

2015

The Feral Cat Conundrum: Assessing the Science and Ethics of Trap-Neuter-Return

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The Feral Cat Conundrum:
Assessing the Science and Ethics of Trap-Neuter-Return

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Honor Scholar Thesis
April 13, 2015

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Acknowledgements

This project would not have been possible without the guidance, support, and encouragement of my thesis committee. I would especially like to thank my sponsor, Jennifer Everett, for the time and energy she devoted to mentoring me throughout the year and helping me to grow as a scholar. I also want to thank Jim Benedix and Lee Roberts for all of their help during the researching and writing process.

I owe my interest in the topic of feral cats and TNR to the DePauw Campus Cat Allies, especially its president Marina Lazic. I also want to give special thanks to my parents and to Zach Allen for their support throughout this project.

Finally, I would like to thank the Honor Scholar Program for giving me the opportunity to complete this transformative thesis as an undergraduate.

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Chapter 1: Overview

The jury remained deadlocked, and in 2007 avid bird-enthusiast Jim Stevenson walked out of a Galveston courthouse free of his animal cruelty charges. In 2006, Stevenson had shot and killed a feral cat to prevent the animal from hunting endangered bird species that lived on the island. The cat had been under the care of tollbooth worker John Newland, who called the cats in that colony his “babies.” When Stevenson fired at the cat, Newland heard the shot and called the police, who arrested the bird-lover as he fled from the scene. Stevenson faced up to \$10,000 and two years in prison for his crime, but he was dismissed after a week in court when the jury could not reach a decision (Barcott 2007; Newman 2007; Rice 2007).

Although this instance is extreme, it is not isolated. The conflict between feral cat caretakers and environmentalists who lament the loss of endangered bird species continues to incite harsh feelings all over the United States. This conflict, however, is larger than simply cats versus birds. The feral cat conundrum sparks complicated questions about human responsibilities to both environmental conservation and animal welfare. Its divisiveness often produces futile cycles of conversation that lead to increasingly bitter feelings, but not solutions. The problem of feral cats in the United States needs to be explored in detail, from a variety of perspectives, in order to produce any real change. In this thesis, I synthesize information from scientific articles, ethics literature, advocacy organizations, the public press, and personal communication to reach a comprehensive understanding of the problems associated with growing populations of feral cats. I use this information to work toward a solution that will be applicable to many communities, including my own of Greencastle, Indiana. But before I

present my argument, we first need to understand what feral cats are, why they are in our communities, and why they are a problem.

What are feral cats?

Neither fully domestic nor truly wild, feral cats occupy a unique space in our communities. According to the Humane Society of the United States (HSUS), there may be as many as forty million feral cats in the United States alone, and as cats tend to reproduce quickly, this population could continue to grow without human intervention (HSUS 2014a). The cats are not evenly distributed across the United States, but are concentrated in various cities, small towns, and suburban communities where they have the resources to survive and reproduce. Populations of feral cats originate when unsterilized, domestic pet cats (*Felis catus*) roam outdoors and reproduce, or when pet cats are abandoned and reproduce. Kittens born outdoors that have not had any contact with humans during their development do not become socialized to humans, and therefore will typically be fearful or even aggressive toward the threat of human contact. As these cats reproduce outdoors, eventually generations of feral cats may exist that are unable to be handled or adopted by humans. Large numbers of abandoned pet cats and unsterilized, free-roaming pet cats only add to the problem of population growth.

Within the debate about how to manage populations of feral cats is uncertainty about how to define feral cats in the first place. Colloquially, most people consider a cat feral if has lived its life outdoors with little to no human contact. Feral cats are typically thought of as extremely difficult to socialize and often unadoptable. This definition of feral, however, is often too simplistic for use in real world applications. Some outdoor pet cats may shy away from human contact, while other cats that have lived outdoors their entire lives in a managed colony will

readily approach their caretakers. Outdoor cats fall somewhere along a spectrum between truly feral cats that will never approach humans and tame pet cats that roam outdoors. For this reason, many Trap-Neuter-Return (TNR) advocates shy away from the label of “feral,” instead preferring to call these cats either “community cats” or simply “free-roaming cats.”

With disagreement on whether cats should even be defined as feral, the debate about the fate of these cats and how we should control their populations is especially complex. A 2010 study that surveyed several national humane organizations and over 550 spay-neuter clinics found rampant inconsistencies about how to distinguish feral cats from frightened or shy pet cats (Slater et al. 2010). Many organizations had no written guidelines at all for feral cat identification. This lack of clear guidelines could prove a challenge for TNR programs if participants cannot even distinguish whether they are sterilizing feral cats or pet cats. Furthermore, a 2013 British study that surveyed feral cat organizations and veterinarians found widespread inconsistencies in their definitions and protocols related to feral cats (Gosling et al. 2013). Many volunteers who worked with feral cats believed that most adult feral cats could be socialized to humans, but most veterinarians believed that only feral kittens could be socialized and adopted.

This lack of agreement about what constitutes a feral cat often leads to problems when population control methods are implemented. It is difficult to know if a given cat is a free-roaming pet or a particularly social feral cat, making it possible for pet cats to be euthanized or taken to shelters under the assumption that the cat is feral. Most TNR programs perform a procedure known as “ear-tipping” on sterilized feral cats so that the same cats will not be recaptured or brought to an animal shelter (Neighborhood Cats 2014). This veterinary procedure

removes a quarter-inch section of a cat's left ear in a straight cut, making it possible to identify feral cats from a distance and to notice when new cats enter an area.

In my thesis, I will use the term “feral” to refer to free-roaming cats that do not belong to any particular person or organization. They may have been born outside, been abandoned by a human family, or have escaped from their homes with humans. Some of these cats may be adoptable, while others are not. A human caretaker might provide food and shelter, but the cats roam freely outdoors and do not live with their caretaker. This definition of feral cats is not perfect, but it will serve my purposes throughout the thesis to represent unowned, free-roaming cats.

Are feral cats a problem?

Growing populations of feral cats have become problematic in communities across the United States because of animal welfare, public health, and environmental concerns. Studies have shown that outdoor domestic cats are capable of reproducing rapidly. An often-referenced Florida study suggested that feral cat pregnancy rates are by far the highest during the spring, and that a single female feral cat gives birth to about 1.4 litters per year (Nutter 2004a). Female cats usually become pregnant with about 4 kittens, but only 3 of these are typically born. In this study, about 75% of kittens died before reaching six months of age. In another study of seven different TNR programs all across the United States, female cats usually gave birth in the spring to an average of 4 kittens (Wallace and Levy 2006). Even with a high kitten mortality rate and other sources of mortality such as predation, cats with abundant resources can reproduce quickly enough for their populations to grow if not controlled.

Groups of unsterilized cats can disturb community members through loud noises associated with fighting and mating, unpleasant smells from male cats marking their territory, and other nuisance behaviors such as digging up a yard or scaring away birds from a birdfeeder (HSUS 2014b). These behaviors often prompt calls to local animal control or animal shelters, but they are not the most pressing concerns associated with feral cat population growth. Animal welfare, public health, and environmental concerns all play roles in making feral cat population growth a problem.

An overpopulation of feral cats poses a threat to animal welfare because these cats may face starvation and other problems related to overcrowding. Some animal welfare advocacy organizations, like People for the Ethical Treatment of Animals (PETA), even argue that feral cats live such miserable lives outside that we are morally obligated to euthanize them (PETA 2014). PETA includes gruesome descriptions on their website of the many horrible fates feral cats may encounter: dying slow, painful deaths from disease, being sliced apart by car engine fans, and facing “agonizing deaths at the hands of cruel people.” Although these awful fates may await some feral cats, scientific evidence suggests that feral cats often live healthy lives outdoors. One study conducted in Hawaii used tooth cementum lines to determine that feral cats who survive past their first year have an average 0.647 survival rate for each year after that, which is higher than the researchers had expected (Danner et al. 2010). Another study from Texas found that while free-roaming pet cats do seem to live longer lives than feral cats, feral cats still survived at fairly high rates during the duration of their six month study (Schmidt et al. 2007). A ten year study in Florida of cats on a university campus found that 83% of the cats on campus at the end of the study had been present for over six years, implying that free-roaming cats in managed colonies tend to live relatively long lives (Levy et al. 2003).

Other studies have suggested that feral cats do not have significantly higher rates of infection with various diseases than free-roaming pet cats, including common infectious diseases feline leukemia virus (Fe-LV) and feline immunodeficiency virus (FIV) (Luria et al. 2004; Nutter et al. 2004b). The lives of feral cats may be a bit shorter on average than the lives of indoor pet cats, but feral cats are capable of surviving in relative comfort outside of human homes. PETA exaggerates the misery faced by feral cat populations and is mistaken in arguing that feral cats cannot live healthy lives outdoors. Even so, the feral cat problem has important implications for animal welfare, especially when populations grow so large that there are not enough resources to support the number of cats in an area.

Many news articles and some advocacy organizations argue that feral cats represent a dangerous public health concern to humans and our animal companions (ABC 2014; Weise 2013; The Wildlife Society 2011). Feral cats can be vectors of zoonotic diseases that could present a risk to humans who come into contact with these cats. Although feral cats can contract several zoonotic diseases including *Bartonella henselae* (cat-scratch disease) and giardiasis, rabies and toxoplasmosis are most commonly mentioned as public health dangers. One veterinary journal article stated that almost 50% of the reported cases of domestic animals infected with rabies in the United States were cats (257 cats), which represents an 11% decrease since 2011 (Dyer et al. 2012). The majority of these cats had been infected with a raccoon rabies virus variant, which is enzootic in certain regions of the United States. Of the 31 cases of rabies in humans between 2003 and 2012, none of them have been contracted from cats. Despite the common fear that feral cats pose a rabies risk to humans, it seems that the rabies risk from feral cats is negligible. If feral cats in a population management program are vaccinated against rabies, this risk will only decrease.

Toxoplasma gondii, another zoonotic disease, is also often cited as a public health risk posed by feral cats. The CDC estimates that over 60 million people in the United States are infected with *T. gondii*, but many people show very few symptoms and do not know that they have toxoplasmosis (CDC 2013). Toxoplasmosis is capable of causing serious health problems, and it poses the largest threat to people with compromised immune systems and to pregnant women. All domestic cats are susceptible to *Toxoplasma gondii*, but free-roaming cats are more likely to be exposed to the parasite than strictly indoor pet cats. A 2004 study suggests that feral cats do not have higher disease prevalence than other outdoor cats, but do have higher antibody titers of *Toxoplasma gondii* (Nutter et al. 2004b). These results suggest that while relatively few feral cats are infected with *Toxoplasma gondii*, feral cats encounter the pathogen more often than pet cats do.

