rough estimate of the cost of influencing this number of people is $1,165,252. This cost is higher than the spay/neuter campaign simply because more responses are needed to reach the goal. The methodology here implicitly assumes that getting a dog owner to change spay/neuter behavior requires the same level of effort~~

as getting a dog owner to change purchase sources. Once again, the public education campaign needs to be repeated only infrequently.

The table below gives the welfare scores after conducting this hypothetical public education campaign.

Welfare Measure	Normalized 10 year	Normalized 30 year	Normalized 100 year	Average 10 year	Average 30 year	Average 100 year
Death	-95.36	-95.35	-95.34	15,732	15,698	15,658
Euthanasia	-70.77	-70.65	-70.51	1,856	1,844	1,833
Life	100	100	100	113,737	113,495	113,270
Measure	**10 year**	**30 year**	**100 year**	**Discounted 6%**	**Discounted 12%**	
Welfare A	100	100	100	100	100	
Welfare B	100	100	100	100	100	
Welfare C	-100	-100	-100	-100	-100	
Welfare D	-97.85	-97.84	-97.84	-98.75	-98.7	
Welfare E	-98.81	-98.81	-98.81	-99.54	-99.52	
Welfare F	100	100	100	100	100	
Welfare G	100	100	100	100	100	
Welfare H	100	100	100	100	100	
Welfare I	100	100	100	100	100	

Table 7.27: Effect of campaign to promote adoption on welfare measures

The next table gives the cost effectiveness per dollar spent for this same adoption campaign. The change per dollar spent assumes that the campaign is conducted every 7.5 years, which is the midpoint between the 5 and 10 years figures used in the spay/neuter case.

	Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000
10 year horizon	Death	0.03	30 year horizon	Death	0.03	100 year horizon	Death	0.03
	Euthanasia	0.188		Euthanasia	0.189		Euthanasia	0.19
	Life	0		Life	0		Life	0
	Welfare A	0		Welfare A	0		Welfare A	0
	Welfare B	0		Welfare B	0		Welfare B	0
	Welfare C	0		Welfare C	0		Welfare C	0
	Welfare D	0.014		Welfare D	0.008		Welfare D	0.014
	Welfare E	0.008		Welfare E	-0.345		Welfare E	0.008
	Welfare F	0		Welfare F	0		Welfare F	0
	Welfare G	0		Welfare G	0		Welfare G	0
	Welfare H	0		Welfare H	0		Welfare H	0
	Welfare I	0		Welfare I	0		Welfare I	0

~~Table 7.28: Cost-effectiveness of campaign to promote adoption~~

~~It should be noted that the effect on welfare of this increase in adoptions is different than the welfare change in the sensitivity analysis. This is not only because the amount of change in adoptions being inputted into the model is different, but also because the change is done differently in the model. For the sensitivity analysis, each variable was changed without any change in other model parameters, but in this case we are examining substitution of sources, so when adoptions are increased, pet purchases from alternative sources are decreased by an equivalent amount.~~

~~Compared to changing the spay/neuter rate, a campaign focusing on adoption seems less cost effective in many cases, although it is effective at reducing euthanasia rates. On the other hand, the adoption campaign is one of the rare treatments that only has a positive impact or zero impact given any of the welfare measures used. The spay/neuter campaign gives a negative welfare result based on some of the measures used. This is because a spay/neuter campaign tends to reduce the dog population in general, while the adoption campaign causes substitution in sources without reducing the population in general (it should be noted that the model dynamics imply some "supply push"--i.e. if~~

there are more strays, friends needing to place a pet, or "free pets" advertised in the paper, some of these excess dogs will go in the hands of the marginal consumer, increasing the total dog population.) Therefore, if a welfare measure focuses primarily on the number of dogs in good homes, a reduction in the dog population through a spay/neuter campaign can actually reduce this welfare measure while an adoption campaign does not.

7.2.2.4 Financial Incentives to Encourage Adoption

A second method that can be used to increase adoptions rather than purchases from breeders and pet stores is to give financial incentives to encourage this behavior. There are two ways these incentives can be structured. The first is to subsidize/reduce the cost of adoption from a shelter in some way, and the second is to increase the cost or tax pet purchases from other sources. As discussed in the literature review, a negative association has repeatedly been found between the price of a dog and later abandonment of the dog. Therefore, many shelters are reluctant to price dogs lower, even if they were compensated in some form for the loss in operating revenue. Of course, it should be noted that this correlation does not necessarily imply causation. Just because low prices may be correlated with abandonment does not necessarily mean that raising prices reduces abandonment. A second problem with making a policy choice to keep adoption prices high to avoid later abandonment is that it ignores a full welfare analysis. For example, if the marginal adopters gained from reducing prices return their animal to the shelter or otherwise abandon the animal 50% of the time, this still leaves 50% of these dogs being successfully placed. Though there may be additional costs to such an action (for example trauma to the dogs placed and then abandoned), it is not at all clear from an

~~animal welfare perspective that these costs outweigh the benefits of successfully placing the other 50%. In fact, it seems that such a policy seems more driven from an animal control perspective that focuses on the additional human costs such as adding to the stray population.~~

~~The welfare impact of a price reduction is not at all clear and depends on factors such as how likely the marginal adopter from a price reduction is to abandon an animal, how the welfare of the dog is in the home of that marginal adopter, and how the suffering of strayed animals and repeatedly abandoned animals is weighted relative to the benefits of successfully placed animals. If shelter prices are reduced so that the cost is negligible, then a price reduction in purchasing shelter animals also has other potential problems such as encouraging illicit animal uses (such as selling animals for research or purchasing animals for the purpose of abusive activities).~~

~~Because of these issues, the focus here will be on increasing the price of substitutes as a financial incentive rather than reducing the price of shelter animals. Of course, there are potential issues with tax programs. One obvious problem is that animal sales are frequently done as a private exchange in which taxes would be hard to monitor or enforce. Taxing also is difficult politically.~~

~~However, though it may be difficult, this does not necessarily imply that a tax is completely unenforceable. Licensed breeders and pet stores can be monitored. Transactions involving higher-priced pure-bred animals could also be monitored even if the transaction involves private owners, since the value of an animal is dependent on keeping records on the animal's lineage. Increasing enforcement for existing dog~~

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registration laws and including the source of the dog in registration information could also serve to make the tax more enforceable.

Based on the results of the survey, a tax that brings the purchase price of a dog to $1,500 could change the behavior of 38% of the relevant population so that they purchase their next animal from a shelter. However, over a $1,000 tax is very high and most likely politically unfeasible. If we instead assume an after tax purchase price of $700, this would change the behavior of 24.7% of the relevant population (assuming actual behavior corresponds with reported behavior). According to the survey results, the average purchase price of a dog from a breeder was $412 and the average purchase price of a dog from a pet store was $474. Taking a weighted average of these gives an average purchase price of $427 which implies a tax of $273 per dog.

The benefit in terms of improved animal welfare can be calculated from the model. However, a more difficult question is the cost of this tax. There is no direct cost to the program (assuming administrative costs are low) since revenue is actually generated from the tax. However, there is a social cost in lost consumer surplus and lost producer surplus. Generally, speaking, the consumer surplus represents the utility consumer's receive from a good in excess of its price, while the producer surplus represents the profit received by the supplier of a good above the cost of production. Theoretically, the size of the producer and consumer surplus should take into account any negative economic effects of reducing or eliminating sales of dogs from breeders and pet stores.

The graph below is adopted from the data in the survey results section indicating how many people would switch to adopting dogs if the price of animals from other sources increased. The graph below converts the data into a standard demand curve so that the

consumer surplus can be determined. In addition to the downsloping demand curve segment shown, a flat line indicating the amount of the tax is shown. The lost consumer surplus is the area between points ABC. Approximating this area as a triangle gives a lost consumer surplus of $80,020. Other consumers outside of this triangular area do lose money from the tax, but the loss for these other consumers is a transfer rather than a deadweight loss.

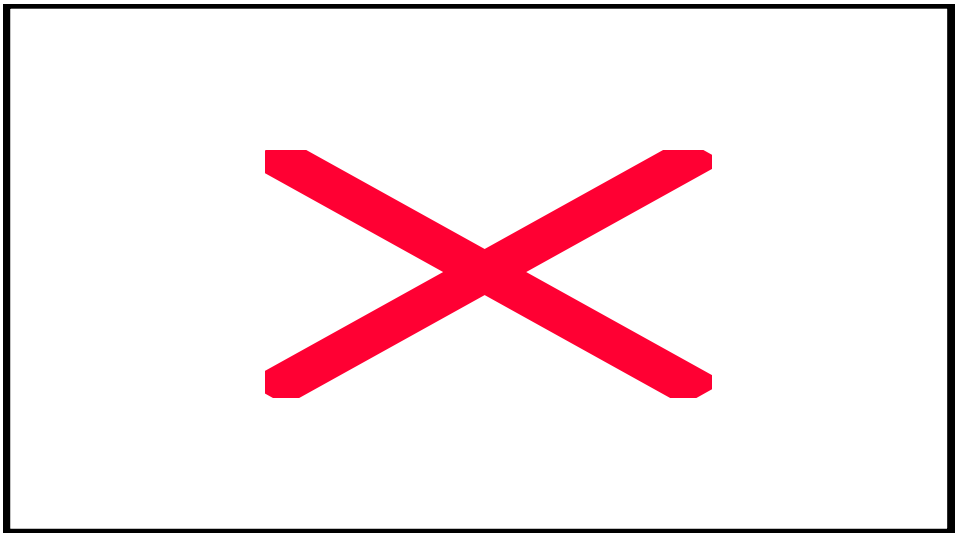


Figure 7.10: Consumer surplus lost from a tax on dogs from non-shelter sources

Calculating the lost producer surplus is a more difficult matter since we do not have the data to construct a supply curve. In fact, there really is no way with the data currently available to accurately estimate producer surplus. For lack of a better method to estimate this value, producer surplus will be assumed to be approximately equal to consumer surplus, giving a very rough deadweight loss estimate for the tax program of $160,000.

Since the result of this treatment is qualitatively the same as the public education program to increase adoption (i.e. both programs hopefully would cause people to substitute adoptions for other dog purchases), the cost effectiveness of these two programs can be compared directly without recreating the welfare impacts of this

~~treatment. The cost of the public education program is estimated to be approximately $25.56 per adoption generated while the social cost of the tax is only $9.91 per adoption generated. On the surface, the tax appears more efficient, however this assumes that the administrative costs of the tax are minimal, that it is enforceable, and that it is politically feasible.~~

~~7.2.2.6 Shelter Marketing~~

~~Rather than conducting a public education campaign focusing on the social importance of adopting dogs over purchasing dogs from other sources, shelters, animal welfare organizations, and government officials have an alternative marketing focus they could take to encourage adoptions. This approach would be to focus on the product rather than a social message.~~

~~According to the survey results, over two-thirds of respondents who did not get their dog from a shelter did not do so at least in part because they wanted specific breeds/qualities in the dog. The two most common specific qualities for those who specified what they were looking for were puppies and/or specific breeds. Many of these respondents also seemed quite willing to go to a shelter if they could get what they wanted. Local shelters regularly do have puppies as well as purebred animals. A marketing campaign could make the public more aware of what is available at the shelter. It could be argued that this is not necessary since puppies and purebred animals tend to get adopted more readily without advertising. However, Mohawk Hudson statistics indicate that even among puppies, almost 10% of the animals are still euthanized. In addition, there quite likely are some consumers who adopt puppies or purebred dogs from~~

shelters now, but who would adopt another type of dog if that is all that is available. For those seeking dogs of a specific breed, shelters could keep names and phone numbers of people interested in specific breeds of dogs and call these people when a dog fitting their needs comes in. This would be an added administrative expense, but it may be a more cost-effective way of increasing shelter adoptions than some of the other programs discussed. There is also the possibility as is done in many for-profit businesses of cross-marketing; if a potential customer comes down to the shelter based on a call or an advertisement and finds the dog they want is no longer there, they may while they are already there be more willing to consider an alternative dog.