Another veterinary study examined fecal shedding of *Toxoplasma gondii* by feral cats, which is how the disease is often transmitted to other animals (Dabritz et al. 2007). The study detected *T. gondii* oocytes in the feces of only 3 out of 326 feral cats captured in the study, suggesting a low seroprevalence in feral cat populations. Even so, the authors warn that infected cats shed *T. gondii* oocytes so prolifically that even this low infection rate could pose a public health risk. It is important to note, however, that humans are far more likely to contract toxoplasmosis by consuming raw meat or unwashed produce than through exposure to cat feces (Cornell Feline Health Center 2014). Infected cats only shed oocytes for a brief period over the course of their life, making it unlikely that most humans will contract the disease from free-roaming cats. It seems that most feral cats do not seem to pose large risks of rabies or toxoplasmosis infection to humans. Even so, it is still important to be aware of zoonotic diseases among feral cats, especially when populations of feral cats are not receiving veterinary care and

are in close contact with humans. Large populations of feral cats may be a public health risk, but more research would be needed to suggest that they are an immediate danger to human populations.

The environmental concerns about feral cats, however, appear much more pressing. Although a study 2011 suggests that well-fed cats hunt less than poorly fed cats (Silva-Rodriguez and Sieving 2011), domestic cats are predators acting on instinct and will continue to hunt even if provided with supplementary food. Free-roaming cats therefore could alter ecosystems through predation on small mammals and birds. Because ecosystems involve so many intricate connections, declines in populations of certain species can have wide-reaching effects on the function of the ecosystem as a whole. On certain islands, cat populations have been shown to have devastating effects on their prey species (Bonnaud et al. 2011; Medina et al. 2014). In fact, ecologists often consider domestic cats a non-native, invasive species because they were introduced by humans and do not have a specific niche in their ecosystems. Native species may not have evolved the defenses necessary to avoid predation by cats, so they could be put at risk by populations of free-roaming cats. Unfortunately, the available scientific studies about the ecological impact of feral cats were conducted primarily on islands and may have limited applications to areas of the mainland United States. Even so, environmental concerns are a legitimate reason to worry about growing populations of feral cats in our communities, and these concerns deserve careful research and consideration.

How can we reduce feral cat population sizes?

If we do nothing to stop populations of feral cats from reproducing, these populations have the potential to grow quickly and pose a variety of problems to the cats themselves and to our human communities. On Aoshima Island in Japan, a small population of cats brought to the island to control rodent populations has exploded to over 120 because the cats were not spayed and neutered (Bowerman 2015). According to IndyFeral, 80% of the kittens that are brought to their shelter each spring are the offspring of feral cats, indicating that unsterilized feral cats can quickly populate an area if they survive to adulthood (IndyFeral 2014). About 72% of cats that are taken to municipal shelters end up being killed, including almost every single adult feral cat admitted (IndyFeral 2014). We have a responsibility to prevent feral cat overpopulation so that these huge numbers of cats are not killed in shelters every year. Doing nothing to stop free-roaming cat population growth simply cannot be a humane option.

Currently, the two main strategies of feral cat population control are Trap-Neuter-Return (TNR) and trap-euthanize. TNR was first implemented in the U.K. during the 1950s, and some TNR programs started during the 1970s and 1980s in the United States (Holtz 2013). By the 1990s, TNR had become more widespread in the U.S., and these programs continue to be initiated across the country today. In TNR programs, volunteers set up live traps for cats and then transport captured cats to a veterinary hospital or clinic to be spayed or neutered. Veterinarians also give the cats a medical examination and vaccinate them against diseases such as rabies¹. Socialized cats, and especially kittens, are often put up for adoption instead of released. Volunteers then release any un-socialized cats back to their original location and provide food and shelter for groups of sterilized feral cats known as colonies. The overall goal

¹ Most TNR programs include vaccination, but Alley Cat Rescue reports that 4% of TNR groups surveyed do not provide rabies vaccination as part of their program (Alley Cat Rescue, Inc. 2012).

of TNR is to reduce populations of feral cats over time by preventing reproduction. Many animal welfare advocates consider TNR a humane method because it reduces population size by decreasing the birth rate, not increasing the death rate.

The trap-euthanize method of population control is similar to TNR in that live traps are set out for cats, and the cats are then transported to an animal shelter or clinic. While volunteers often help with TNR efforts, trappers are sometimes hired for trap-euthanize. Adoptable cats and kittens are placed in animal shelters, and shelter employees euthanize any cats not considered socialized. Unlike TNR, the trap-euthanize method removes free-roaming cats from human communities entirely, controlling population sizes by increasing the death rate of feral cats. Trap-euthanize is often preferred by environmentalists who consider cats an immediate harm to wildlife species in their ecosystems. This process in which cats are humanely captured and euthanized, however, rarely exists in practice. Instead, trap-euthanize tends to be a euphemism for something far more sinister.

Throughout this thesis, I will use the term “trap-euthanize” to refer to a population control method in which feral cats are humanely trapped, assessed for adoptability, and then euthanized at an animal shelter if they are not able to be socialized. Most scientific journal articles assessing feral cat population control methods use this terminology and present trap-euthanize as the most common alternative to TNR. In reality, however, this practice is rarely implemented. According to Dr. Lee Roberts (personal communication, March 19, 2015), trappers are often hired both to capture and to kill free-roaming cats, often using inhumane methods such as drowning and shooting. These cats are not assessed for adoptability and do not see a veterinarian at all. In this method, it is also very possible for pet cats to be accidentally trapped and killed by trappers, potentially leading to fierce legal conflicts.

For this reason, “trap-euthanize” is often a euphemism for “trap-kill.” In fact, Alley Cat Allies accurately refers to this method as “catch and kill.” The term “trap-euthanize” is misleading because it implies that the cats do not suffer as they are killed, when in reality they do. My thesis uses the term “trap-euthanize” to refer to a practice that is rarely used in the United States, but a practice that is typically heralded as the alternative to TNR. To stay consistent with the scientific literature, I will use the term trap-euthanize in my thesis to refer to a method in which feral cats are trapped and painlessly killed.

Who are key players in the feral cat debate?

National advocacy organizations often play a key role in the feral cat debate because of their large numbers, resources, and ability to spread information quickly via the internet and social media. We can break these key organizations into two basic groups: pro-TNR and anti-TNR. Pro-TNR organizations tend to be animal welfare groups dedicated to reducing suffering among individual animals, while anti-TNR groups are usually environmentally focused, especially on the conservation of bird species. Among the pro-TNR groups, Alley Cat Allies stands out as a leader and is a firm presence in debates and controversies about feral cats. This advocacy organization was founded in 1990 in an effort to reduce the euthanasia of healthy cats in animal shelters and has grown to become a national organization of up to 500,000 members, with 40 staff members working at a headquarters in Maryland (Alley Cat Allies 2015a). Alley Cat Allies strives to support feral cat caretakers, veterinarians, and volunteer groups to implement and carry out TNR across the United States, aiming to reduce populations of cats without resorting to mass euthanasia. The group often appears in news stories about feral cat controversies in which Alley Cat Allies makes statements about feral cat management and

publically supports nonlethal control efforts. Alley Cat Allies is also very prominent on social media, with frequent Facebook posts, an active blog, and regular newsletters posted on their website. Alley Cat Allies' website thoroughly cites many sources in their arguments for TNR including peer-reviewed, scientific journal articles, government reports, and materials from other advocacy groups. It seems important to this organization that its methods are firmly grounded in science, not anecdotal evidence alone.

Other national animal welfare organizations also play important roles in conversations about feral cats. The American Society for the Prevention of Cruelty to Animals and the HSUS both advocate TNR as a humane method of cat population control (ASPCA 2014; HSUS 2013). Specifically, the ASPCA website explains how to distinguish stray and feral cats and recommends methods for helping them (ASPCA 2014). It advocates TNR for managing feral cat populations, stating that this method is actually less expensive and more sustainable than trap-euthanize strategies. Similarly, the HSUS considers TNR a humane way to eliminate or greatly reduce feral cat populations, but it also expresses concern about the impact of outdoor cats on wildlife populations (HSUS 2013; HSUS 2015). Because animal welfare is central to the philosophies of the ASPCA and the HSUS, their pro-TNR positions make sense. These organizations appear less often in the feral cat debate than Alley Cat Allies and do not advocate as actively for TNR, but they do provide resources to assist in TNR efforts and state their support for these programs.

Two organizations focused on bird conservation, the National Audubon Society and the American Bird Conservancy (ABC), play the largest role among advocacy organizations in anti-TNR efforts. The National Audubon Society firmly believes that all cats should be kept indoors to help conserve bird species (National Audubon Society 2014a). It does not support TNR, but

instead argues that outdoor cats should be removed as humanely as possible and preventative measures should be taken to reduce outdoor cat populations. The National Audubon Society carefully cites several sources on its website in support of its “cats indoors” stance, including the Smithsonian, the U.S. Fish and Wildlife Service, and the Canadian Federation of Humane Societies. ABC has an almost identical stance and has even launched an online “Cats Indoors” campaign in attempt to eliminate outdoor cats in the United States (ABC 2014). This organization’s website includes many scientific sources such as the IUCN and peer-reviewed journals in ecology, parasitology, public health, and conservation. The Audubon Society and ABC maintain a close relationship and often collaborate in their avian research and conservation efforts. ABC’s Cats Indoors campaign is actively backed by the Audubon Society as a good way to eliminate outdoor cat populations in the United States (National Audubon Society 2014b). Both the National Audubon Society and ABC are outspoken in their anti-TNR stance, often appearing in news articles alongside Alley Cat Allies and engaging in debates about the environmental impact of free-roaming cats.

For example, one story that has been widely covered by the media is the debate about Ted Williams’ 2013 article in the Orlando Sentinel that advocated shooting, poisoning, or otherwise killing outdoor cats in order to protect bird populations (Williams 2013). The article vehemently describes feral cats as “your enemy,” “vermin,” “rabies infested kitties,” and “born killers” and argues that citizens should use Tylenol to poison feral cats². Ted Williams happened to be editor-at-large for the National Audubon Society. Outraged, Alley Cat Allies and other humane organizations issued statements about the cruelty in Williams’ article and demanded that the Audubon Society respond. The Audubon initially dismissed Williams, stating that his

² The original article has been taken offline since I began working on this project and has been replaced with a postscript submitted by Ted Williams.

opinions did not reflect their own policies toward free-roaming cat removal. Two weeks later, Audubon stated that they “accept Ted’s apology” for his “mistake” and reinstated him (Yarnold 2013). National Geographic and The New York Times picked up the story about the aftermath of Williams’ article in 2013, giving the feral cat debate a national audience (Dell’Amore 2013; Haughney 2013). This controversy is an excellent example of the animosity between bird-lovers and cat-lovers in the feral cat debate and of the role that advocacy organizations play in controversies about feral cats.

Do we have a responsibility to the feral cat problem?

We recognize that feral cats in the United States pose potential risks to animal welfare, public health, and especially the environment. But do human beings have a responsibility to use our resources to solve this problem? I believe that we have a responsibility to take action. To start, feral cats are domestic animals. We bred them according to our desires for companionship and pest control, making them into the social animals and skilled hunters that they are today. Feral cats are in our communities because we dumped them there. They are the kittens abandoned in a box on the side of the road, the descendants of the cat a family dumped because it could no longer afford her, and the offspring of our unneutered pet cats we let roam free during the day. Although they may not be socialized to humans, these cats still bear traces of the dependency we bred into them. They seek out human communities for food and shelter because they are not wild animals that could thrive entirely on their own. Therefore, I believe we have a special responsibility to help the animals that we created and then abandoned.