There was a tie in the survey for the second most common reason for not purchasing at a shelter. These were people who visited a shelter but could not find the type of dog they wanted, and people who said their purchase was an impulse decision. The next most common response was from people who just did not consider a shelter at the time of the purchase. All three of these groups could probably be successfully targeted with a marketing campaign. Respondents who searched at a shelter but did not find what they wanted are already receptive to purchasing from a shelter. For these consumers, selection appears to be the key issue. Once again, potential customers could be put on a list. In addition mailings, advertisements/news media featuring adoptable pets, and websites can all be used to make these potential customers aware of dogs as they become available. Cross-listing animals with other locations within a reasonable distance might also "grab" some of these potential customers.

The other two groups, those who did not think of a shelter at the time of purchase or who made an impulse decision, may be the easiest potential marginal customers to

convert into sales. Some of these respondents talked about seeing and falling in love with a particular dog and purchasing it on the spot. The purchase choice of these individuals may often simply be a function of what they are most frequently exposed to (e.g. a dog at a pet store in a mall versus a profile of a shelter dog or an actual live shelter dog). Exposure of shelter animals can be increased through profiles of animals in the media as well as by live appearances by the animals (for example many of the private no-kill organizations bring their animals to public locations like PetSmart regularly).

The percentages in these four categories alone add up to about 110% of consumers since more than one option can be selected on the survey. When this is taken into account, 90.2% of people who did not purchase from a shelter fell into one of these four categories. Therefore, the potential market for such a campaign is quite large.

If the cost effectiveness of such a marketing campaign is estimated assuming that the marketing campaign gets potential dog purchasers to switch purchase sources and that the response rate is based on the same data used before, the cost effectiveness would come out exactly the same as for the adoption public education campaign. This is because the true responsiveness of the consumer to each campaign is unknown and only a generic average figure is used. Therefore, such a calculation yields no new insight. However, we can at least say that with the two programs in combination, there is the potential to reach most if not all people who do not currently purchase from a shelter.

A more interesting question that can be examined using this model is to assume that the (product-based) marketing campaign is more effective than the public education campaign but that the marketing campaign may expand the market rather than getting consumers to switch suppliers. If we assume for example that all of the respondents to a

~~marketing campaign would not have purchased a dog at all, what are the welfare implications of this compared to a public education campaign that converts the source people use to purchase dogs?~~

~~The table below compares the welfare figures for the two scenarios.~~

	Welfare Measure	Welfare assuming substitution	Welfare assuming new buyers	Factor (Change in new buyers required for same impact as substitution)
10 year horizon	Death	-95	-98.41	2.87
	Euthanasia	-70.77	-75.86	1.27
	Life	100	103.54	0
	Welfare A	100	103.62	0
	Welfare B	100	103.6	0
	Welfare C	-100	-102.99	0
	Welfare D	-97.85	-100.87	-2.37
	Welfare E	-98.81	-101.58	-0.75
	Welfare F	100	103.67	0
	Welfare G	100	103.75	0
	Welfare H	100	103.64	0
	Welfare I	100	103.42	0
30 year horizon	Death	-95	-103	-1.53
	Euthanasia	-70.65	-84.15	1.85
	Life	100	107.03	0
	Welfare A	100	107.12	0
	Welfare B	100	107.12	0
	Welfare C	-100	-106.72	0
	Welfare D	-97.84	-105	-0.43
	Welfare E	-98.81	-105.61	-0.21
	Welfare F	100	107.16	0
	Welfare G	100	107.21	0
	Welfare H	100	107.15	0
	Welfare I	100	107.01	0
100 year horizon	Death	-95	-107.31	-0.64
	Euthanasia	-70.51	-91.92	3.65
	Life	100	110.28	0
	Welfare A	100	110.38	0
	Welfare B	100	110.39	0
	Welfare C	-100	-110.19	0
	Welfare D	-97.84	-108.85	-0.24
	Welfare E	-98.81	-109.39	-0.13
	Welfare F	100	110.4	0
	Welfare G	100	110.44	0
	Welfare H	100	110.41	0
	Welfare I	100	110.36	0

~~7.29: Comparison of adoption through substitution versus adoption through new dog owners~~

~~The first row in the table is a repeat of the welfare figures for the public education campaign previously discussed. The second row gives the welfare figures for a campaign of equivalent effectiveness and size but which causes all new buyers to purchase at a shelter rather than causing substitution of dog sources. The row labeled "factor" gives how much more (or less) would have to be spent in the latter case to equal the welfare change in the former case. For example, using the welfare measure of the number of deaths averaged over 10 years, if people substitute dog sources (as in a public education campaign), the number of deaths is reduced to 95.36% of its original value while if the additional people buying at shelters are new dog owners (which may be the case with a product-based marketing campaign), deaths are only decreased to 98.41% of its original value. Therefore, to equal the effectiveness of the public relations campaign using this particular measure, 2.87 times as much money would have to be spent in the latter case (or the marketing campaign would have to achieve a response rate 2.87 times as high). In general, if the goal is to reduce death or euthanasia only, substitution is somewhat more effective than getting new dog adopters. However, if the welfare measure used positively values dogs living in homes, then getting new people to adopt dogs is generally more effective if the two programs have the same response rate (on the other hand, if the welfare measure focuses on suffering and death, then expanding the dog population by getting new owners would generally be considered bad).~~

~~7.2.2.7 Public Education Campaign Encouraging Responsible Ownership~~

~~One final approach a public education campaign could take is to focus on reducing abandonment rather than adoptions or spay/neuter behavior. The campaign would educate people regarding the serious decision involved in taking on a pet, make more tangible the suffering and death caused by animal abandonment, and encourage people not to take on dog ownership unless they understand the costs, responsibilities, and time involved in responsible dog ownership.~~

~~If this public education campaign results in less abandonment but at the expense of lower levels of pet ownership, it should be intuitively clear that evaluating the results of this particular campaign will depend on the definition of animal welfare. If death and suffering is the focus of the welfare measure, then the campaign probably will yield positive results. However, if the focus of the welfare measure is on the number of animals living reasonably happy lives in good homes, then the campaign may yield negative results if some potentially good households are discourage from purchasing pets.~~

~~Several assumptions will be tested here, however, we will start by assuming that for every two dog owners discouraged by this public education program, one would have actually abandoned their dog. The assumptions for the cost and responsiveness to the campaign used will be the same as used previously, with each dog owner discouraged considered a response rather than each abandonment eliminated.~~

~~The two tables below give the welfare impact and the cost-effectiveness respectively of a public education campaign for responsible pet ownership that affects 10% of the dog-purchasing population assuming that half of this 10% would actually abandon their animal. As expected, for measures focusing on death or suffering (generally the negative numbers), the campaign has a positive impact while for measures that put a higher value~~

on dogs living in homes, the welfare impact is negative. In general, assuming the same response rates and costs as other media campaigns, this campaign is less cost effective at reducing death and euthanasia than a spay/neuter campaign or an adoption education campaign. However, these estimates are very rough so the difference may be within the variance of the forecast.

Welfare Measure	Normalized 10 year	Normalized 30 year	Normalized 100 year	Average 10 year	Average 30 year	Average 100 year
Death	-98.61	-96.57	-94.68	16,268	15,899	15,550
Euthanasia	-98.77	-95.3	-92	2,590	2,488	2,391
Life	98.26	96.8	95.38	111,753	109,863	108,036
Measure	**10 year**	**30 year**	**100 year**	**Discounted 6%**	**Discounted 12%**	
Welfare A	98.52	97.06	95.63	97.23	98.03	
Welfare B	98.39	96.92	95.49	97.21	97.97	
Welfare C	-94.58	-93.09	-91.64	-93.26	-94.08	
Welfare D	-96.44	-94.7	-93.04	-95.58	-96.39	
Welfare E	-96.46	-94.68	-93.03	-95.34	-96.33	
Welfare F	98.57	97.12	95.7	97.29	98.08	
Welfare G	98.97	97.52	96.11	97.72	98.56	
Welfare H	98.24	96.8	95.39	96.94	97.68	
Welfare I	97.39	95.91	94.46	96.08	96.9	

Table 7.30: Welfare impact of public education campaign to encourage responsible ownership

	Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000
10 year horizon	Death	0.005	30 year horizon	Death	0.013	100 year horizon	Death	0.02
	Euthanasia	0.005		Euthanasia	0.018		Euthanasia	0.031
	Life	-0.007		Life	-0.012		Life	-0.018
	Welfare A	-0.006		Welfare A	-0.011		Welfare A	-0.017
	Welfare B	-0.006		Welfare B	-0.012		Welfare B	-0.017
	Welfare C	0.021		Welfare C	0.026		Welfare C	0.032
	Welfare D	0.014		Welfare D	0.02		Welfare D	0.027
	Welfare E	0.014		Welfare E	0.02		Welfare E	0.027
	Welfare F	-0.005		Welfare F	-0.011		Welfare F	-0.016
	Welfare G	-0.004		Welfare G	-0.009		Welfare G	-0.015
	Welfare H	-0.007		Welfare H	-0.012		Welfare H	-0.018
	Welfare I	-0.01		Welfare I	-0.016		Welfare I	-0.021

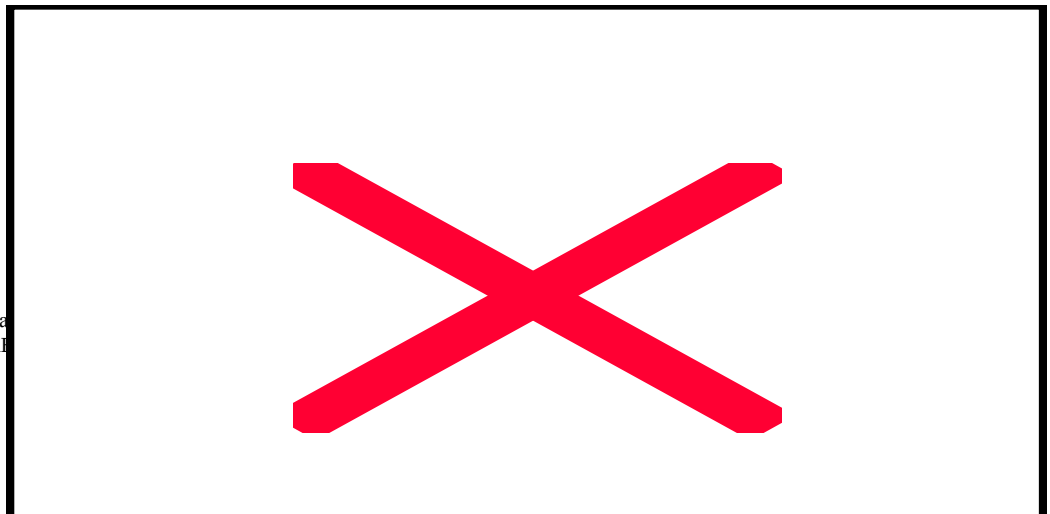
Table 7.31: Cost effectiveness of public education campaign to encourage responsible ownership

It should be noted that the welfare estimates for this public education campaign do not take into account any impact the program may have on the quality of life for the dogs.

~~Dog quality of life from this campaign can improve in two ways. First, it seems reasonable that marginal dog owners (i.e. the ones who decide not to own dogs based on the campaign) are more likely to be neglectful or even abusive to the animal than the typical dog owner. In addition, the campaign may also make other dog owners think about their relationship with and treatment of their dog thereby increasing the welfare of all owned dogs. Therefore, the numbers given above quite likely understate the welfare benefits of the public education campaign.~~

~~Appendix F gives one example of adjusting for these quality of life factors. In this case, the improvement in quality of life is somewhat arbitrarily assumed to be 10%; indicating that life for the average owned dog is valued 10% higher after the public education campaign. With this adjustment, the welfare is improved after the public education campaign with any of the measures used. The welfare impact of the campaign after the adjustment compares much more favorably with the other public education campaigns discussed.~~

~~The outcome of this public education campaign also depends on the ratio of the reduction in dog ownership to the reduction in dog abandonment caused by the campaign. The chart below shows how two selected welfare measures (euthanasia and "welfare measure D") change as this parameter changes. Scores for all welfare measures for two of these alternative values are also shown in Appendix F.~~



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~~Figure 7.11: Effect of abandonment change on two welfare measures~~

~~It should be noted that some values above 100% are shown here. This is possible if abandonment falls more than dog ownership does. Hypothetically, this is possible if some current dog owners decide not to abandon their animal based on the campaign or if potential dog owners still purchase animals but do not abandon their dogs.~~

~~7.2.2.8 Shelter Space~~

~~As indicated in the sensitivity analysis changing the amount of shelter space in the model alone has a negligible effect on the welfare outcome. However, as previously mentioned, a significant portion of dog owners who do not buy from a shelter do so because of a lack of selection. More shelter space would increase the range of dogs available to the public, which could therefore result in more dogs being adopted. In addition, shelter data currently indicates that the inflow of dogs is greater than the~~

adoption rate, regardless of season. However, if the inflow and outflow become more balanced, shelter space can become important in reducing euthanasia due to seasonal or random fluctuations in demand.

Based on the survey, 15.2% of respondents who did not purchase from a shelter visited a shelter but did not find the dog they wanted. If this is taken to be the potential market from increased selection from expanded shelter space, an asymptotic function can be created using shelter space as the X variable and the percent of the public buying from a shelter as the Y variable. The chart below shows the function used here.

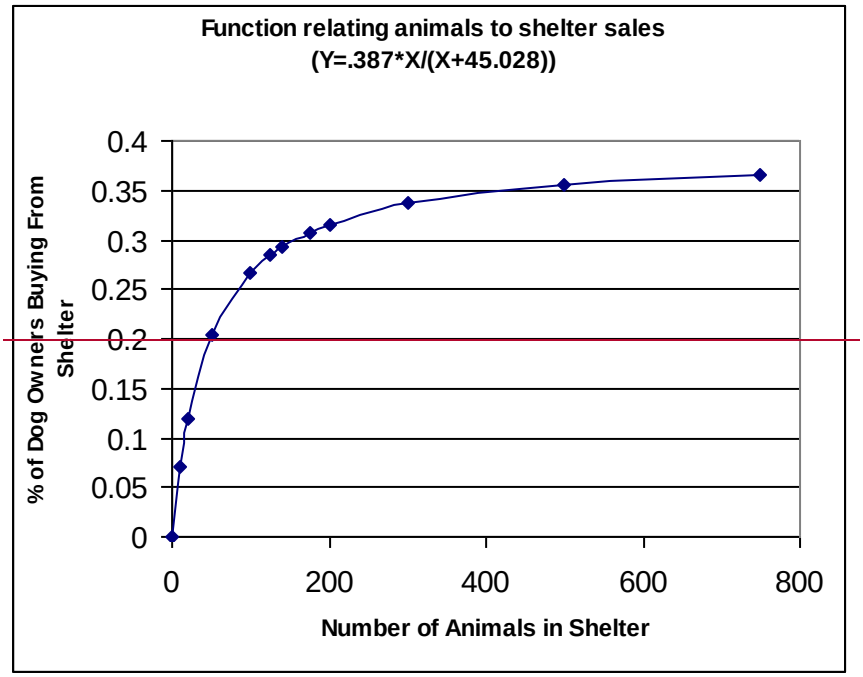


Figure 7.12: Hypothetical function relating shelter space to increase in shelter purchases

This function uses the form (Y=.387*X/(X+45.028)). The function was generated by solving for the following three requirements: 1) When shelter space = 0, no dogs are adopted, 2) When shelter space is at its current level (141) the current percentage of dogs are adopted (i.e. 29.3%), and 3) As shelter space approaches infinity, the percentage of

dogs adopted from shelters approaches 29.3% + 15.2% times the number dogs not from shelters or strays or 38.7%.

According to personal communications with Mohawk Hudson and other private shelter personnel, a rough average cost including all expenses of sheltering one dog is $10/day. Using this cost and the assumed function for the increased adoptions, the effect of increased shelter space on welfare can now be estimated using the model. The tables below gives the welfare effect and cost efficiency respectively of a 50% increase in shelter space. Similar tables for a 20% and 100% increase are shown in appendix G.

Welfare Measure	Normalized 10 year	Normalized 30 year	Normalized 100 year	Average 10 year	Average 30 year	Average 100 year
Death	-98.43	-98.43	-98.43	16,240	16,205	16,166
Euthanasia	-90.14	-90.1	-90.05	2,363	2,352	2,340
Life	100.06	100.06	100.06	113,806	113,563	113,337
Measure	**10 year**	**30 year**	**100 year**	**Discounted 6%**	**Discounted 12%**	
Welfare A	100.01	100	100	100	100	
Welfare B	100	100	100	99.99	99.99	
Welfare C	-100.37	-100.37	-100.37	-100.37	-100.37	
Welfare D	-99.47	-99.47	-99.46	-99.86	-99.85	
Welfare E	-99.93	-99.92	-99.92	-100.15	-100.16	
Welfare F	100	100	100	100	100	
Welfare G	99.92	99.92	99.92	99.92	99.92	
Welfare H	99.93	99.93	99.94	99.93	99.93	
Welfare I	99.95	99.95	99.95	99.95	99.96	

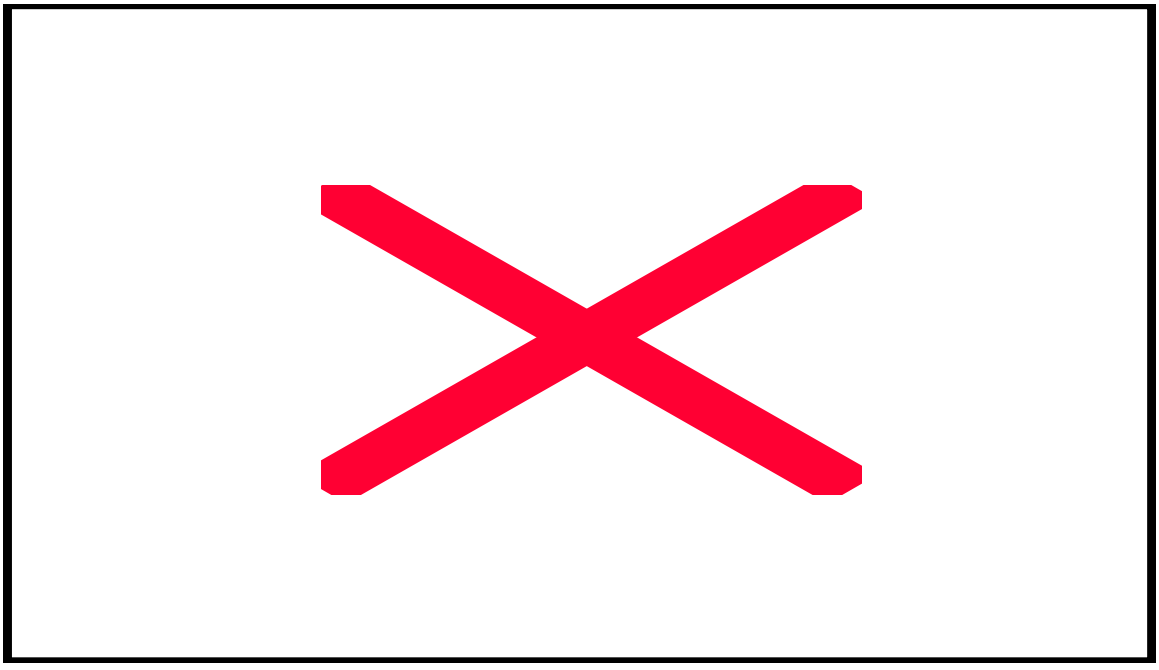
Table 7.32: Welfare impact of increase in shelter space assuming adoptions increase

	Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000		Welfare Measure	Change /$1,000
10 year horizon	Death	0.061	30 year horizon	Death	0.061	100 year horizon	Death	0.061
	Euthanasia	0.383		Euthanasia	0.385		Euthanasia	0.387
	Life	0.002		Life	0.002		Life	0.002
	Welfare A	0		Welfare A	0		Welfare A	0
	Welfare B	0		Welfare B	0		Welfare B	0
	Welfare C	-0.014		Welfare C	-0.014		Welfare C	-0.014
	Welfare D	0.021		Welfare D	0.021		Welfare D	0.021
	Welfare E	0.003		Welfare E	0.003		Welfare E	0.003
	Welfare F	0		Welfare F	0		Welfare F	0
	Welfare G	-0.003		Welfare G	-0.003		Welfare G	-0.003
	Welfare H	-0.003		Welfare H	-0.003		Welfare H	-0.002
	Welfare I	-0.002		Welfare I	-0.002		Welfare I	-0.002

Table 7.32: Cost effectiveness of increase in shelter space assuming adoptions increase

The increase in shelter space appears to be very cost efficient at reducing euthanasia rates, although its impact on other welfare measures is less impressive. In fact, of all the treatments discussed so far, this appears to be the most effective if euthanasia is all that is being considered (assuming that adoptions increase as shelter space increases as predicted). This is mainly due to the relatively low cost of the program. A 50% increase in shelter space can be implemented for an annual cost of $25,733. Of course, due to the asymptotic functional form, increasing shelter space exhibits diminishing returns so there are limits to the usefulness of this type of program.

The two figure below illustrate those diminishing returns. The first figure shows the average and marginal cost efficiency of adding shelter space at reducing euthanasia using different levels of shelter space.



7.13: Cost efficiency of increased shelter space at reducing euthanasia

As indicated, both the marginal and average cost efficiency decline as shelter space increases. Although a 100-year horizon is shown here, the graph is almost identical for shorter time horizons.

The second chart shows the reduction in the equilibrium (steady-state) euthanasia rate as a percentage of the initial euthanasia rate. It can be clearly seen that although shelter space can effectively reduce euthanasia to some extent, no matter how much shelter space is added, the best that can be achieved is about a 30% reduction.