Furthermore, overpopulation would not good for feral cats, so I argue that we are required to take some kind of action in reducing their population growth. We also have

responsibilities to the feral cat problem related to public health. If feral cats pose even a slight risk of rabies and toxoplasmosis outbreaks among humans and companion animals in our communities, it is our job to prevent these diseases from spreading. We need to protect our community members from the risk of disease that could be associated with growing populations of feral cats, even though there is still scant evidence that feral cats pose a major public health risk.

I contend that we also have a responsibility to the prey species of feral cats. Humans introduced domestic cats into our communities and put some bird and small mammal populations at risk. Some of these species may be vulnerable to extinction if expanding populations of domestic cats continue to prey upon them. This is not only a hazard for individual birds and small mammals, but also to ecosystem function. We have responsibilities to protect the environment from unnecessary damage due to human activities. If feral cats are truly causing widespread extinctions and are dramatically changing their ecosystems, then we have a duty to step in and prevent further damage. I argue that humans have a responsibility to take action in solving the feral cat problem.

My Argument

My thesis assumes that growing populations of feral cats are a problem that deserves our attention, thought, and resources. Doing nothing to stop feral cat population growth simply should not be an option. Therefore, we need to assess whether TNR and trap-euthanize are effective, ethical methods of population control that will work for communities in the United States. One problem with the feral cat debate is that it tends to consider science and ethics separately. Scientists writing journal articles about feral cats seem to assume that the most

effective method is always the preferred method of population control, often ignoring ethical implications and issues of feasibility. The ethics literature has little to say explicitly about feral cats, and this complicated ethical situation is difficult to fit neatly into existing theories of animal ethics. In the real world, neither science nor ethics can be considered alone. To reach relevant solutions about the feral cat problem will require a synthesis of scientific evidence and ethical thinking that also considers social, economic, and political factors. My thesis uses an interdisciplinary approach to solve the feral cat conundrum and provides realistic recommendations to local communities. Using science and ethics in tandem, this project attempts to fill a current gap in the conversation about feral cats that can help us move forward in targeting areas that need more research and in making decisions about how to manage feral cat populations.

In my thesis, I examine scientific articles that assess the ecological impact of feral cats on various ecosystems (Chapter 2: Ecological Impact). I found that most of these studies tended to be conducted on islands, where feral cats are often a huge problem due to large numbers of endemic or vulnerable species that are preyed upon by cats. The ecology literature suggests that domestic cats are generalist, opportunistic hunters, but that they prey primarily on mammal species and secondarily on birds. The effect of feral cats on their ecosystems seems to vary largely by location and from study to study. Studies that estimate total numbers of prey animals killed by cats in entire countries prove problematic and are often too general to answer questions about whether these levels of predation could alter ecosystem function. I argue that more ecological research needs to be done on feral cats, particularly in the mainland United States, in order to truthfully assess the effect of their predation.

I then use scientific literature to argue that both TNR and trap-ethanize can effectively reduce populations of feral cats in specific circumstances (Chapter 3: TNR Effectiveness). The model-based studies suggest that trap-ethanize seems to be the more efficient strategy and will work in some conditions where TNR might not, such when population sizes are very large and when immigration or abandonment rates are high. Many scientific articles point to migration, abandonment, and cat adoption rates as key factors in the success of any population management strategies, including trap-ethanize. There are many gaps in the scientific literature about TNR and trap-ethanize effectiveness, however, making it difficult to draw concrete conclusions about the utility of these methods. The geographical and community specificity of these articles also makes it difficult to apply their results to other locations.

After examining the available scientific literature about population control effectiveness and ecological implications, I bring an ethical perspective into the conversation (Chapter 4: Ethical Arguments). I examine utilitarian and rights based approaches to animal ethics and explain how they relate to the feral cat question. Then, I build upon Sue Donaldson and Will Kymlicka's political theory based modification of animal rights theory to use a citizenship model in my explanation of human duties to feral cats. I reinterpret their framework, however, to situate feral cats into the category of domestic animals instead of liminal animals³. I then analyze the feral cat conundrum using this political, animal rights based framework to inform how I approach the questions of animal welfare and environmental responsibility. My argument places value on environmental conservation, but it ultimately rejects an ecocentric environmental ethic in favor of a zoocentric ethic. This section of my thesis explores the ethical complications of the feral cat problem and how ethics should inform our decisions about choosing a feral cat population management strategy.

³ Liminal animals are animals that live in or near human societies but have not undergone domestication.

Ultimately, I argue that TNR is the most ethical method of feral cat population control because it values the lives of individual cats and avoids killing healthy cats that humans are responsible for breeding and abandoning in the first place. Scientific studies, however, suggest that TNR may not work in every community. Also, in some ecologically sensitive areas, TNR might not reduce cat population sizes quickly enough to save populations of vulnerable prey species, whose extinction could alter ecosystems dramatically. In these cases, I argue that trap-ethanize is a permissible last resort to the default method of TNR. Community members need to work collaboratively to choose which population control strategy they should implement in their areas.

I next explain other critical considerations in the TNR debate, including the importance of preventative measures, alternative sterilization methods, the ecological vacuum effect, and a social science perspective on which control method community members will tend to support (Chapter 5: Key Considerations). I conclude my thesis by relating my findings and arguments to my community of Greencastle, Indiana and suggesting future steps that Greencastle should take to prevent populations of free-roaming cats on campus and in town from growing (Chapter 6: Implications for Greencastle).

Chapter 2: Ecological Impact

One of the most common criticisms of TNR is that it does not protect local ecosystems from the impact of free-roaming cats. Anti-TNR advocacy organizations such as the National Audubon Society and ABC claim that free-roaming cats are currently devastating populations of birds in the United States and will cause even worse damage to the environment if cat populations are not controlled. Advocacy organizations in favor of TNR, on the other hand, argue that the impact of feral cats on birds is negligible compared to the impact of humans on our environment, and therefore we are not justified in killing cats to protect the birds. The ecological impact of feral cats is important because it could play a large role in deciding which population control strategy to use in a particular community. If cats are destroying local ecosystems so quickly that TNR will not be fast enough to reduce the damage, then perhaps communities would choose lethal control. If feral cats are not significantly affecting local ecosystems, however, TNR might be the preferred choice because it is more humane. The effect of feral cats on their ecosystems is currently widely disputed, so it is important to carefully examine the available evidence in order to assess how free-roaming cats alter their ecosystems and what implications this evidence could have for population management decisions.

When we debate the ecological impact of feral cats, ethics must play a role. If cats are affecting local ecosystems, we need to use ethical principles to decide if these effects are a problem and choose which methods of population control would be morally permissible. In the branch of environmental ethics called ecocentrism, ecosystems themselves have intrinsic value (Kernohan 2012). Ecosystems, therefore, have rights that should not be violated, and they

should not be used merely as a means to human ends. Ecocentrists believe in preserving natural ecosystems however we can, even if that means disrupting humans or animals in the process.

They place value on the ecosystem as a whole, not its individual, living parts. Aldo Leopold is a classic example of an ecocentrist; he believed that the land has rights and should not be used indiscriminately by humans (Leopold 1949). Many ecologists seem to adhere to an ecocentric ethic and are willing to kill certain nonnative organisms for the overall good of the ecosystem. Culling is a common method of population control when a certain species' population exceeds what would be best for the ecosystem. In this viewpoint, feral cats are just another nonnative species and should be culled or otherwise eliminated if they harm ecosystem function.

Many animal welfarists reject this point of view, instead adopting a zoocentric perspective by valuing the lives of individual animals (Kernohan 2012). People who adopt a zoocentric perspective place value on the lives of cats and on the lives of animals that the cats may kill such as birds and rodents. Zoocentrists, therefore, would strive to protect individual cats from harm, but would also attempt to reduce predation on other animals. They would likely support humane population control of feral cats in order to prevent rates of predation from increasing. In the feral cat debate, there exists a sharp contrast between environmentalists who take an ecocentric perspective and animal welfarists who adopt a zoocentric perspective when deciding how to manage populations of cats. The ethics of the feral cat conundrum are so complex because they involve an intersection between environmental and animal ethics. I will discuss this intersection and its implications to my argument about TNR in greater length in Chapter 4.

With these ethical complications in mind, we need to examine the ecological literature to assess whether feral cats are truly harming local ecosystems. Domestic cats are natural predators

that have been introduced to locations all over the world, and predation is the most commonly mentioned environmental problem attributed to feral cats. Several studies in the past fifteen years have examined various aspects of domestic cat predation including the composition of their diet, their predation rates, and the effects of their predation on prey populations. Researchers are interested in determining which species feral cats choose to hunt and how prolifically they tend to kill small mammals and birds. Although many advocacy organizations emphasize the potential impacts of cats on bird species, cats have historically been used as a pest control method to manage populations of small mammals such as rats, mice, and rabbits. The ecological literature does not tend to mention that, in some communities, free-roaming cats fill a pest control role that may otherwise be accomplished through poison or lethal traps.

As we examine the ecological literature about feral cats, it is important to note that the vast majority of available studies about feral cat predation were conducted on islands. It is much more difficult to find ecological studies about feral cats on the continental United States than it is to find studies about the impact of free-roaming cats on islands across the world. Because more endemic and endangered species tend to live on islands than on the mainland United States, it makes sense that ecologists are more concerned about the impact of feral cats in those ecosystems. There may also be more funding for scientists to study feral cats on islands if vulnerable species that the scientific community wants to protect live there. The problem with the abundance of island studies and dearth of mainland studies, however, is that island studies may have limited applications to mainland cities and rural areas. At this point, however, these island studies and few mainland studies are our main source of information about how feral cats alter their ecosystems.

A commonly cited 1998 Canadian review article examines available studies across the world to determine the prey species and trophic levels of domestic cats (Pearre and Maass 1998). Many of the cited studies were conducted on islands, but mainland studies were also included. The results suggested that mammals are the primary prey species of cats, followed by birds. This study also found that average prey size for cats is only about 1% of their body weight, which is much smaller than relative prey sizes for other carnivores. Pearre and Maass 1998 found that domestic cats had broader niches in warmer locations at low latitudes and also during warmer seasons of the year. This review article is outdated, but is still useful in showing that domestic cats are opportunistic predators that tend to prefer mammals as their primary prey. Importantly, it also shows that the niche of domestic cats broadens in warmer seasons and geographic locations. This finding may suggest that cats have a larger predatory impact in tropical areas than in temperate areas.

Other studies have suggested that small mammals make up the largest portion of free-roaming domestic cat diets, but birds are also commonly consumed. A 2003 study conducted in Great Britain used a survey of cat owners to estimate how many and which kinds of prey species domestic cats tend to kill (Woods et al. 2003). The study showed that about 69% of prey species were mammals and 24% were birds, while reptiles, amphibians, fish, and invertebrates made up the remaining 7%. Although bird conservationists emphasize the impact of domestic cats on bird species, this study suggests that cats tend to kill nearly three times as many mammals as birds. The study did not estimate how many individuals each outdoor cat kills per year, but concluded that the predatory impact of free-roaming cats could be significant. An Australian study published in 2012 was interested in the prey composition of free-roaming cat diets, but also examined the approximate sizes of selected prey (Kutt 2012). Kutt collected the stomachs of 169

domestic cats from northeastern Australia and analyzed their contents to determine prey species and sizes. He found that cats seemed to prefer to eat mammals, especially small mammals between 50 and 100 grams. The cats also ate birds of between 50 and 100 grams and reptiles of 10 to 50 grams. Kutt points out that many small mammals in northern Australia of the size range targeted by cats are declining and claims that his study shows which species will be most vulnerable to predation.