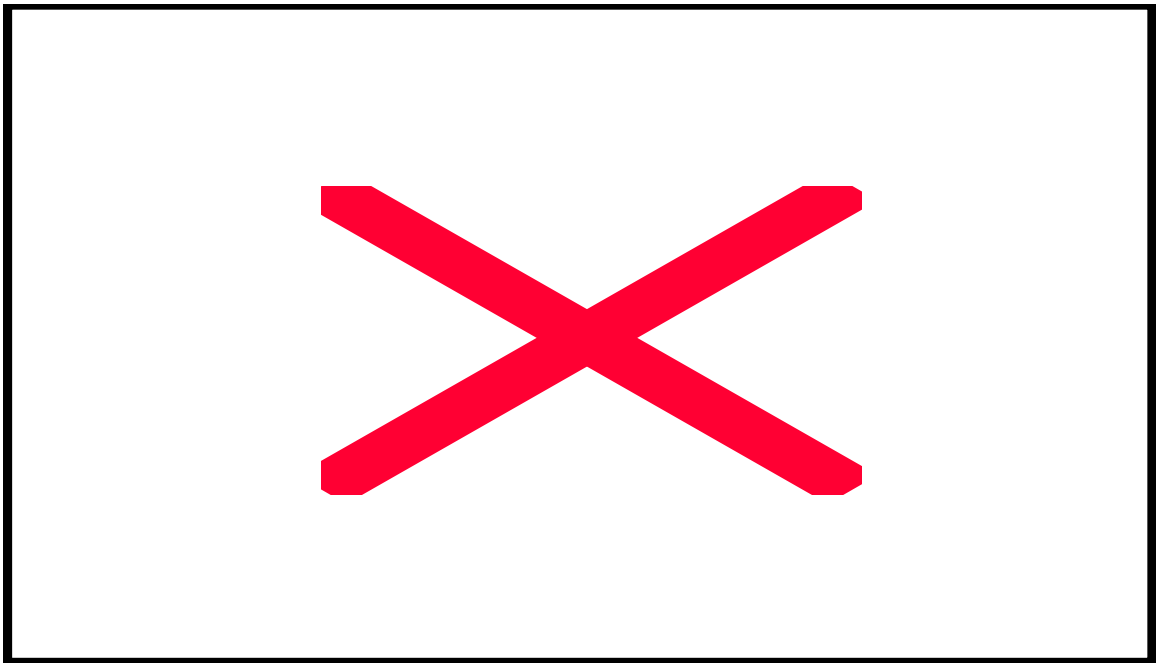


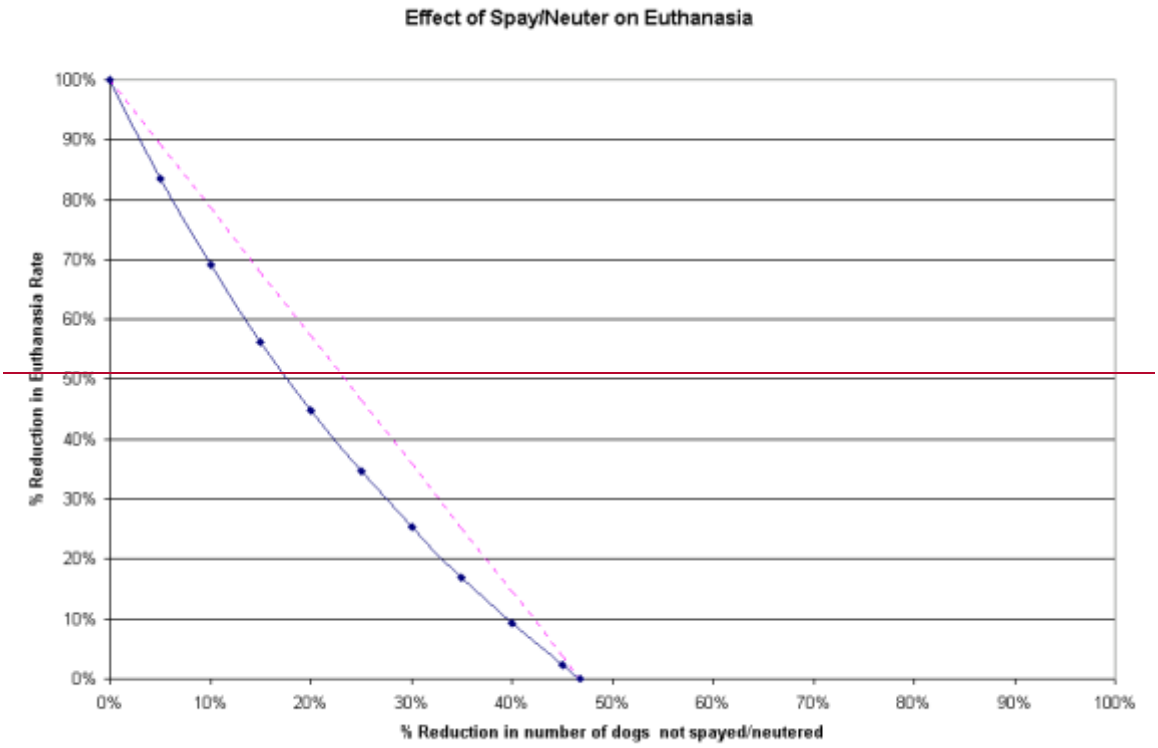
Figure 7.14: Limit to reduction in euthanasia from increased shelter space

Synergies, the Production Possibility Frontier and a "No-Kill" Society

~~If we momentarily simplify our goal and concentrate on the effort of groups such as Maddie's Fund to achieve a no-kill society, the model can be used to address several important questions. These include: (1) What does it take to achieve a no-kill society? (2) Are there diminishing or increasing returns to treatments as society approaches no-kill? And (3) Are there synergies from combining treatments or do they have reduced effectiveness when combined?~~

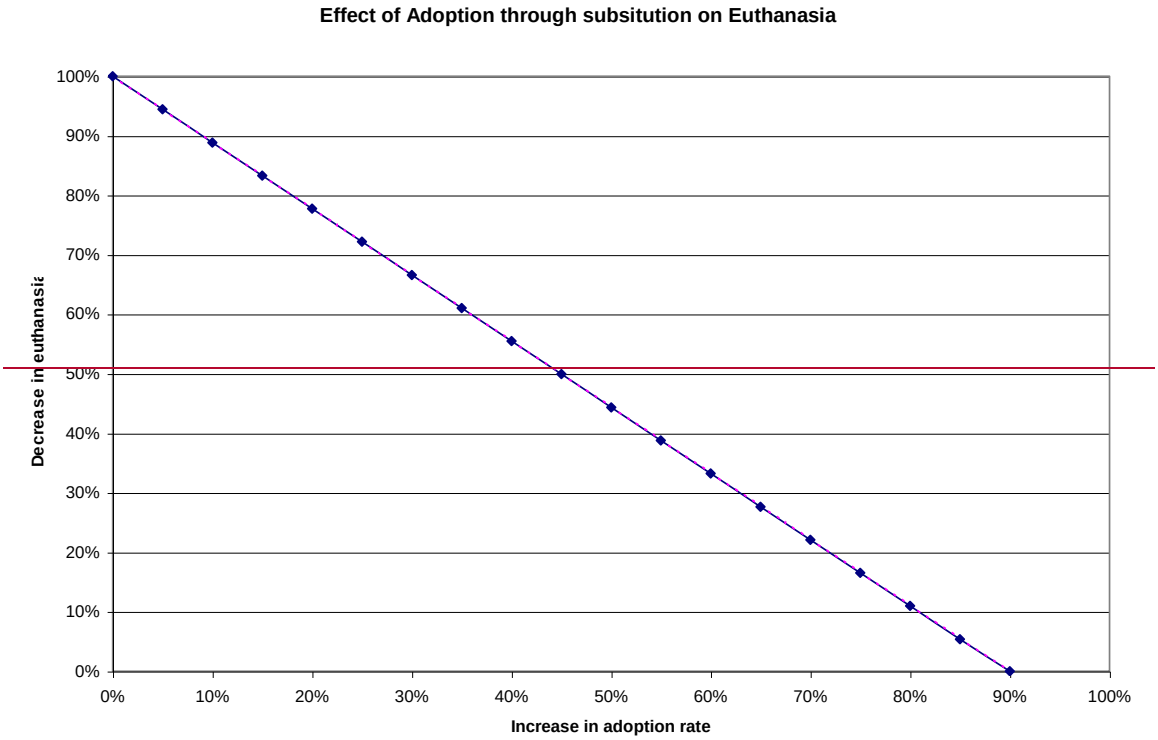
~~The first two questions are addressed in the following four graphs. The graphs show the euthanasia rate in terms of percentage of the initial euthanasia rate as a function of different amounts of various treatments. The graph below shows how the euthanasia rate changes as the spay/neuter rate is increased. To make the percentages easier to interpret, the spay/neuter rate is shown in terms of the percentage of the population that does not spay/neuter their dog. As the graph indicates, a reduction of 46.8% in the percentage of dog owners who do not spay/neuter their animal will result in the New York State Capital Region being able to sustainably maintain a no-kill policy. It should be noted that the euthanasia rate used here is the long-term steady-state value. The solid line charts the actual data while the dotted line is a straight line with the same starting and end points. The straight line indicates constant returns as treatment level increases. As indicated, the actual data lies below the straight line. This demonstrates that increasing spay/neuter levels shows diminishing returns. In other words, as more and more people spay and neuter their animal, additional increases in the spay/neuter rate show less benefit. However, it should also be noted that the curvature of the data points is mild, indicated that returns do not diminish very rapidly.~~

Data and Funding for this study come from Maddie's Fund. Correspondence should be sent to
FIREPAW, 228 Main Street, #436, Williamstown, NY 01267-2641, Phone: 518-462-5939, email: firepaw@earthlink.net



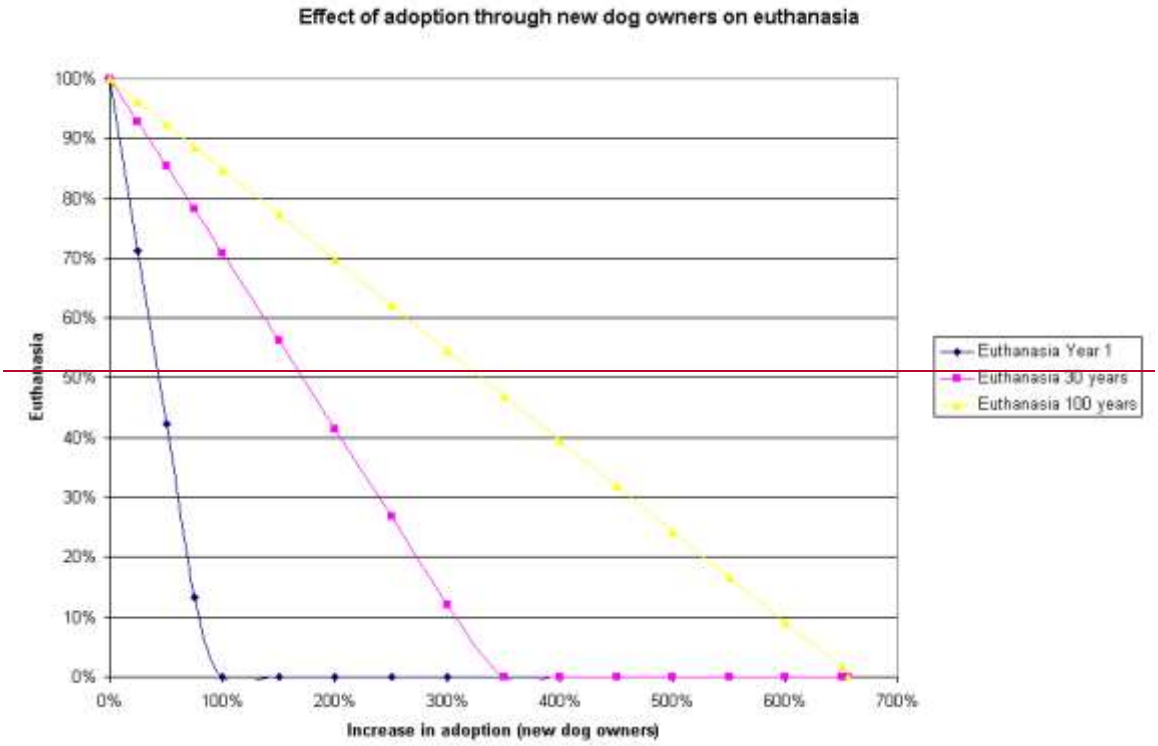
~~Figure 7.18: Effect of increasing spay/neuter rate on euthanasia~~

~~The second treatment tested was increasing adoption through substitution of sources (as opposed to adoption by new dog owners). As indicated on the graph below, if the adoption rate increases 90%, the region can become sustainably "no-kill". The graph also shows approximately constant returns to scale, with the dotted straight line appearing almost directly below the data points. Once again, the euthanasia rate used here is the steady state value.~~



~~Figure 7.19: Effect of increasing adoption through substitution on euthanasia~~

~~The next treatment to be tested was increasing adoption by attracting new dog owners. As the graph below indicates, the results for increasing adoption by new dog owners is dramatically different than the results for increasing adoption by substitution of sources. Using the euthanasia rate 100 years after treatment, the adoption rate would have to increase 656% using new dog owners to eliminate all euthanasia (compared to an increase of 90% for substitution of sources). Also in this case, three data series are shown. This is because the impact of the treatment is quite different depending on what time period is considered.~~



~~Figure 7.20: Effect of increasing adoption by new owners on euthanasia~~

~~Looking at the impact one year after treatment, euthanasia reaches zero when the adoption rate is increased close to 100%. However, looking at euthanasia after 30 years or after 100 years, the effort required to reach "no kill" increases dramatically. Intuitively, this is because the number of pet owners has increased due to the higher adoption rate, which causes more abandonment and reverses much of the benefits of the increased adoptions. It should also be noted that returns to scale are close to constant.~~

~~The final treatment examined here was decreasing the abandonment rate. The graph below indicates the reduction in the abandonment rate required to reach a no-kill level. In this case, abandonment was assumed to be reduced without changing the number of~~

dogs purchased. This is done for two reasons; first it allows us to observe the impact of changing the abandonment rate alone, and second the prior assumption used does not work for this particular exercise. The prior assumption was that dog purchases go down 2% for every 1% drop in the abandonment rate, however using this assumption, the abandonment rate can only be reduced by less than 50% (otherwise dog purchases go down to zero). Using this methodology, no abandonment rate reduction less than 50% leads to a long-term "no-kill" scenario. Therefore, a no-kill goal can only be achieved for this exercise if we assume that the abandonment rate can be changed in isolation. As in the previous graph, because of widely varying effects over different time horizons, the euthanasia rate is shown for 1 year, 30 years, and 100 years.

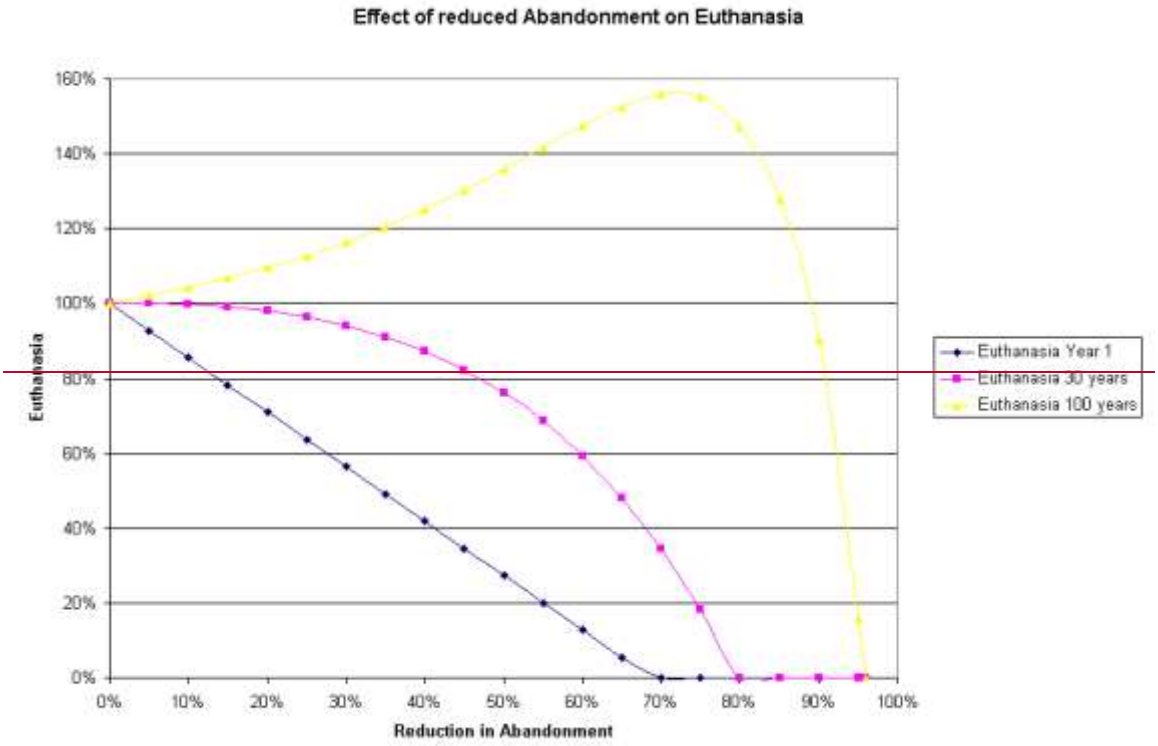


Figure 7.21: Effect of reducing abandonment in isolation on euthanasia

~~As indicated, the abandonment rate must be reduced about 70% to stop euthanasia in one year. However, abandonment rates must be reduced 96% to keep the euthanasia level at zero for 100 years. But the most interesting part of the graph is the shape of the curve as the time horizon changes. At a 100-year horizon, euthanasia sharply goes up before it declines. Once again, this is due to a sharp dog population increase that occurs under the assumptions used in this treatment. It was assumed under this treatment that birth rates (per dog), pet purchases, and adoptions remain stable even though abandonment rates go down. Therefore, the dog population increases and the number of dogs abandoned increases in some cases even though the abandonment rate goes down.~~

~~The final question regarding the effect of combining treatments (i.e. are there synergies or possibly reduced effectiveness when combined) can be answered by using the economic concept of a production possibilities frontier (PPF). A PPF curve shows all the combinations of two inputs that can be used to achieve a certain level of output. PPF curves were created for different pairs of treatments. A goal of reducing euthanasia by 50% over a 30-year horizon was chosen to calculate the PPF.~~

~~The graph below shows the PPF curve for different levels of improvements in spay/neuter rate and adoption rates.~~

Data and Funding for this study come from Maddie's Fund. Correspondence should be sent to
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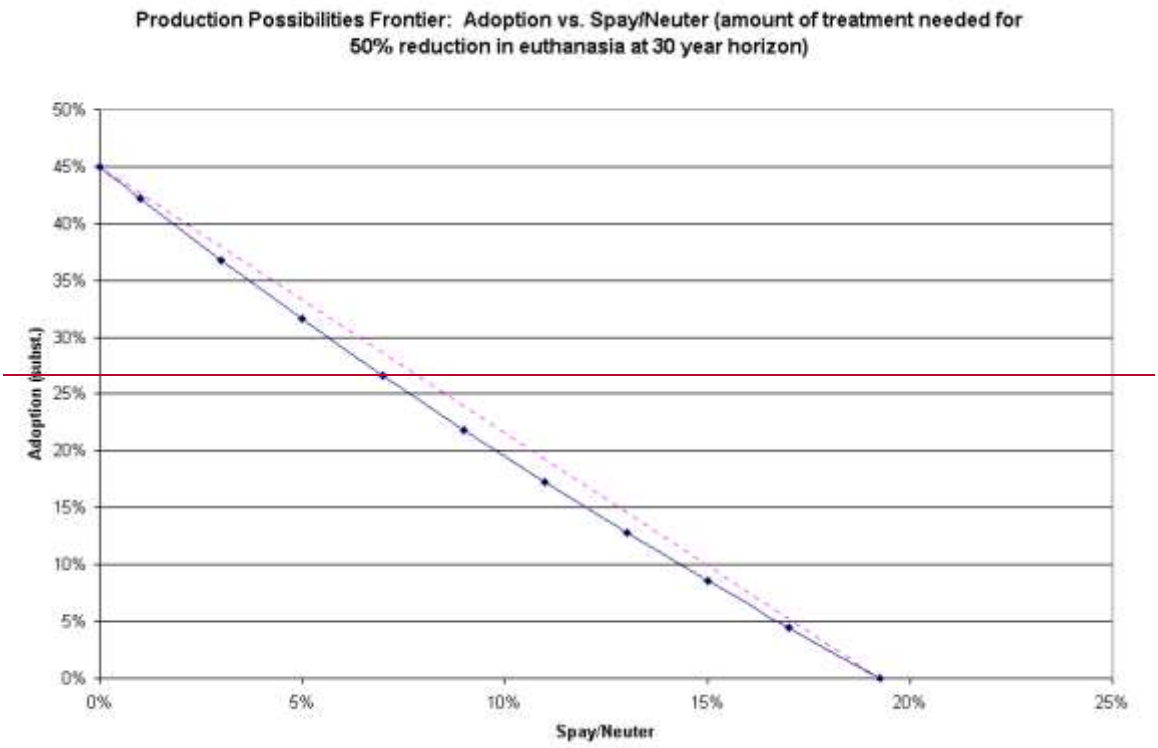
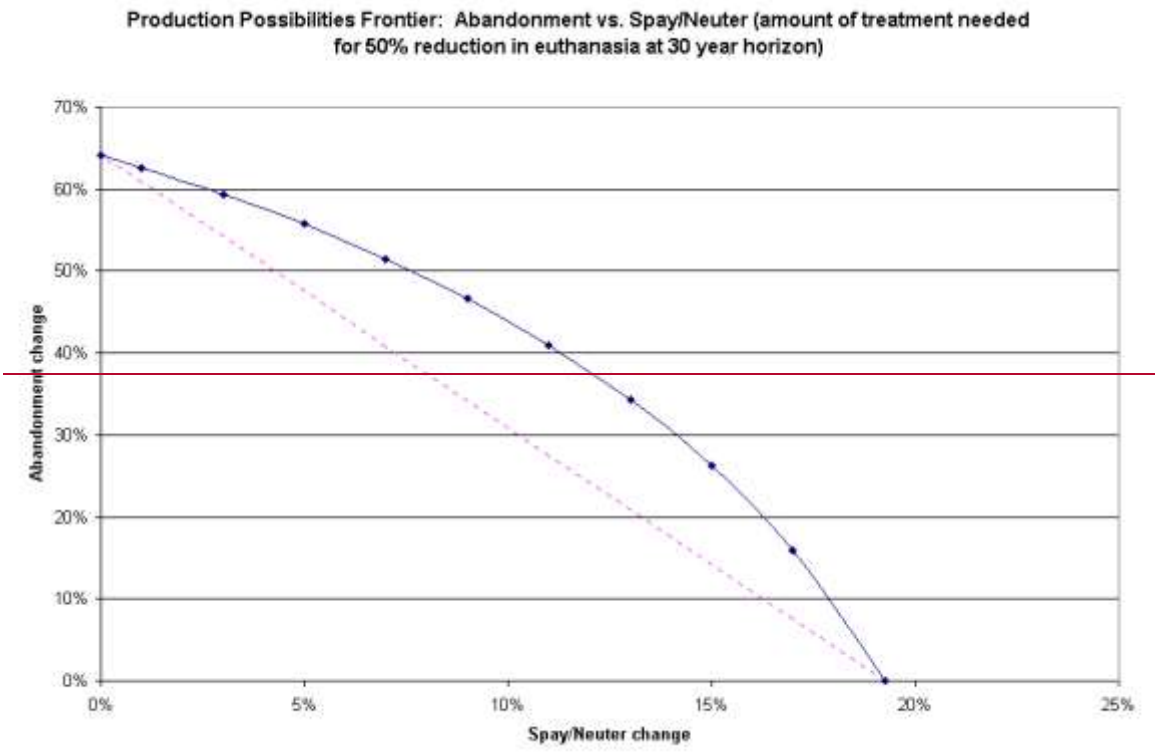


Figure 7.22: Production possibilities frontier for adoption through substitution vs. spay/neuter

The axis for adoption indicates the percent increase in the adoption rate from its starting level. Adoption is assumed to be through substitution in all the PPF curves. The spay/neuter axis indicates the percentage decrease in the number of people not spaying/neutering their dog. The dotted curve is a straight line, while the actual data (solid curve) plots slightly below this line, indicating that less resources are required in combination than when the two treatments are done separately. In other words, there are some synergies when the two treatments are done in combination.

However, the other two PPF curves show the opposite situation. The curve below shows spay/neuter combined with reduced abandonment.



~~Figure 7.23: Production possibilities frontier for abandonment vs. spay/neuter~~

~~The abandonment axis indicates the percentage reduction in abandonment rates. For the sake of consistency with the prior "no kill" simulation, it was once again assumed that abandonment rates were reduced without affecting other model variables. The curve lies above the straight dotted line, indicating that more resources are required when the two treatments are done in combination than when they are done separately. Somehow, these two treatments hamper each other's effectiveness.~~

~~The final PPF curve below shows abandonment and adoption treatments in combination. Once again, the actual data lies above the dotted line indicating that these two treatments also hamper each other's effectiveness when combined.~~