Another helpful review article published in 2011 explores the diets of feral cats on islands around the world (Bonnaud et al. 2011). This review examined 72 studies of feral cat diets on 40 insular islands across the world. It found that domestic cats consume a large range of prey species including mammals, birds, reptiles, amphibians, fish, and invertebrates, some of which are considered threatened by the IUCN. Bonnaud et al. 2011 also found that a few species of introduced mammals such as mice, rats, and rabbits make up the main diet of many populations of feral cats, with birds and other animals eaten secondarily. Interestingly, the study found that cats at higher latitudes consumed more rabbits, while those living in tropical regions consumed more reptiles and invertebrates. The distance of the island from the mainland was also positively correlated with bird predation, suggesting risks for endemic bird species on distant islands. Bonnaud et al. 2011 concluded that although domestic cats seem to prefer mammals as their primary prey, they are opportunistic hunters able to survive in island ecosystems around the world. Overall, it seems safe to conclude that domestic cats tend to primarily hunt mammals and then supplement their diet with other available animals such as birds and reptiles. Cat diets vary by geographic location and season in part because of differences in prey availability.

Other ecological studies have examined the impact of feral cats on a particular prey species over time to assess whether we need to be concerned about their predation. One

interesting study examined the effect of domestic cat predation on a population of terns on an island to the southeast coast of Africa (Peck et al. 2008). The researchers found that cats primarily preyed on small mammals and insects when terns were not breeding, but during the tern breeding season, predation on terns increased dramatically, with cats killing an average of 5.96 terns per day. The cats killed 22% more terns than they ate during this period, implying that the cats hunted more based on instinct than hunger. Even so, the matrix model predicted that the tern population would not begin to decline unless the population of cats in the area tripled. In other words, even this high level of predation on the terns would not affect the growth of the tern population unless the cat population increased three-fold. This study is important because it shows that seasonal factors can affect cat predation; cats may kill more animals than they can eat; and in some locations, even high rates of predation do not significantly affect prey populations as a whole.

A recent study published in 2014 sought to determine the effect of feral cats on a native mammal species in mainland Australia, a change of pace from the usual ecological studies conducted on smaller islands (Frank et al. 2014). The authors of this study sought to empirically measure the impact of predation by a low-density cat population on the population of a local small mammal. The researchers set up two 12-15 hectare enclosures in a tropical savannah in which cats had access to one half of the plot but not the other, creating four different treatment areas. Twenty native rats were released into each of the four areas. The researchers used radio tracking and mark-recapture to estimate the number of rats in the enclosure over time and employed video surveillance to observe the cats in the area. Frank et al. 2014 found that the populations of rats persisted over 18 months in plots without cats, but all of the rats were gone after 18 months in the plots with cats. One of the plots with a high rate of cat entry into the area

had a local extinction of the rats after 3 months, while the other plot had extinction after 16 months. Frank et al. 2014 argues that this study shows that low densities of free-roaming cats can cause the extinction of local mammals in a relatively short period of time on a mainland setting. The small sample sizes in this study, however, warrant future research to assess how free-roaming cats affect actual populations of small mammals.

Three final studies concerning predation by free-roaming cats involve estimates of cat predation in the United Kingdom, Canada, and the United States. These studies tend to be more speculative than the other studies of predation I have presented, and they have also incited more discussion and controversy. In a 2008 study in Great Britain, the authors used questionnaires of people in ten sites in Bristol, UK to estimate the density of free-roaming cats, the number of birds killed by cats per year, and the impact of this predation on the bird populations. The authors predicted that although over 60% of the cats studied never brought any birds home, cat predation was great enough to negatively impact the bird populations in the city. Baker et al. 2008 noted, however, that the birds killed by cats were significantly weaker and unhealthier than birds killed by collision into windows, suggesting that cats tend to target birds that will not survive as well as other birds in the first place. Baker et al. 2008 concluded that even though cats tend to target weaker prey individuals, the sheer density of cats in Bristol and the estimated predation rates could present a problem to bird species in the area.

In a study focusing on feral cats in Canada, Peter Blancher estimated the number of birds killed by domestic cats in Canada yearly based on estimates of the number of cats in Canada and estimates of the number of birds each cat kills per year (Blancher 2013). The study made distinctions between birds killed by urban pet cats, rural pet cats, and stray or feral cats. Blancher estimated that between 100 and 350 million birds in Canada are killed by cats per year,

and that feral cats kill more of these birds than free-roaming pet cats do. The study estimates that between 2% and 7% of birds in southern Canada are killed by cats per year, which Blancher argues is likely larger than any of source of human-related mortality among birds. Blancher admits, however, that he was unable to base his model on any data of cat predation in Canada, and that his estimation of the number of feral cats in Canada is very approximate. Pro-TNR individuals have pointed to many problems with the estimates in this study, which they argue cause Blancher to make inappropriate claims about the impact of feral cats in Canada (Wolf 2014). Even so, this study is one of the few sources to estimate predation by feral cats and is therefore useful in attempting to understand how free-roaming cats impact their environment.

Finally, a study conducted with funding by the Smithsonian and the U.S. Fish and Wildlife Service focuses on the ecological impact of free-roaming cats in the contiguous United States (Loss et al. 2013). This controversial article has been cited often in the TNR debate as evidence that feral cats have devastating impacts on wildlife in the United States. Besides being actively discussed by Alley Cat Allies, Vox Felina, and the Smithsonian, news stories about this article have appeared in USA Today, the New York Times, and NPR (Alley Cat Allies 2015b; Wolf 2013; Nuwer 2013; Raasch 2013; Angier 2013; King 2013). Its estimated numbers of prey animals killed per year in the contiguous United States, 1.4-3.7 billion birds and 6.9-20.7 billion mammals, have received widespread attention in the media, inflaming the feral cat debate. Organizations such as Alley Cat Allies even released official statements discrediting the article and petitioned Smithsonian in protest of its publication. Loss et al. 2013 used previous studies of cat predation in the temperate regions and studies about the numbers of free-roaming pet and feral cats in the United States to estimate the overall number of birds and mammals killed per year by domestic cats. The authors concluded that 69% of bird predation by cats is due to feral

cats instead of pet cats, and that cats kill far more birds than other human-related causes such as window strikes or pesticides.

Gregory Matthews points out that the authors of the article often used dubious studies in their estimations, including studies that were not peer-reviewed, studies from a very wide range of geographic locations and scales, a study that was counted twice in their analysis, and even a study published in 1930 (Matthews 2013). Matthews also argues that Loss et al. 2013 did not perform a meta-analysis even though the authors used widely varying sources that could result in very large degrees of error. Loss et al. 2013 also used extrapolation in many parts of their estimates, which resulted in a higher estimation of predation that did not take geography or season into account. The controversy surrounding this article makes me suspicious of whether it is a useful estimation of the impact of free-roaming cats on birds and mammals. Loss et al. 2013 alone cannot be used to argue that feral cats are wreaking unacceptable havoc on ecosystems in the United States.

Overall, examining the predation studies about domestic cats leaves us with some fairly confident conclusions and many more questions. It seems clear that small mammals typically make up the bulk of free-roaming cat diets, but cats also prey on birds, reptiles, amphibians, and other animals. Domestic cats are opportunistic predators whose diets vary according to prey availability, which changes with the season and with geographic location. It seems that they tend to target weaker, less healthy individuals when hunting, as may be expected of many predators. What is unclear, however, is how much of an impact feral cats are having on their prey populations. Their impact likely depends on a multitude of factors including the biodiversity of the area, the climate, the presence of endemic or threatened species, and competition with other predators. Some estimates suggest that feral and free-roaming cats exhibit extremely high

predation rates, and therefore pose an acute risk to wildlife species across the world, but not every study implies that this trend is true. We need more studies of feral cat predation, especially in temperate, mainland areas, to be able to assess the risk feral cats pose to bird and mammal populations in the United States. For now, it seems we must assess communities and ecosystems on an individual basis to determine whether feral cats are having a significant ecological impact.

These studies bring up an important point that is sometimes left out of the feral cat debate: where feral cats tend to live. Do feral cats tend to live and hunt close to human settlements, or do they prefer to live off in more “wild” areas? Do unowned cats and pet cats occupy the same ecological niches, or does ownership make a difference in how cats live and hunt? How does the management of feral colonies play a role in the home ranges and hunting dynamics of free-roaming cats? A handful of ecological studies around the world have attempted to find answers to these questions. These studies can help us better understand which factors determine where feral and free-roaming cats tend to live, how much their territories tend to overlap, and how large their territories typically are. If we are primarily concerned about feral cats because of predation risks, we need to understand where these cats are living and preying to help us determine what kind of risks, if any, they pose to ecosystems. Ecological studies like these can help us get a clearer sense of the predator-prey dynamics of feral cats so we can assess what role they play in local ecosystems.

One study conducted on a South African college campus examined the home ranges and distributions of about 55 cats that lived on campus (Tennet and Downs 2008). The researchers used a transect sampling method and found that the cats were not evenly distributed in their locations on campus, but their distribution was dependent on available resources. These

resources were influenced by habitat type on campus and especially by supplemental food supplied by residents. Tennet and Downs 2008 also used radio collars on eight cats over a 13 month period to determine their approximate home range sizes and locations. They found that the campus cats had relatively small home ranges that overlapped significantly with one another. No difference between the ranges of sterilized and unsterilized cats was detected during this study. Surprisingly, Tennet and Downs 2008 noted that no feral cats were found within the nature reserve near campus, which did not have any cat feeding stations. Cats instead preferred to stay near feeding stations and accessible garbage. This study suggests that feral cats tend to rely on humans for food resources, and that abundant resources may lead to small home ranges.

A similar study from a small suburban area in Texas sought to examine feral cat home ranges, movement, survival, and fecundity (Schmidt et al. 2007). This study was also interested in how ownership of cats affects their population dynamics. The researchers used radio collars to track the movement and survival of owned, feral, and semi-feral cats for about one year. Unowned cats were considered semi-feral if residents of the community were observed feeding them. All of the unowned cats in the study were sterilized, and none of the feral or semi-feral cats were sterilized. Over the course of the study, Schmidt et al. 2007 found that all ten pet cats survived, but 8 of the 44 semi-feral or feral cats died. They also found that increased ownership corresponded to decreased cat ranges, so pet cats had the smallest ranges and unfed feral cats had the largest. Overall, unfed feral cats exhibited the most movement, while the movement of pet cats and semi-feral cats did not differ significantly. This study suggests that pet cats tend to have smaller home ranges and survive better outdoors than feral cats do. Unfortunately, however, the researchers did not study any feral cats that had been sterilized. Including this subset of cats would have allowed Schmidt et al. 2007 to draw better conclusions about how managed colonies

affect feral cat home ranges. We cannot tell if the pet cats in this study had smaller home ranges because they were owned or because they were sterilized.