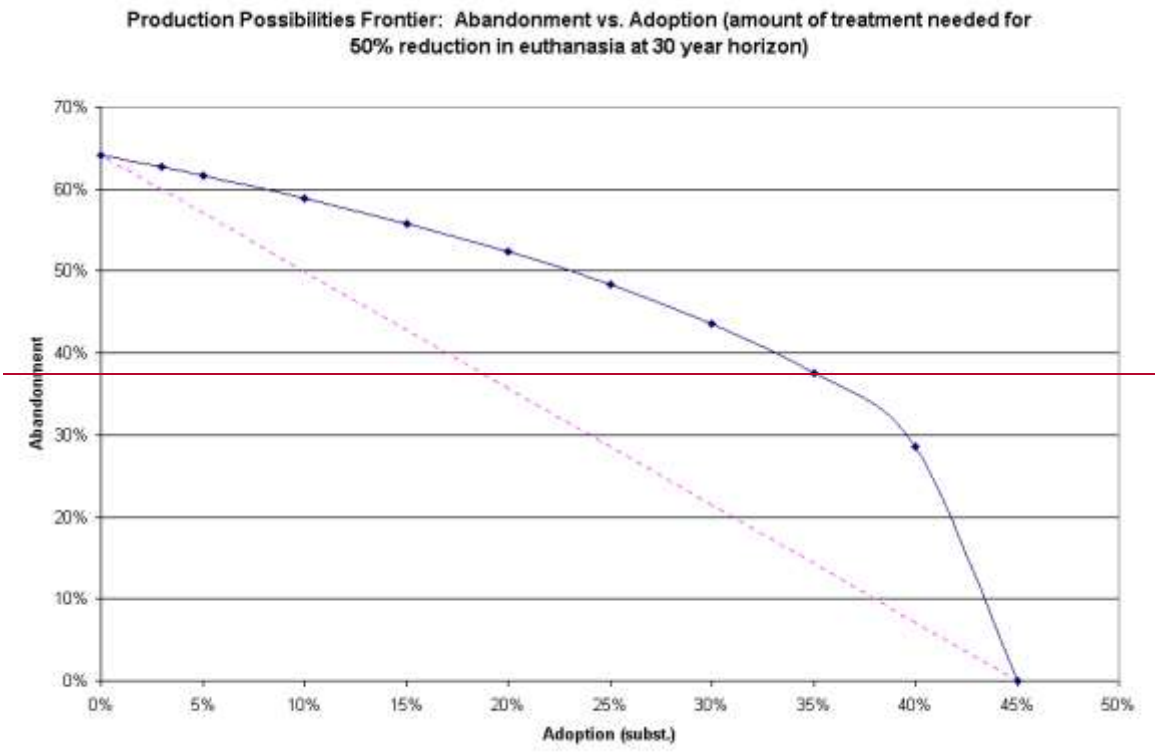
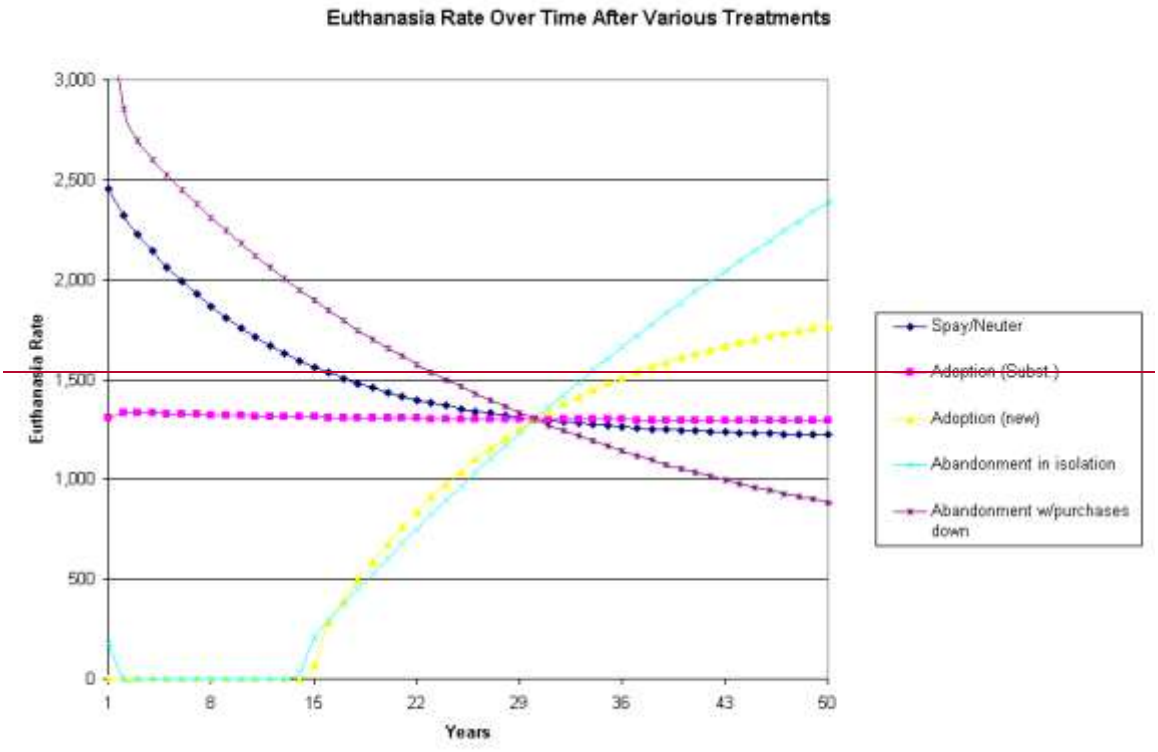


Figure 7.24: Production possibilities frontier for abandonment vs. adoption through substitution

7.2.2.12 Effect of Time

Often, fairly long time horizons have been utilized here to address the question of sustainability and long-term steady state. However, a very important question to a community or organization that decides to spend a large amount of money on an effort to address the surplus dog population problem is how long they need to wait for the treatment to show full effectiveness. Once again using the simple goal of reducing euthanasia rates, the following graph shows how the euthanasia rate changes over time for various treatments. The level of each treatment is chosen to create a 50% reduction in euthanasia rates (compared to the before-treatment rate) after 30 years.



~~Figure 7.25: Impact of various treatments over time~~

~~The chart shows that the spay/neuter treatment benefits occur gradually, and stabilize given this level of treatment after about forty years. Increasing adoption rates through substitution shows immediate and permanent benefits, with only a slight change over time. Adoption by adding new dog owners also shows immediate benefits. However, this benefit decreases over time as the dog population rises. Eventually, the benefit appears to stabilize at a new reduced level. Decreasing abandonment rates also shows immediate benefits if it is assumed that this variable can be changed in isolation. However, these benefits disappear as the dog population rises. On the other hand, if we assume that abandonment can only be reduced by deterring likely abandoners from purchasing dogs and we use the same percentage as before (i.e. two dog purchasers must~~

be deterred to eliminate one abandonment), then the abandonment treatment has exactly the opposite pattern over time. Initially, the euthanasia rate is high (this is due to adoptions going down along with other sources of animal supply). However, this euthanasia rate goes down rapidly, and eventually becomes the lowest of all treatments on the graph.

8. DISCUSSION AND CONCLUSIONS

According to the results of the model, if the goal is to make the New York State Capital Region to a "no-kill" area, this could quite possibly be achieved at a cost of a couple hundred thousand dollars a year (with the exact amount depending on exactly how the result would be achieved and how quickly the goal is to be achieved). With over 173,000 households willing to pay about $15 on average to eliminate the dog population problem according to the survey, this suggests that the goal of becoming a "no-kill" region may be well within reach at a price that the public as a whole would find acceptable.

However, to arrive at quantifiable cost efficiencies for a wide range of hypothetical and untested programs, some significant assumptions were made in this study. These assumptions included advertising response rates and costs, other program costs, consumer behavior assumptions (such as how an increase in adoption demand comes about), model parameters/dynamics (which imply the indirect population responses to treatments), and assumptions about the survey being representative of actual behavior/preferences by the

general public. As with all mathematical models using complex assumptions, actual results may differ from the model results. Therefore, these results in general should be considered suggestive rather than conclusive.

However, even if the numbers coming out of this research cannot be assumed to be highly reliable cost estimates, they do hold much value for policy decisions. The research shows how treatments interact when combined, how the effects change over time, how different definitions of welfare affect the results, and how the effectiveness of treatment may change as society approaches a "no-kill" status. Perhaps most importantly, even if treatment effectiveness varies from the results here, this study gives policy makers a powerful starting point which can be used to decide what programs are likely to be effective at certain goals and therefore deserve to be tested in a real pilot program (such as a limited advertisement campaign prior to conducting a larger scale campaign).

8.1 General Findings

The model and survey results have provided many valuable insights that can be useful to policy makers and other researchers. These findings include:

The Importance of Welfare Definitions: One recurring theme throughout the results coming from the model was the importance of specifying what is meant by "welfare". The model clearly demonstrates that two advocates of animal welfare with different definitions of "welfare" could reasonably support quite disparate and even opposing policies. Therefore, if groups or individuals working to improve the welfare of animals

decide to combine their efforts to reach what they believe are joint goals, those groups/individuals should first explicitly verify that their goals are in fact identical. What seem like minor differences in how goals are defined could in fact lead to major differences in what treatment should be prescribed.

The possible welfare measures or definitions are limitless, and only a small group of these possible measures have been used in here. It is not claimed that any of the somewhat arbitrary measures used here is the "right" one, but they were intended to give a cross-section of some reasonable measures that could be used and show how these definitions affect the results. Some issues have not been addressed at all in the welfare measures here. These include how the quality of life varies for dogs between shelters and between households. In terms of shelters, the welfare of a dog at a shelter can range from negative (i.e. better off dead) to very high, depending on the shelter and the perspective of the observer. The physical conditions for dogs at some shelters can be uncomfortable, unpleasant, and unhealthy. The conditions at some no-kill shelters can be much different. For example "Best Friends", a large animal sanctuary in Utah, with 700+ dogs includes large enclosures where dogs roam freely and can interact with other dogs. The conditions at rescue organizations that place dogs in foster homes can also be much more pleasant than a typical shelter.

The conditions and welfare of dogs in the owned population also can vary greatly. At the bottom in welfare terms are those dogs who suffer overt abuse or extreme neglect. Probably one slight step up are those dogs who are fed and not physically abused, but who are kept permanently chained with little or no stimulation or activity. The welfare of dogs in these situations raises a real dilemma and point of controversy among animal

advocates. Some would probably argue that a dog at a shelter (who will probably be euthanized) is better off to not be adopted into such a home while others would argue that any except an extremely cruel home is better than no home at all. Since some rescue workers and shelters do screen prospective adopters rather heavily despite the magnitude of the excess dog population, this question has important implications regarding policy. Of course, above the level of dogs kept on a chain with little stimulation there are a range of home environments that dogs live in, where dogs enjoy a range of levels of status, care, attention, and freedom. With one exception, no attempt was made in this study to take into account how the various treatments postulated here affect the quality of life for dogs in homes, though it is in fact possible that the quality of life for the marginal owned dog (i.e. the dog added or subtracted from the population due to a policy change) may be systematically different than the quality of life for the average owned dog.

One welfare effect found in this study that needs to be considered when debating policy is the trade-off between death/suffering and life. Reducing euthanasia through programs such as spay/neutering more animals may also have the unintended consequence of reducing the number of animals living in homes. This is because there is assumed to be some "supply-push" effect. Purchasing or adopting a dog is often an impulse decision that happens serendipitously. It may occur because a friend or relative knows of a dog that needs a home or because a stray dog is simply found and taken in. More dogs born may lead to more death but it also paradoxically leads to more life.

This implies a dilemma that is often not considered by people working to improve the welfare of dogs. Typically these efforts will be aimed at reducing the obvious signs of disutility in the dog population (i.e. reducing the unnecessary suffering and death that is

often seen particularly among unwanted dogs). However, some thought should first be given to whether reducing disutility is really doing the same thing as increasing utility. And when these goals do not coincide, those interested in animal welfare need to consider what goal they should be working to reach.

In the end, much will depend on the perspective of the decision-maker. If death (assuming it comes without suffering) is viewed merely as a lost potential for a life rather than a harm in itself (i.e. death is merely "the absence of life" rather than an inherent source of disutility), then maximizing life (as long as it is a worthwhile life rather than an unpleasant life) is a more important goal than minimizing death. On the other hand, if death is viewed as a great inherent harm (or alternatively if the suffering of strays and shelter animals is considered a greater harm than the possible utility gained by an owned dog), then minimizing death and abandonment is the appropriate goal. By highlighting the importance of precisely defining welfare, the results of this dissertation have relevance for the general philosophical debate on animal rights and animal welfare. Just what is meant by rights and utility needs to be precisely defined. This insight may disfavor solely using a rights approach that utilizes broad categories that are only vaguely defined.

The Importance of Indirect Effects: A second important finding of this study is that in a complex and dynamic population such as dogs, simply looking at the immediate impact of a measure is not sufficient. There can be significant indirect effects that must be considered. One way to consider these indirect effects is by using a population dynamics model such as the one developed here.