A 2010 study conducted on an island near California did examine the effect of feral cat sterilization on movement and home ranges (Gutilla and Stapp 2010). The island had human communities near the coasts, but the interior remained largely undeveloped. Gutilla and Stapp tracked 14 sterilized and 13 unsterilized feral cats to study their movement, home ranges, and home range overlap. This study suggested that free-roaming cats on the island tended to move freely between areas of human development and more natural ecosystems. Male cats tended to have larger ranges than female cats, and there was no difference in the ranges of sterilized and unsterilized cats. Gutilla and Stapp argued that movement of feral cats between wilderness and developed areas shows that TNR programs would be difficult to implement because cats would not stay close to human settlements. This study is important because it suggests that on this island ecosystem, cats can find abundant resources outside of human developed areas and therefore tend to roam into more natural areas. This finding seems to contrast with Tennet and Downs 2008, which suggested that the feral cats on a college campus in South Africa tended to stay in human developed areas. Feral cat movement may depend on the specific resource availability in a given community, limiting applications of these studies to other communities across the world.

Two related studies in New Zealand also examined the home ranges of feral cats and how they correspond to resource availability (Recio and Seddon 2013; Recio et al. 2014). In these studies, the authors note that the feral cats live completely independently of human contact and without obtaining any resources from human communities. These feral cats, therefore, may behave quite differently from the cats studied in all of the other research articles I have

examined. It seems atypical for feral cats to live completely independently from humans, but Recio and his colleagues have observed feral cats living in the wild in New Zealand. In Recio and Seddon's 2013 study, the researchers used GPS collars to examine feral cat home ranges and movement in relation to the availability of resources such as rabbit burrows. The authors found that home ranges were related to the inclusion of rabbit burrows, especially in female cats. Most cats remained solitary except for occasional interactions between cats, especially male and female pairs. Recio and Seddon conclude that because cats seemed to prefer to remain solitary and home ranges were limited by the spacing of rabbit burrow areas, feral cats in New Zealand may regulate their own population densities. It is unclear how much this research can apply to feral cats who gain supplemental food from humans.

In a similar study in 2014, Recio used GPS collars and satellite technology, but this time to study fine-scale resource selection among feral cats (Recio et al. 2014). This study showed that the feral cats tended to choose home ranges that overlapped with the habitats of rabbits, their favorite prey species on the island. This article did not mention that rabbits are actually considered a pest in New Zealand; they are an invasive species introduced from Europe that may be legally hunted or otherwise controlled anywhere in the country (New Zealand Department of Conservation). In this study, some cats often spent time in areas inhabited by ground-nesting birds, which can threaten these island species. Overall, it seemed that the location of the feral cat's mammalian prey was the primary determinant of the cat's home range locations and sizes. This study could be important in locations that have populations of endemic or vulnerable animals and which are relatively free from human influence. It is strange, however, that the authors never mentioned that the rabbits these cats primarily preyed upon are considered pests. The feral cats may actually be providing an ecological service to the area by controlling the

population of an invasive species. Further studies on the impact of feral cats on populations of invasive mammal species may reveal that cat predation is not always ecologically harmful. The threat to ground-nesting birds in this study, however, is much more legitimate.

The few available studies of feral cat home ranges suggest that cat ranges are primarily determined by food availability, especially human-provided food or abundant prey animals. In general, it seems that pet cats and fed feral cats have smaller home ranges than feral cats who hunt as their main source of food. Tennet and Downs 2008 seems to suggest that supplemental feeding on a college campus kept free-roaming cats out of more natural areas, while Guttilla and Stapp 2010 found that feral cats on an island moved freely between developed and natural areas. It is unclear if the implementation of TNR would have any effect on predation or on the roaming of feral cats. It is also unclear whether sterilizing free-roaming cats will decrease their roaming or hunting. The Guttilla and Stapp 2010 study and the Tennet and Downs 2008 study found no difference in home ranges between neutered and unneutered cats, but their sample sizes were also very small. Schmidt et al. 2007 suggested that pet cats have smaller ranges than feral cats, but all the pet cats were sterilized and the feral cats were not, limiting our ability to draw conclusions due to this confounding variable. More studies are needed to confidently assess how far feral cats will roam when hunting and whether implementing TNR programs would affect their behavior.

The available ecology literature paints a mixed, sometimes contradictory, picture of the ecological effect of feral cats. Free-roaming cats are predators that will inevitably affect their ecosystems by hunting small mammals primarily and other animals such as birds secondarily. The magnitude of the effect of feral cats on their ecosystems, however, varies by location. Feral cats particularly seem to cause problems on islands and when they prey on small populations of

native species. The estimates of nationwide predation in the UK, Canada, and the US tell us little about the impact of feral cats on individual ecosystems and what policy implications these impacts should have. Even if feral cats did kill billions of birds per year, this number alone does nothing to tell us if or how ecosystems across the United States will be affected. We are also currently unsure of how implementing TNR programs will affect the ranges and predation rates of feral and free-roaming cats. Although the task will be labor intensive, we may need to assess communities on an individual basis to decide if elimination of feral cats is the only way to prevent species from going extinct and ecosystems from crumbling. The ecology literature on feral cats is far from conclusive evidence that TNR is right for every ecosystem, or that feral cats will destroy every ecosystem unless trap-euthanize is implemented. These studies help us learn more about how feral cats affect their ecosystems, but do not provide us with any definitive answers about how communities should respond.

Chapter 3: TNR Effectiveness

If we agree that growing populations of feral cats are a problem, then we need to find a control method that will work. Although some individuals argue that feral cats should simply be killed using guns or poison, animal cruelty laws typically prevent this from occurring. The most widely accepted, debated, and studied methods of population control are TNR and trap-ethanize. In the TNR method, feral cats are trapped in live traps, spayed or neutered by a veterinarian, vaccinated, and then released into their original location. This method is meant to reduce populations slowly through sterilization instead of by immediate removal. TNR requires the resources needed to trap and sterilize cats and also typically requires local caretakers to feed and provide shelter for the released cats. In the trap-ethanize method, feral cats are captured in live traps and taken to animal shelters, where they are either deemed socialized enough to be put up for adoption or are euthanized by shelter workers. This method requires the resources needed to trap the cats, pay for them to be euthanized, and place socialized cats in an animal shelter with the potential of being adopted. As I mentioned before, this version of the trap-ethanize method is commonly examined in the scientific literature, but in practice it may involve shooting the cats instead of euthanizing them.

Both pro-TNR and anti-TNR advocacy organizations cite peer-reviewed, scientific journal articles in their arguments, yet these groups disagree sharply on whether TNR is an effective population control method. This discrepancy fuels the debate about feral cats and illustrates the complexity of interpreting scientific literature. There have been several scientific studies published in veterinary and ecological journals assessing the effectiveness of both trap-

ethanize and TNR methods. Some of these studies empirically collected data on actual feral cat populations, while others used population models to predict the effectiveness of trap-ethanize and TNR under varying circumstances. Both types of studies are useful in determining whether trap-ethanize and TNR work, and if so, which of the methods tends to be more effective.

Empirical Studies of TNR

I have found that relatively few recent studies exist that assess actual TNR or trap-ethanize programs and their effects on feral cat populations over time. In my search for peer-reviewed articles written in the past fifteen years, I have found only six studies that seem the most relevant to my research questions. One of the most often cited studies by pro-TNR organizations is a 2003 article published in the Journal of the American Veterinary Medical Association (JAVMA) that examines a TNR program at the University of Florida (Levy et al. 2003). The study took place over eleven years from 1991 until 2002 and tracked free-roaming cat population sizes during the course of a TNR program. This 11 year period is much longer than most studies of feral cat populations, but as feral cats can live longer than 11 years, an even longer study would provide us with a more accurate estimate of how effectively TNR is working. The free-roaming cat populations in this area included about 75% truly feral cats and 25% socialized cats at the beginning of the program. After 11 years, 47% of cats had been adopted, 17% had been euthanized due to fatal injuries or disease or had died, 21% had moved away, and 15% remained in the area. The population decreased overall by 66%, from 68 cats in 1991 to 23 cats in 2002. The authors of the study hail it as a TNR success story, and many TNR advocacy organizations use the 2003 study to support their claims. The results of the study, however, are not deemed a success among anti-TNR advocates. It took 11 years to reduce a population of

feral cats that was already much smaller than populations in other areas. Levy et al. 2003 did not mention migration or abandonment as significant factors in their program's success, but these variables can often thwart TNR efforts. Some anti-TNR advocates scoff at the number of cats removed through adoption in this experiment, but adoption is a part of every TNR program and prevents population growth by removing healthy, socialized kittens from an area. Overall, I see Levy et al. 2003 as an example of TNR success, but recognize that its relatively long duration and small starting population size contribute to the large 66% population reduction rate.

Another study often used by Alley Cat Allies to support their program is a 2002 study that examines the effectiveness of a TNR program at Texas A&M University during a two year period (Hughes and Slater 2002). This study examines how many cats were captured in these two years and tracks the fate of each trapped cat. It does not mention how many total cats lived on campus before or after the study, but focused on the cats involved in the veterinary school's TNR program. Of the 158 cats trapped, 101 were sterilized and returned to campus, 32 were adopted, and 23 were euthanized because they had FIV, Fe-LV, or other diseases. Feral kittens less than 3 months old were deemed adoptable as well as some older, socialized cats. The most interesting finding of Hughes and Slater 2002 is that twenty kittens were captured in the first year, but only three the second year. The three captured the second year also appeared to be abandoned by humans rather than born to an outdoor cat, implying that sterilization was working to prevent free-roaming cats from reproducing on campus. The results of Hughes and Slater 2002 suggest that TNR could be reducing feral cat population sizes, but the study's short duration makes it difficult to draw many conclusions about the overall success of the program. While Alley Cat Allies uses this article as an example of TNR's effectiveness, it is only a preliminary example of TNR success.

A well-known study conducted in Rome, Italy is also often used by advocacy organizations to support TNR (Natoli et al. 2006). This study examines a ten year period in Rome after a no-kill policy for feral cats was introduced and TNR programs were implemented. About 8,000 cats were sterilized and released during the program. In Rome, the Veterinary Public Services were tasked with keeping careful records of registered colonies of feral cats throughout the city, which helped the researchers to keep track of the total numbers of cats in these colonies over the ten year period. Of the 103 colonies studied, 55 decreased in numbers, 20 remained stable, and 28 increased. While the researchers say cat populations declined overall in that period by about 22%, the immigration rate of new cats entering the area was about 16%. Without this immigration, the overall decrease in cat numbers would have been 31%. The authors of Natoli et al. 2006 stress that people need to be educated about cat sterilization and prevented from abandoning their pet cats in order for TNR programs to be worth the time, effort, and money. Some anti-TNR critics claim that this program was not successful because in ten years, only about half of the colonies decreased in size. Still, pro-TNR advocates use Natoli et al. 2006 as an example of a humane and effective way to reduce populations of feral cats in a city where euthanizing healthy stray cats is prohibited. This study is also valuable because it examines so many different colonies within the same city over a relatively long time span, while most other TNR studies only track a few colonies over the course of one to two years. Although 28 colonies experienced increased numbers of this time period, the 75 colonies that decreased in size or remained stable provide hope that the TNR program may be working to manage cat populations in Rome.