~~For example, if a region or organization decides to reduce the number of surplus dogs at shelters by encouraging people who do not currently own a dog to adopt a shelter dog, the direct and indirect effects can be quite different. The direct effect is an increase in shelter adoptions and improved flow out of the shelter. However, eventually dog ownership has also been increased which will also at least partially offset the increased adoptions by eventually leading to more dog abandonment.~~

~~The importance of indirect effects is already known to some extent by animal welfare policy makers. Spaying/neutering animals does not directly save any animal, yet it is often advocated as a key method of addressing overpopulation. There is an obvious indirect linkage that policymakers assume between spaying/neutering now and future dog overpopulation. Since altering spay/neuter behavior was among the most powerful measures studied here, the importance of indirect effects is quite clear. However, the model also demonstrated many indirect effects that policymakers may not typically consider, such as the example given earlier.~~

~~**The importance of time horizon:** A closely linked finding from this study is that time horizon can have an important impact on welfare outcomes. As demonstrated using the model results, the relative effectiveness of a set of treatments can differ substantially when the time-scale is changed. For example, the effectiveness of reducing euthanasia by increasing spay/neuter behavior builds up over time as does the impact of reducing abandonment by discouraging dog ownership among people who are likely to abandon. On the other hand increasing adoptions or reducing abandonment by getting current dog~~

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owners to keep their animals initially is very powerful but can lose effectiveness over time.

Perhaps more surprisingly, not only can treatments change effectiveness over time, but they can actually change the sign of their welfare impact. In other words, a treatment that initially improves welfare could eventually reduce that same welfare measure or visa versa. Therefore, it is very important for policy makers to know what time-frame they are considering. In terms of what the "right" time-frame is, working for short-term improvements can be attractive (especially since population dynamics can change long-term in a non-controllable manner without any intervention due to changes in societal norms and culture), however policy should be implemented with some thought given to its long-term sustainability.

In addition to highlighting the importance of short versus long-term times frames, this study also gives some insight into just what is the short, medium, and long-term for animal welfare treatments. In general, many would probably find the time-frames over which changes took place here surprisingly long. Five or ten years may not be enough to see the full impact of a policy. Sometimes a time horizon of thirty years or more is needed. Even after thirty years policies can still change in their impact.

This can be frustrating news for policy makers who want to have an immediate impact. Unfortunately, some of the most effective treatments (such as changing spay/neuter behavior) only show their impact after many years. It also has implications for empirically evaluating the effect of a real program. For example, analyzing the change in shelter inflows three or even five years after implementing a regional spay/neuter program will greatly underestimate the program's long-term impact.

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On the other hand, the length of time it takes to fully realize the impact of some policy changes can also be interpreted as good news. There is some evidence of shifting in public attitudes/behaviors and reduced dog overpopulation in recent decades. Because of the gradual impact that these changes in attitudes have, it is possible that the dog overpopulation problem will continue to improve for many years to come based on prior shifts in behavior.

Advantages/Disadvantages of Various Treatments: Of course, one of the key insights gained from this analysis is the advantages/disadvantages of the specific treatments studied here. First, it should be noted that no single treatment can be described as "optimal" or even most cost-effective. This is because the relative efficiency of various treatments depends on the definition of welfare and the time frame being considered. However, this dissertation did bring out many advantages/disadvantages to the possible treatments considered.

Low-cost Spay/Neuter Programs: Despite arguments made by some researchers to the contrary, based on the reported sensitivity of survey respondents to a price reduction, subsidized spay/neuter programs have the potential to be a very powerful tool. One advantage of this type of treatment is its cost-effectiveness, although its efficiency depends greatly on how many people use the spay/neuter program who would have spayed or neutered their animal anyway. However, one of the reasons some researchers claim these programs are not very effective is that only a small percentage of the population utilize these programs when they are put into place. This could actually be interpreted as evidence that these programs are cost effective since most of the population

~~that spay/neuters their animal anyway are still going through their traditional veterinary practice for the spay/neuter procedure. Yet at the same time, as the results of this study indicate, the program can still be very powerful because a small change in the spay/neuter rate can result in a large change in euthanasia and abandonment rates.~~

~~A second advantage of a low-cost of spay/neuter program is that it improves in effectiveness over time. Even after thirty years, there can still be small improvements in euthanasia rates from a one-time permanent shift in the spay/neuter rate. However, this is also a disadvantage of a spay/neuter program since it can take close to a decade for even 50% of the program's eventual impact to be felt.~~

~~Another disadvantage of a subsidized spay/neuter program is that though it can be quite powerful, it has a limited potential impact. Based on the number of people who reported being willing to spay/neuter their dog at a lower price, a subsidized spay/neuter program could not bring the region to a "no-kill" level on its own (though it could reduce euthanasia by more than 50%). Spay/neuter programs also show some diminishing returns, so that the effectiveness of the treatment goes down slightly as society dynamics approach a euthanasia rate of zero.~~

~~A final disadvantage of a low-cost spay/neuter program is that it does not necessarily lead to an improvement in welfare across all possible measures. In fact, programs that increase spay/neuter behavior reduce death, abandonment, and euthanasia by reducing the size of the population. Therefore, the number of dogs living in homes is also reduced by spay/neuter programs. In fact, if an additional year of life in a home is considered as important as reducing the death of one dog, the model would indicate that spay/neuter programs are not an improvement at all.~~

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Spay/Neuter Public Education Efforts: The advantages and disadvantages of a spay/neuter public education effort are very similar to those for a low-cost spay/neuter program since both efforts focus on influencing the same model variable. Like a subsidized spay/neuter program, an education program can be very powerful with the impact improving over time. On the other hand, the program is slow to reach full effectiveness and has a negative impact using some welfare measures.

One difference between a public education program and subsidized spay/neuter program is that an intensive public education program may do enough alone to allow society to reach a no-kill goal (because only some people are responsive to monetary incentives while more may be responsive to a social message or a shift in cultural norms). As indicated in the results section, the cost of a subsidized spay/neuter program is in the same general range as the cost of a public education spay/neuter program. Exactly which program would be cheaper depends on many factors such as the public's responsiveness to the education campaign and how many people utilize the spay/neuter program, though the results here indicate that the public education program is likely to be slightly more cost effective.

The survey results also suggest that a public education program may make the public more sensitive to a subsidized spay/neuter program, therefore a spay/neuter effort using both approaches may be more cost effective than either program alone.

Public Education Campaign to Encourage Adoption: An important distinction needs to be made with any program that encourages adoption. One way to increase adoption rates is to get current purchasers of dogs from other sources to adopt their next dog. The second route to increasing adoption is by influencing people who would not otherwise

purchase a dog at all to adopt a shelter dog. The survey results suggest that there could be potentially satisfied dog owners who do not yet own a dog. This is implied by the survey results which indicate median benefits of dog ownership are higher than expected, even for experienced dog owners, while median costs are equal to expectations. This suggests that there may be more potential dog owners who would gain more benefits than costs from ownership but who are simply not aware of the benefits that they would receive.

In the very short-term both adoption through substitution and through new ownership have similar impact on reducing euthanasia, while getting new owners to adopt has the added advantage of yielding a net increase in the number of dogs in good homes (assuming the average home for a dog adopted through these efforts is "good"). However, long-term, adoption through substitution causes a permanent benefit in terms of reduced euthanasia. On the other hand, adoption by new owners increases the population size causing future abandonment that can eventually negate part or even all of the initial reduction in euthanasia rates.

If we assume that a public education campaign can successfully target adoption through substitution, the program can be very effective at reducing euthanasia and has an immediate and permanent benefit (assuming the switch in behavior is permanent). One disadvantage of this type of program is that it has little or no effect on other dimensions of animal welfare outside of euthanasia (among other things it has no effect on the number of dogs dying as strays) and therefore has a low cost-effectiveness when measured with welfare scales other than purely the euthanasia rate.

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~~Financial Incentives for Adoption: By levying a tax on alternative sources of dogs, adoption rates can also be increased. The advantages and disadvantages to this measure are similar to those for a public education campaign that encourages adoption through substitution. One potential advantage of using a tax is that it can effectively focus on substitution rather than encouraging a mix of new adoptions and substitution adoptions. This is because a tax on other sources does nothing to encourage animal ownership. In fact, if anything dog ownership may go down if some owners choose not to purchase animals due to the tax rather than substituting sources. Whether reducing dog ownership is a benefit or a cost once again depends on how animal welfare is defined.~~

~~Another potential advantage of a tax over a public education program is that a rough cost/benefit analysis indicates that it probably would be more cost effective (in terms of the social cost of the tax) than a public education program. In addition, since the cost is a social cost and there is a net inflow of cash to the government, there is no problem financing the program and it could in fact be used to finance other animal welfare efforts. On the other hand, the most obvious disadvantage of such a tax is that it would face stiff political opposition, both from consumers and from breeders/pet stores. Enforcement also could be a problem. The tax could also have the unintended effect of encouraging home-breeding of animals if this source of new dogs could not effectively be taxed.~~

~~It should be noted that if the goal is to encourage the adoption of unwanted animals, found/stray animals could be exempted from the tax (this would also be a difficult channel to enforce in any event). However, though this treatment appears to be cost efficient, the practical considerations may make this option unattractive.~~

~~Increased/Improved Shelter Marketing: If it is assumed that shelter marketing attracts new dog adopters as well as causing substitution, the effects of this treatment can be quite different than for a treatment that just encourages adoption through substitution. In general, because of the indirect increase in abandonment from increasing the dog population, this treatment will be less cost effective long-term at reducing euthanasia than encouraging adoption purely through substitution. The other disadvantage is that the effectiveness over time of this treatment goes down (in terms of reducing euthanasia). The advantage of this treatment is that it can have a positive effect on other welfare measures that consider the number of dogs in homes to be a benefit. An additional advantage of this treatment is that it may be more cost effective than presented in the results section here. This is because there appear to be many opportunities to improve shelter marketing. Therefore, such a program might get a higher response rate than the generic rate presented in the results section.~~

~~Opportunities to increase marketing include listing adoptable dogs through various media sources and physically showing these animals in public forums. Shelters already do this to some extent. For example, one local television news broadcast, one large regional paper, and one smaller local paper regularly feature available animals at the Mohawk Hudson shelter. There are also occasional events/promotions done in conjunction with corporate partners. However, much more could be done in this area. For example, the newspapers featuring adoptable animals have done this on there own initiative rather than through any concerted effort from the shelter, and the single largest paper in the region does not include any regular feature on adoptions. Local media are often very receptive to broadcasting this kind of information free of cost, since as the~~

~~publisher of one local paper stated "we get more response to animal features than to anything else". Simply putting the information into the hands of the media rather than making the media work to get the information could go a long way.~~

~~Another area that could be quite fruitful for marketing is focusing on the population looking particularly for pure-bred animals and puppies. Shelters could advertise the presence of these animals through the media. In addition shelters could maintain lists of people interested in particular types of animals and contact those potential adopters when animals of that type become available.~~

~~Potential adopters who do not adopt due to lack of selection can also be addressed through exchange programs with nearby shelters. If transportation costs are reasonable, cross-listing animals that are in nearby shelters can improve the selection available to consumers visiting any of the shelters.~~

~~Marketing can also be used to address the concerns of consumers regarding shelter animal quality. This may be more of a perception issue than an issue of actual animal quality. The survey results here indicate that unexpected costs are not any higher for shelter animals (in fact if anything they are lower) and unexpected benefits also are at least as high. If the issue of shelter quality is one primarily of perception, marketing can be very effective tool at altering perceptions. For those potential adopters who associate animal history with quality, more effort can be made to get information/keep records on incoming animals and notify potential adopters when this information is available.~~

~~Another group of potential adopters that could potentially be reached are those that find a shelter "too depressing". Changing shelter layouts, procedures, or bringing the animals to the public using a mobile unit in high-traffic areas are ways to reach this~~

group. Other marketing channels that are rarely used including simply paying for either direct mail or media ads that focus on available animals. If potential marketing efforts such as those suggested above lead to a high response rate at a relatively low cost, the cost-effectiveness of marketing could be much higher than the rate shown in the model results.

Public Education to encourage "responsible pet ownership": As indicated in the results section, the impact of a program to encourage responsible pet ownership and thereby reduce abandonment varies in effectiveness depending on how much it reduces pet ownership relative to how much it reduces abandonment (presumably the program would include public service announcements indicating that pet ownership is a big decision, that pets are not disposable, and encouraging people to think hard before getting a pet they may not keep). One disadvantage of this treatment is that it has a relatively moderate cost-effectiveness. Another disadvantage is that if pet ownership is not assumed to go down, then the reduced abandonment eventually leads to more dogs and the breeding of these dogs leads to a population increase which can make up for any initial reduction in abandonment/euthanasia rates.