A 2011 study conducted in Israel concluded that neutering cats in a TNR program actually increased the immigration of unsterilized cats into the area and also decreased

emigration, leading to a population increase at TNR sites (Gunther et al. 2011). In this study, TNR was implemented on two colonies of fed cats and compared to two other colonies that were used as control groups. Each colony had been cared for and fed by local caretakers for several years before the start of the study. Over the course of one year, cats were identified and monitored on a weekly basis at each site to track changes in population size. At the two TNR sites, about 75% of the cats were sterilized during the course of the year. There was significantly greater immigration into the TNR colonies than into the untreated colonies, and there was significantly greater emigration out of the untreated colonies than out of the TNR colonies. The cats that immigrated into the TNR sites tended to be feral cats, not abandoned pet cats. Gunther et al. hypothesizes that the TNR sites experienced greater immigration because the sterilized cats exhibited fewer aggressive behaviors than the unsterilized cats at the control sites, allowing more cats to move in and integrate into the group. They also conjectured that neutering male cats decreased their tendency to roam and find mates, causing them to stay in the TNR sites instead of migrating to other areas. The authors concluded that for TNR to work, aggressive TNR campaigns would be needed to maintain a high relative proportion of sterilized cats in the target areas and prevent immigration from hindering TNR efforts. One potential problem with this study is that it only lasted over the course of one year, a time frame in which it is unreasonable to expect TNR to reduce populations of feral cats. Even so, Gunther's 2011 study provides one empirical example in which TNR did not reduce feral cat populations and also highlights the key role of immigration in TNR success.

Often cited by anti-TNR organizations, a study in two Florida parks where TNR programs were implemented found that the cat population in one park increased over time, while the population in the other park remained stable (Castillo and Clarke 2003). The authors

attributed this failure of TNR to reduce population sizes to the migration and abandonment of cats in the area, possibly because they were attracted to food sources provided for the colonies. The study mentioned that the abandonment of entire litters of kittens and adult pet cats was witnessed by the researchers. Although anti-TNR organizations frequently cite this study as evidence that TNR is counterproductive, there are several problems with extrapolating that conclusion from this limited study. Data was only collected for one year at one of the parks and for two years at the other, which is not enough time to expect populations of cats to decrease significantly through natural death and adoption alone. One of the sites remained at a stable population despite cat abandonment in the area, which implies that the program was somewhat successful in population management. Furthermore, Castillo and Clarke 2003 failed to adequately explain how TNR was implemented at these sites, as the paper did not include the duration of the program or sterilization rates, both of which can contribute significantly to the success of TNR. Castillo and Clarke seem to rely upon the idea that every TNR program is equivalent, which is far from the case in practice. The authors suggested preventative measures such as education as a solution to the feral cat problem, but disparaged TNR while dancing around the idea that something must be done about the cats already in the parks. Overall, Castillo and Clarke 2003 is important because it shows that high rates of cat abandonment and migration can thwart TNR efforts, but it provides limited evidence that TNR is generally unsuccessful as a population control method.

A 2014 study conducted in Gainesville, Florida has recently abounded in news articles about TNR and in conversations in the pro and anti- TNR communities. This study examines a 2 year TNR program in a Florida zip code in which 54% of free-roaming cats in the area were captured, sterilized, and then either adopted or re-released (Levy et al. 2014). The researchers found that

shelter intakes of cats decreased by 66% in the two years and euthanasia rates in the zip code were 17.5 fold lower than those in surrounding zip codes. Over 2300 cats were captured during the study and either placed into homes for adoption, euthanized due to incurable medical problems, or sterilized and released. The authors of Levy et al. 2014 suggest that high impact TNR can be highly effective in reducing cat shelter intake and euthanasia. It is worth noting that the study did not actually examine the number of feral cats in the target area over the course of the two years. This fact makes anti-TNR advocates question whether TNR actually reduced feral cat populations, or if the only change is that fewer cats are now being admitted to shelters. A study that surveyed the number of feral cats in the area before and after TNR was implemented would be helpful in assessing the overall effectiveness of this TNR program.

The six studies I have just explained make up the bulk of empirical scientific evidence about whether TNR programs work. Somehow, advocacy organizations use these studies as enough evidence to support their claims either that TNR is an effective method or that it will not work. This handful of studies alone, however, does not provide us with definitive evidence that TNR will or will not reduce feral cat population sizes. Four of the six studies took place in two years or less, which is simply not enough time to assess whether TNR is a sustainable solution. One did not actually survey the number of feral cats in the area, and one failed to provide any information about the TNR program used. So few studies that empirically assess TNR exist because these studies are extremely labor intensive and require adequate time, commitment, and especially funds. Although Alley Cat Allies and other organization often cite anecdotal evidence that TNR has been successful in certain communities, but we do not have peer-reviewed studies to back them up. Furthermore, every community and ecosystem is different, which makes extrapolating the results of any of these studies difficult.

When I began this project, I also was unable to find any research articles that studied the effectiveness of trap-ethanize programs, so I had nothing to compare to the available TNR studies. In February 2015, however, an Australian article was published that examines the effects of low rates of culling on feral cat populations in Tasmania (Lazenby et al. 2015). Cats in this study were killed by being trapped and then shot in the head with a rifle. This method of culling clearly brings up ethical issues including inadvertently killing pet cats without a microchip or collar, killing nursing mother cats, and causing suffering if the cat could not be killed instantly with a single shot. After 13 months of culling a total of 26 cats, the number of cats in the two target sites increased by 75% and 211%, suggesting that culling was not an effective population management strategy during this time frame. Because many people consider culling and trap-ethanize animal cruelty and oppose these control methods, few studies exist about their effectiveness. Anti-TNR advocates often argue that science has proven trap-ethanize to be more effective than TNR, but we cannot reach this conclusion by using published research. The lack of data concerning trap-ethanize or culling makes it impossible to compare TNR and trap-ethanize strictly using empirical studies.

Despite the many issues with these six studies, they are important because they are the only peer-reviewed, empirical research we have so far about TNR's effectiveness. The studies show us that TNR programs implemented at higher rates tend to be more efficient, and that an influx of new cats into the area due to abandonment or migration has the potential to significantly alter the outcome of TNR programs. We should also note, however, that abandonment and immigration will also impact the effectiveness of trap-ethanize, perhaps substantially enough that the control method will not work. These studies alone are not enough to prove that we should adopt or dismiss TNR unconditionally. Alternatively, several

researchers have used model-based studies to predict the effectiveness of TNR and trap-euthanize on populations of feral cats in various circumstances. These studies prove valuable in assessing population control methods given the relative dearth of empirical research on the topic.

Model-Based Studies of TNR

I have found nine recent studies that evaluate the potential effectiveness of the TNR and trap-euthanize methods using computer models. One often-cited JAVMA study suggests that trap-euthanize is more effective at reducing population size than TNR; in this model over 75% of cats in a population needed to be neutered to reduce population size, while only over 50% of cats needed to be euthanized (Andersen et al. 2004). While this study does show that trap-euthanize is more efficient, it still suggests TNR can be effective if executed at a high enough rate. It is very important to note that this study did not include the adoption of social cats and kittens as part of its TNR model. Since every TNR program I have seen includes adoption as an important component of the program, it is a mistake for this study to ignore it. The model in Andersen et al. 2004 underestimated the effectiveness of TNR because it takes adoption rates out of the equation. Even so, the benchmark of about 75% sterilization in a colony mentioned in this study appears in almost all of the model-based approaches. Perhaps if a community is able to trap and neuter about 75% of the cats in their area, TNR could be an effective method of population reduction.

A different model-based study published in 2010 used a decision support model to determine whether communities should choose TNR or trap-euthanize (Loyd and DeVore 2010). This study did include adoption as part of its TNR program. The results suggested that TNR tends to work best for colonies of fifty cats or less, while trap-euthanize is more effective for

larger colonies. The authors found that initial population was the most important determining factor for predicting which management strategy will work best. Loyd and Devore argue that using TNR for small cat populations and trap-euthanize for large populations will give an optimal combination of the lowest possible predation rates and lowest costs. The study also noted that trap-euthanize is a quicker solution when wildlife may be at risk. It argues that while trap-euthanize is often the more efficient method for feral cat population control, it will tend to meet resistance among community members which may prevent it from being implemented unless the population of feral cats is extremely large. Similar to the Andersen et al. 2004 model, Loyd and DeVore et al. 2010 supports the idea that TNR can be effective for small populations of feral cats, but may not work for larger ones and may not be ideal when at-risk wildlife live in the area.

A 2005 study of two TNR programs in large regions of Florida and southern California over a ten year period used a population model combined with empirical data to assess TNR's effect on free-roaming cat population size (Foley et al. 2005). This study used the number of cats captured and neutered along with expected birth and death rates to model changes in population size. The authors admitted that being able to actually measure the populations sizes of the cats would provide a more accurate story of whether the population size has changed over time. The model used in this study suggested that at least 70% of all cats in a colony would need to be neutered to prevent population growth, which was much higher than the rate of trapping and neutering in these two programs. This 70% sterilization rate could be achieved by neutering 14% per year in the California location and 19% per year in the Florida location based on carrying capacities and expected life spans. Although TNR in these locations did not reduce population sizes, the populations also did not grow significantly despite cat abandonment and

migration, suggesting that TNR at least stabilized the populations. The article did not mention an adoption program for the adoptable kittens and socialized adult cats in this study, but it is hard to imagine a large-scale TNR program that does not include adoption. It also did not mention cat abandonment or the movement of cats into or out of an area. Foley et al. 2005 asserts that TNR could potentially be effective if targeted to small, well-defined areas at which high rates of sterilization were implemented. The large scale TNR projects in Foley et al. 2005 sterilized only a small percentage of the total cats in each county, and the author's model suggests that the program was ineffective in population reduction.

A 2009 study published in the *Journal of Applied Animal Welfare* used a matrix population model to assess the effectiveness of no intervention, TNR, and nonsurgical contraception on a hypothetical population of feral cats (Budke and Slater 2009). Budke and Slater did not include trap-euthanize in their model. The model found that to stop population growth over a ten year period, 51% of adult and juvenile cats would have to be sterilized per year, or 71% of the female population would need to be sterilized at all times. This would equate to about 14% of the total female population being sterilized per year. The authors stated that nonsurgical sterilization methods seemed less effective, as 60% of cats would need to be sterilized per year. This study also found that a sterilization proportion of about 70% would allow TNR to reduce population sizes, although their model focused on sterilizing only female cats. Budke and Slater, however, made many assumptions in their model that tend to make it less realistic. It was assumed that there was no immigration into the population and no adoption out of the population; cats bred continuously throughout the year; there was no carrying capacity for the population; and only female sterilization affected population size. Although Budke and Slater primarily meant to compare TNR with nonsurgical contraception, leaving out migration

and adoption as factors in the model make it difficult to extrapolate these findings to most communities.