However, on the other hand, if pet ownership does go down at least as much as the abandonment rate, the impact of this treatment actually grows over time in terms of reduced abandonment and euthanasia. Another potential advantage of this treatment is that by encouraging responsible pet ownership it has the potential to increase the welfare of dogs within the home both by changing the treatment of dogs by owners and by changing the average profile of who owns a dog. As shown in the results section, if the average welfare of owned dogs improves enough, all welfare measures used here can be

increased by this treatment and the potential cost effectiveness of this treatment is improved.

Increasing Shelter Space: Money to increase the amount of shelter space is a common plea of animal welfare organizations and shelters. More space seems intuitively to many to mean that less animals will have to be killed since animals are only killed when a shelter runs out of space. However, this intuition is not generally correct. As shown in the results here, for most communities, there is little direct impact on euthanasia rates from having more space to shelter the animals. This is because having a larger "stock" does nothing to change the flow of animals in and out of the shelter, and as long as the inflow exceeds the outflow by the same amount, about the same number of animals will have to be killed. However, there are two situations where shelter space can make a significant impact. The first is when increased space improves selection and therefore increases adoption rates. As shown in the results section and based on the responses to the survey, improving selection through expanded shelter space can be an effective method of increasing adoptions and reducing euthanasia. In fact, at moderate levels, this can be among the most cost-effective treatments at reducing euthanasia. Since this treatment will most likely increase adoption through substitution of sources, its other advantages and disadvantages are similar to those discussed previously for financial incentives or public education campaigns to increase adoption. One additional advantage of this particular treatment is that it is very cost effective at low levels while an additional disadvantage is that the marginal effectiveness rapidly declines at higher levels of treatment.

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~~A second important scenario where increased shelter space can be very powerful is when the inflow of animals into a shelter is close to the average flow of animals out of a shelter (i.e. when society is close to "no-kill"). As stated previously when inflow is much higher than outflow, killing cannot be avoided. On the other hand, when inflow is much less than outflow, high shelter capacity is not necessary. But when inflow is very close to outflow, seasonal and random variation in these flows can cause animals to be killed that would not need to be killed if there was an adequate buffer of shelter space. Under these flow conditions, moderate increases in shelter space can make a large difference in euthanasia rates. This is in addition to any benefit from increased selection due to more shelter space.~~

~~What it takes to get to "No Kill":~~

~~One encouraging finding of this research is that society (at least for an area with dynamics similar to the Capital Region of New York) can reasonably achieve a "no kill" goal. The exact cost would depend on the assumptions, methods, and time frames used. The optimal strategy would probably be to start by expanding shelter space until the marginal benefits of increased selection start to decline below that of the next best alternative, then a combined spay/neuter education and subsidy program would be the next most effective treatment at reducing euthanasia. The goal of no euthanasia might be achievable with annualized spending of as little as a hundred thousand dollars to two hundred thousand dollars a year using this strategy.~~

~~With over 173,000 households in the region, this comes out to about a dollar a household which is far less than the average willingness to pay to reach this goal of~~

$15.08 found among random respondents to the survey. Even if the cost estimates used here significantly underestimate the cost of reaching a "no-kill" goal, the cost could be a level of magnitude higher and still fall within the region's willingness to pay. It should also be noted that this willingness to pay does not even consider any value of a dog's life to the dog itself. If a dog's life is given value beyond the amount sympathetic human beings place on it, then the amount that would be reasonable to pay to reach this goal may be much higher.

The results of the model indicate that the only real obstacle preventing society from stopping the killing of millions of healthy but unwanted dogs every year is the will to make that goal reality. Measures are available that could reach the goal at a price that is not cost-prohibitive for society. In fact that price is probably significantly less than the amount people as a whole are willing to pay to achieve that goal.

Value of shelter space/role of shelters: The predisposition of many employees and volunteers working with shelter animals seems to be that the best way to help more dogs is to work towards increasing the number of animals that can be sheltered. However, the results of this research suggest that the efforts of shelter administrators may be much better spent focusing on increasing the flow of animals out of the shelter (i.e. increasing adoption rates). In fact, except when inflow is very close to outflow, the only value of additional shelter space is in its ability to increase adoption rates by improving selection. However, there are many other ways to increase adoptions other than increasing selection. Shelter personnel should probably focus on increasing adoptions as their goal

rather than shelter space as a goal in itself, since additional space does little to alleviate the dog overpopulation problem as long as the flow of dogs remains unchanged.

Combined effects/economies of scale: The results here also showed some useful information regarding the impact of combining treatments and increasing levels of treatment. In terms of increasing levels of treatment, the results are encouraging. Increasing adoption shows constant returns to scale and so does decreasing abandonment over short time horizons (over moderate time horizons, decreasing abandonment shows increasing returns to scale). Spay/neuter treatment shows some evidence of declining returns to scale, but even in this case the decline is gradual, with spay/neuter treatment still showing good effectiveness as society approaches a no-kill status.

In terms of combining treatments, decreasing abandonment loses some of its effectiveness when done in conjunction with other treatments. However, increasing adoption and increasing spay/neuter rates actually show some synergies when combined. The results indicate that it would generally be better to use these two treatments in combination than to use decreasing abandoment rates along with other treatments. However, there are still marginal benefits to decreasing abandonment if it can be done cheaply along with other treatments, therefore there may be cases where this method should be used simultaneously with others. For example, if a public education campaign is being conducted to increase adoption and/or spay/neuter rates, if reducing abandonment can also be added to the advertising message with little extra cost, then it is probably worthwhile to do so.

The cost of dog overpopulation: The results here provide several useful sources of information regarding the cost of dog overpopulation. One source is the amount of

money people actually spend to address this problem. According to the survey results, the random respondents donated an average of $12.85 per year and volunteered an average of 5.4 hours to help animals and animal welfare causes. However, not all of these time and monetary donations have been spent to benefit dogs. There are a variety of animal welfare causes that have nothing to do with the dog and cat population. In terms of time donations, there are more opportunities to work with the local cat and dog population than there are to work more remote animal causes. The free response comments on the survey also support the conclusion that the vast majority of time donations are made to benefit dogs and cats. If we assume that 80% of time donations are to benefit dogs and cats and that this 80% is split 50% between dogs and cats, then 5.4 x 0.40 = 2.16 hours is the amount spent per year on average to benefit dogs. If we assume even a modest average hourly wage of $10 hour (the median household income in the region is $36,000 which would suggest a higher hourly rate if less than two people are working per household on average), this implies an average time donation of $21.60. Even if the wage rate or the amount of time being devoted to dogs assumed here are incorrect and the exact value of the time donation varies from this amount, it is still quite clear that using monetary donations alone greatly underestimates the public's willingness to pay since time donations appear to be many times higher in value than monetary donations.

The results of the question regarding respondents' willingness to pay to eliminate dog overpopulation indicate an average willingness to pay among random respondents of $15.18. However, it is not clear whether respondents were willing to pay this instead of their current time and monetary donations or in addition to their current donations. If it is

assumed to be in addition to current donations, then this makes the average total willingness to pay much higher than this amount.

A final important question is what the cost of dog overpopulation would be if we move away from an anthropocentric definition of value and grant value to a dog's life independent of human valuation. Developing an adequate theory and methodology of valuing animal life is beyond the scope of this dissertation. However, it is worthwhile to very briefly explore this concept in light of the survey results.

In many respects the value of human life is determined by the market place. However, even looking purely at human life, many would disagree with this marketplace valuation since it values the lives of the rich greater than the poor (this objection is discussed in Kelman, 1981 and Jones-Lee, 1994 for example). Public policy must frequently value human life in the course of making decisions (for example in deciding how much to spend to reduce the risk of death from a given source). Again, reviewing the entire literature on valuing human life is beyond the scope of this dissertation. However, it should be noted that many of the techniques used for valuing human life used in public policy would not be viable with non-humans. Dogs do not make choices regarding job risk, purchase insurance, or otherwise make economic decisions that would reveal their preferences. However, there are some techniques that can lend insight here. Weisbrod (1961) discusses two measures of measuring the value of life. One is the discounted value of future earnings and the second is the value of earnings net of consumption (i.e. earnings minus consumption). Although dogs do not keep earnings, they do provide services that are valued by human beings. One measure of value of the services provided by a dog is the amount that people would be willing to accept in exchange for their dog.

~~This methodology would results in a relatively high value for a dog's life between $233,000 and $813,000. Even if "consumption" by dogs was netted out of this calculation, using a figure of $600 per year from the literature review section, if an average dog lives about ten years, than the value of a dog's life is still $227,000 to $807,000.~~

~~Another method of valuing a dog's life is to use the amount that people are willing to pay for a medical procedure to save that dog. This method may be biased downward since some respondents indicated that they are willing to spend less because the dog is very old. Using this methodology, the value of a dog is between $7,400 and $22,700. A final method that could be used is to take the amount that is typically paid by an owner for the dog over its lifetime which at about $600 a year would very roughly be $6,000.~~

~~Of course, all these methodologies assume that these "contributions" are used as a general measure of a dog's value and that this value is held uniform across dogs even for dogs that are not "contributing" economically. But this is often done with human beings in public policy, where a general value of human life is estimated and applied uniformly across income levels, and even for humans who have no earnings at all.~~

~~One final method should be briefly mentioned that does not rely on valuing a dog's contribution. There are a variety of valuations already existing for human life. The intrinsic value of animals could be set with a weighted scale based on a percentage of the value of a human life (for example, a dog could be assumed to hold a value equal to 20% that of a person). The advantage of such a system is its wide applicability across animals that do not contribute economically. Of course, its disadvantage is that the weighting~~

would be arbitrary and controversial with many implications for the way human society treats animals in a variety of contexts.

Regardless of the methodology used, with thousands of dogs killed or dying as strays every year in the Capital Region of New York, if dogs are granted intrinsic value independent of human valuations and the value of a dog is at least many thousands of dollars, then this makes the cost of dog overpopulation become at least a level of magnitude higher. Therefore, so does the implied amount that society should be willing to spend.

In addition to the findings above, a few other brief comments should be made regarding the study results. First, many types of public education campaigns appear to be effective ways of addressing dog overpopulation. The costs of these campaigns may be overestimated here. This is because several messages can quite possibly be combined into a single campaign at a reduced total cost. In addition, since the message would be very similar for a campaign to reduce cat overpopulation, these two goals could be cost-effectively combined into a single campaign. And if the societal cost of cat overpopulation is similar to that of dog overpopulation, this would allow even more resources to be devoted to such a campaign

It is also important to mention that only a small number of potential treatments were discussed here. In many cases, this was done because of difficulty in quantifying certain treatments. One such treatment that was a part of the survey results is the use of chemical spay/neuter procedures. As indicated in the results, this procedure has the potential cut the number of people who do not spay/neuter their dog in half. If actual results were

similar to these self-reported results, then using chemical spay/neuter procedures could be powerful enough in itself to make the New York State Capital Region a no-kill area. This result highlights not only the benefits of this particular procedure, but also the potential impact of research in general. Research may be underutilized because of its long-term nature and uncertain in results. For example, if the same amount that was spent on spay/neuter programs over the last three decades was instead spent on research to develop alternate sterilization methods, the results may have been even more powerful and cost effective.

Other difficult to quantify treatments that may have powerful effects include the use of new technology such as the internet to link shelters, cross-market dogs, take advantage of underutilized capacity, create universal lists of people desiring certain types of animals, and to share data in general. Some of the most cost-effective methods of increasing public awareness may also be the cheapest. The public appears particularly interested in stories and information concerning dogs and cats. Creative methods to get stories, information, and beneficial messages across to the public could be particularly effective. Other potentially powerful programs include efforts to address specific reasons for abandonment. One of these is education and professional assistance to help owners address dog behavioral "problems" (and to prepare owners to accept "problems" that are actually normal behaviors). A second program is to provide leads on animal-friendly rentals and deposit insurance programs to help address housing issues which are another common cause of abandonment. Other programs include temporary animal housing for people facing crisis situations such as women facing domestic violence who are themselves going to a shelter. Innovative programs such as these are being tested in

~~many areas, and though it may be too early in many cases to quantify the results, they may be among the most effective at addressing the issue of dog overpopulation.~~

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