In a 2012 Brazilian study, researchers determined the population density of feral cats in a specific area and then used a population model to assess population control methods (Lessa and Bergallo 2012). The study was conducted on a coastal island in Brazil that includes a large urban area but is primarily covered in rainforest. Surveys of pet owners and a line transect method were used to estimate the number of free-roaming cats, both pet cats and feral cats, on the island. This model compared the effects of no population control, neutering males only, spaying females only, sterilizing both males and females, and using trap-euthanize as a control method. The model showed that female sterilization alone seemed to most efficiently reduce feral cat reproductive rates. Sterilization of both sexes worked well but was not as efficient, and the authors also found that trap-euthanize was not as efficient. A high rate of 70% of the female cats in a population would need to be sterilized or removed to cause population decline over time. Importantly, Lessa and Bergallo did not include migration or the adoption of socialized cats in their model, making it difficult to apply these results to most communities. This study shows that a version of TNR in which only females are captured and sterilized should work at high enough rates of implementation. Lessa and Bergallo note that residents of the island need to be educated about the harm of abandoning or failing to sterilize their pet cats, and that an inspection process at ports on the island should be used to prevent more cats from immigrating.

Another important model-based study was conducted to predict which population control methods could be effective in combatting cat population growth in Oahu, Hawaii. This study used a population model to determine whether trap-euthanize or TNR would be more efficient and cost effective over a 30 year period (Lohr et al. 2013). The researchers used data from actual

cat colonies on Oahu to estimate the number of feral cats on the island and the carrying capacity for these cats. Costs of euthanasia, sterilization surgeries, food and care for colony cats, and microchips were included in the model, as well as estimated monetary losses due to predation calculated by assigning a value to each bird's life. The results suggest that trap-euthanize appears to be more cost effective and efficient than TNR, but abandonment of pet cats is the most important factor in determining if a population size will change. TNR only worked in the model in populations of fewer than 1000 cats and worked best when there was little to no migration of outside cats into the area. TNR was also more cost effective than trap-euthanize when there were less than 1670 cats originally in the colony. The authors of Lohr et al. 2013 favor trap-euthanize over TNR, but argue that the reduction of abandonment is an enormous factor in the size and growth of feral cat populations. This study was based specifically on an island ecosystem that could have very different needs than communities in the mainland United States that have fewer endemic and vulnerable species.

A 2009 study also suggests that an influx of cats into an area through migration or abandonment can drastically change which population control method should be chosen. This study used a population model to predict the results of trap-euthanize and TNR on an unmanaged population of feral cats in suburban Texas (Schmidt et al. 2009). The model took into account immigration rates of 0%, 25%, and 50% and implementation rates of TNR and trap-euthanize of 25%, 50%, and 75%. The authors' consideration of various implementation rates and various rates of immigration is important because it makes the results of this study more applicable to real communities. The results of Schmidt et al. 2009 showed that euthanasia and TNR are about equally effective if there is no immigration of cats, and trap-euthanize is more labor intensive. The model suggested that TNR must be implemented at rates of over 50% of cats per year in

order for the population to decline, which is a difficult rate to achieve in large cat populations. If immigration does occur at a rate of 25% or above, however, only trap-euthanize is able to cause a decline in population size, and only at an implementation rate of at least 75%. The authors stress that TNR can also be problematic in environmentally sensitive areas because it takes longer to reduce cat populations than trap-euthanize does. One important problem with Schmidt et al. 2009 is that it does not include the adoption of socialized cats and kittens in its TNR model. Adoption can play a significant role in reducing feral cat population sizes and should be considered in realistic population models. Like most other studies on feral cat management, Schmidt et al. 2009 also concluded with the sentiment that better public education and low cost spay and neuter clinics could help reduce the problems associated with feral cats in the first place.

A handful of population model studies have examined methods besides TNR and trap-euthanize in their assessment of feral cat control methods. A 2013 study conducted at Tufts University asserts that Trap-Vasectomy-Hysterectomy-Return (TVHR) works better than TNR and trap-euthanize in managing feral cat populations (McCarthy et al. 2013). Unlike spaying and neutering, in which all reproductive organs are removed, vasectomies and hysterectomies prevent reproduction without removal of the testicles or ovaries. Cats that undergo these surgeries still retain sex hormones, which the authors of this study argue causes them to continue defending their territory and keeping other cats out. TVHR, therefore, may reduce feral cat population sizes more effectively than TNR because fewer unsterilized cats will move into the area if hormonally intact cats are present to keep them away. Because TVHR is not widely accepted as a method of population control sterilization in the veterinary community, I will only examine the TNR and trap-euthanize results of McCarthy et al. 2013. Trap-euthanize was a

more effective form of population control than TNR in this model and needed to be implemented at lower rates than TNR to succeed in reducing population sizes. Both TNR and trap-euthanize needed an implementation rate of over 57% per year to reduce population sizes, which is higher than noted in most other population models. This study focused on TVHR and therefore does not provide much information about TNR and trap-euthanize. It is very important to note, however, that adoption was not considered in this model whatsoever, again limiting its likeness to actual TNR programs. Trapping rates were assumed to be the same for each method of population control, and migration was not considered. These gaps in the model make it difficult to believe that McCarthy et al. 2013 provides us with an accurate prediction of TNR and trap-euthanize success. Even so, it is helpful in suggesting that in certain circumstances, either method can work at high enough implementation rates, but trap-euthanize tends to be more efficient.

A final interesting model-based study just published in 2014 includes demographic connectivity in its assessment of TNR, trap-euthanize, and nonsurgical contraception methods (Miller et al. 2014). The authors of this study argued that whether populations of free-roaming cats were isolated from one another or could move freely between areas needed to be considered in the assessment of population management strategies. Given how important migration has proven to be in the empirical studies, these authors were wise in including connectivity as a factor in their model. They also included the abandonment of kittens, supplement feeding in urban environments, and cat dispersal rates to their model to make it more realistic than most previously published model-based studies. The model first showed that free-roaming cat colonies can grow up to 20% per year in urban environments if unmanaged and tend to grow about 5.5% per year in rural environments. It also showed that TNR and trap-euthanize could

both effectively eliminate feral cat colonies in ten to fifteen years when there was low demographic connectivity. Trap-euthanize, however, only needed to be implemented at a rate of 30% per year, while TNR needed a 40% rate to achieve similar population declines. When there was high demographic connectivity, however, neither method could completely eliminate feral cat populations, but instead the population would level off to an equilibrium value. This value was lower for trap-euthanize than for TNR, suggesting that trap-euthanize will do a better job of maintaining a low cat population. The model also suggested that having about 75% of the cats in a population sterilized will contribute to population decline, a statistic very similar to those found in other model-based studies.

Miller et al. 2014 is extremely valuable because it includes connectivity as a factor in modeling feral cat management strategies and shows that with high enough demographic connectivity, neither TNR nor trap-euthanize implemented at achievable rates will actually eliminate feral cat populations. Migration is an important, frustrating factor in population control that cannot be ignored in any study or model attempting to assess control methods. Other preventative factors such as education of pet owners, access to affordable sterilization, and laws prohibiting pet abandonment are necessary factors for both TNR and trap-euthanize to work in areas of high migration or abandonment. Overall, Miller et al. 2014 shows that both TNR and trap-euthanize could work in isolated areas, although trap-euthanize required a lower capture rate, but neither strategy will completely eliminate free-roaming cat populations in areas with high demographic connectivity.

What do these scientific studies tell us?

After assessing the evidence from these thirteen studies, it is clear that we still have much to learn about the effectiveness of feral cat population control methods. To start, I could only find one study that assessed the effectiveness of culling, which suggested that killing cats in a remote area in Tasmania actually increased cat populations. This study alone is not enough to prove that trap-ethanize cannot work, but it does make it very difficult to claim that empirical data provides evidence for the effectiveness of trap-ethanize or culling. The empirical evidence about TNR as a whole remains inconclusive. Two TNR programs in these studies seemed to work well (Levy et al. 2003; Hughes et al. 2002), and two seemed ineffective (Gunther et al. 2011; Castillo and Clarke 2003), but each study had many variables that complicate these oversimplified conclusions. The study in Rome showed a decrease over a ten year period that was somewhat offset by migration and abandonment (Natoli et al. 2006), and the recent Florida study showed significant effects on shelter intake and euthanasia rates, but did not assess cat population sizes (Levy et al. 2014). I do not agree with Alley Cat Allies that these studies alone prove the effectiveness of TNR, but I would also argue against ABC's statements that TNR has never proven an effective method. In short, we need more empirical evidence to accurately assess TNR's effectiveness. These studies are time consuming and labor intensive, but they could help us better understand whether TNR is actually effective in reducing feral cat population sizes.

The model-based studies shed a bit more light on the TNR debate. Most models show that either TNR or trap-ethanize can be effective in reducing population sizes, but trap-ethanize tends to be a more efficient method. Trap-ethanize often requires lower trapping rates than TNR and works better when outside cats immigrate into existing colonies. TNR tends

to work best in populations of small or moderate size where there is little immigration or abandonment of pet cats and where trapping effort is high. Many models suggest that an overall sterilization percentage of about 70-75% of cats in a population is needed for TNR to be effective in reducing population sizes. Miller et al.'s 2014 model demonstrated the importance of migration by noting that neither TNR nor trap-euthanize will work in urban areas of high connectivity because the number of incoming cats will exceed the number of cats eliminated through population control methods. In this case, TNR or trap-euthanize can work to stabilize a low equilibrium of cats, but not to eliminate all feral cats from an area.

In fact, although I have been primarily assessing these studies for how well TNR or trap-euthanize will eradicate populations of feral cats, eradication may be an unrealistic standard. Population control methods may need to be assessed for how well they can stabilize populations of feral cats and prevent growth, not for whether they can eliminate all of the cats in an area. Miller et al. 2014 and other studies suggest that abandonment and immigration will thwart both TNR and trap-euthanize efforts at eradication. These methods, however, may help stabilize cat populations despite frequent influxes of new cats into the area. The scientific studies seem to consider complete elimination the ultimate goal of population control methods, but eradication is not a realistic standard. Feral cat population control methods need to be evaluated for sustainability and population management, not for the ability to eliminate cats from an area in a given length of time.

There are also some serious flaws in many of the model-based studies that make them less applicable to real world situations. For example, some of the models did not take the adoption of socialized cats into account when assessing the effectiveness of TNR. Adoption is a huge component of TNR and plays a crucial role in reducing the number of cats in an area, so

ignoring adoption entirely from these models is very misleading. Furthermore, studies that did not address cat abandonment or migration are very unrealistic because cat populations seldom, if ever, exist entirely in isolation. As Miller et al. 2014 suggested, demographic connectivity may be one of the major factors in determining whether a population control method will reduce cat population sizes. Finally, most of these models use the same rate of trapping success when modeling both TNR and trap-euthanize (McCarthy et al. 2013; Lohr et al. 2013; Lessa and Bergallo 2012; Loyd and DeVore 2010; Schmidt et al. 2009; Andersen et al. 2004). In reality, however, TNR may have the advantage of higher trapping rates because the programs work directly with people who know the cats and may be able to trap them more effectively. Trap-euthanize methods, on the other hand, often employ trappers who know less about the behaviors and preferences of individual feral cats and who will not be assisted by community members. The model-based studies of TNR leave out significant real world details, such as trapping rates, which could ultimately make their results less applicable to actual communities. In the future, feral cat population models may need to become increasingly detailed and specific to accurately represent the dynamics of actual feral cat populations.

So, what does the science have to say about TNR? Despite anecdotal evidence of TNR's success or failure, empirical studies do not yet provide us with any clear conclusions about whether TNR or trap-euthanize can work as population control methods. The single available study about culling feral cats demonstrates that this method was ineffective. TNR seems to have worked in some communities and not in others, but so many factors differ between each study it is difficult to compare their results or extrapolate them to other areas. These studies do show, however, that migration is an extremely important variable in TNR success. The model-based studies seem to suggest that TNR can work under certain circumstances such as relatively small

population sizes and high trapping rates, but trap-ethanize tends to be more efficient. Again, migration plays a key role in the success of both TNR and trap-ethanize, potentially preventing either strategy from working effectively.

More long term, empirical studies on TNR programs are needed to help us understand in which circumstances TNR can work. Organizations and community members that implement TNR should keep careful records of their surgeries, rereleases, and adoptions so that we know exactly how many cats have been captured and removed. Furthermore, scientists need to find ways of accurately assessing feral cat population sizes before and after TNR programs are implemented so that we can quantify capture rates and assess the success of these programs. Migration and cat abandonment need to be measured and studied so that they can factor into assessments of TNR. Unfortunately, these projects require funding, manpower, and adequate time to see the effects of population control. Until more studies are published, we must rely on the information we have available to make decisions about which population control methods to implement.

Chapter 4: Ethical Arguments

Scientific literature certainly helps us understand some facets of the feral cat conundrum. I have used science to examine how free-roaming cats may be affecting local ecosystems through predation and through the size and location of their home ranges. Science shows us that both TNR and trap-euthanize can be effective in certain circumstances, but that trap-euthanize may be more effective in areas with high cat population density and high migration rates. Even so, abandonment and population connectivity have the ability to thwart both TNR and trap-euthanize efforts. Science helps us approach the feral cat problem well-educated about its nuances, but it does not simply hand us a decision. As we have seen, the available scientific studies are quite complex, and interpretation can be subjective. Although science can provide us with information about the problem and about potential solutions, it cannot determine how we choose to act. We now need to use morality to decide what our role should be in helping to fix the feral cat problem.

For example, just because trap-euthanize seems like the most effective population control method does not mean it is ethically acceptable. Some environmental activists advocate for shooting feral cats on sight or poisoning them with Tylenol to reduce their impact on bird species. Many individuals, however, would not tolerate this blatant killing of domestic cats in their communities, and most regions have laws prohibiting this form of animal cruelty. Shooting cats could ultimately be the most effective method of population control, but we do not condone it for moral reasons. Similarly, when picking between trap-euthanize and TNR, ethics need to

play a role. We need to ask ourselves if it is permissible to euthanize healthy feral cats to reach the goal of population control.

Ethical principles necessarily inform our decision-making about feral cats, so it is important to have a basic understanding of relevant ethical theories. One useful distinction in ethical theories is between utilitarian ethics and rights-based ethics. In utilitarian theories, the objective is to maximize the total amount of “goodness” in the world (Shafer-Landau 2012). Utilitarians believe that each person should choose actions based on which ones will provide the best overall results. In this theory, harm to individuals may be justified if it provides a net benefit to the world. Utilitarianism is morally flexible in this way; no actions are absolutely forbidden if they could result in an overall good. If the ends justify the means, any action could be morally permissible. One issue with utilitarianism is that it could be difficult, or even impossible, to know in the moment whether an action would result in the best possible state of the world. Utilitarians must base their actions on current knowledge and understand that their current prediction of which action would be best could prove wrong later. Another issue is that utilitarian theories could condone serious crimes, such as murder, if these actions will bring about an improvement in the world.

Rights-based theories, on the other hand, reject the idea that the ends always justify the means. Instead, committing certain harms to another being is never morally desirable even if it results in an overall better state of the world (Shafer-Landau 2012). For example, murder and rape may be considered morally impermissible under any circumstances. Rights-based theories posit that individuals have intrinsic value that is not based on their utility to others, but is innate. The rights of these individuals should not be violated because their violation is morally wrong despite possible net benefits to society or the world as a whole. For example, a government may

save a large amount of money if it denied access to free education to children under a specified IQ. This money could be used to bolster the education system and ultimately help the country thrive more than it is hurt overall. Denying children access to education because of their IQ, however, is a violation of their rights and would not be acceptable in the United States. Rights-based theories argue that it is impermissible to deny an individual's human rights for the sake of the greater good.

Both utilitarian and right-based approaches have been applied to animal ethics and inform different theories about how humans should interact with animals. The utilitarian form of animal ethics is represented well by Peter Singer's philosophy in *Animal Liberation* (Singer 2003). Singer argues because sentient animals are able to suffer, they have interests in not suffering just like humans. An animal's well-being, therefore, should be given equal consideration to a human's because animals suffer just as we do. Singer also posits that species designation is not a legitimate reason to favor the interests of humans over other animals and labels this discrimination as speciesism. Under Singer's philosophy, humans should not raise animals for food if we have other nutritious options because the small benefit of a replaceable meal for us does not outweigh the pain and suffering experienced by the farmed animals. If a family of four was starving in the forest, on the other hand, and was able to painlessly kill a deer for food to keep them all alive, Singer would probably consider this action permissible. In the utilitarian philosophy of animal ethics, we must weigh each sentient being's interest against others in order to make decisions that will cause the most benefit and the least suffering overall. This philosophy sometimes condones killing animals or causing them to suffer as long as the overall suffering in the world is decreased more than it would be in any other available option.

On the other hand, animal rights theory is based on the idea that many nonhuman animals are subjects of a life just like humans are, and that these nonhuman animals therefore have intrinsic value. To Tom Regan, being the subject of a life means that an animal has thoughts, feelings, desires, experiences, and an interest in continuing to live (Regan 1989). Because animals have innate value in animal rights theory, it is considered wrong to use them simply as a means for human ends. In this perspective, animals should not be treated as human resources and should be valued for what they are instead of what they can give us. Some animal rights theorists are abolitionists that believe humans should no longer use animals for food, clothing, entertainment, transportation, and in some cases even as companions. Others believe that we can maintain respectful relationships with animals as long as we treat them as individuals with rights just like our own.

In the United States today, most people do not think critically about the welfare or rights of nonhuman animals. Farming animals by the billions for meat and dairy production, keeping animals in captivity for entertainment, and using animals for research are often justified by the sentiment that these practices benefit the world, or at least human society, as a whole. This argument has utilitarian elements, but does not match the utilitarianism of Peter Singer and other advocates of animal welfare. Peter Singer would disagree with factory farming, poor conditions in circuses, and painful research on animals because the pain experienced by these animals would not outweigh the overall benefits to society. Utilitarian theories assert that animal suffering is undesirable because it violates animals' interests in not suffering, but they also contend that this suffering can be justified in certain circumstances. Some forms of farming and research on animals may be permissible to utilitarians, but it depends on if the suffering of those animals would bring about an overall better state of the world. The veterinary community in the

United States tends to take a largely utilitarian approach to animal welfare, with the American Veterinary Medical Association (AVMA) stating, “The responsible use of animals for human purposes, such as companionship, food, fiber, recreation, work, education, exhibition, and research conducted for the benefit of both humans and animals, is consistent with the Veterinarian's Oath” (AVMA 2015).

Animal rights activists, on the other hand, argue that these practices violate animal rights by treating animals as human instruments instead of as beings with their own inherent value. They oppose factory farming and painful animal research not only for the suffering that they cause, but also because the animals are denied basic rights not to be used as a means to human ends. Within the animal rights perspective, there are disagreements about the moral relevance of death. Many animal rights theorists do not believe that painless death is a harm to an individual animal because the animal does not suffer. In other perspectives, however, even painless death is considered a harm to an animal because it denies that animal a future potentially filled with satisfying experiences. These animal rights activists believe that painless death can only be defined as euthanasia if it honors the interests of an animal who is suffering and will not recover. Advocates of no-kill animal shelters adhere to the perspective that all painless death is not euthanasia.

Both approaches to animal ethics, utilitarian and rights-based, are commonly used in the conversation about feral cats. These broad theories, however, are somewhat limited in their applications to intricately complex issues like the feral cat conundrum. Sue Donaldson and Will Kymlicka's book *Zoopolis* provides an ethical framework that comes closer than general utilitarian and rights-based approaches to being applicable to the feral cat problem (Donaldson and Kymlicka 2011). *Zoopolis* uses animal rights theory as a foundation to build a political-

theory based approach to animal ethics. Although the authors accept many tenets of animal rights theory, including the intrinsic value of animals and the moral wrong of using them as tools, they assert that traditional animal rights theory is limited in its real world applications to many groups of animals.

Traditional animal rights theorists, for example, often distinguish only between domestic animals and wild animals. They assert that while we have positive duties to domestic animals because of our role in their domestication, we should usually leave wild animals alone so that we do not harm them. Abolitionists take an even more extreme view, arguing that we should not only refrain from interacting with wild animals, but prevent all domestic animals from reproducing in order to prevent future generations from being “used” by humans. Donaldson and Kymlicka reject the abolitionist view of animal rights theory as limited and alienating to many animal lovers. They also reject the idea that there are only two rigid categories of animals: domestic and wild. Instead, Donaldson and Kymlicka present a modified form of animal rights theory largely based on human political theory. Instead of only focusing on negative duties not to harm animals, the authors explain the many positive duties humans have to promote the well-being of nonhuman animals. They also create a third category of animals, liminal animals, that lives among humans and is neither domesticated nor truly wild. This third category allows *Zoopolis* find a place for many kinds of animals that span the spectrum between wild and domestic and promotes the idea that humans are never completely separated from “nature.” Examples of liminal animals are “pests” that live in our homes like mice, animals that thrive in cities like pigeons, and animals whose habitats have been compromised by humans like gray wolves in North America.

Donaldson and Kymlicka argue that citizenship theory provides an excellent framework for exploring how animals can fit into our society and adds the complexity needed to distinguish between our duties to a wild animal, a domesticated one, and an animal that lives on the boundaries of human civilizations. The authors argue that animals can be members of our society without being able to directly communicate their needs to us and without being expected to contribute to society in the ways generally expected of many humans. In fact, some humans cannot participate in our political system in the same ways as others, but this does not mean that their rights should be limited or stripped. Kymlicka and Donaldson argue that meaningful distinctions between humans and animal do not exist in many contexts, so animals should be fully incorporated into our political systems.

In this political framework of *Zoopolis*, domestic animals should be considered co-citizens of our human communities; wild animals should be treated as members of sovereign nations; and liminal animals should be treated as denizens like migrant workers or undocumented immigrants. Donaldson and Kymlicka give a wide range of examples explaining what our responsibilities toward animals would look like for each of these categories by using examples from the human political system. They argue that their politically based version of animal rights theory is both more applicable to real life situations and fairer to animals that may not fit neatly into the traditional categories of domestic and wild. *Zoopolis* has many applications to the problems associated to feral cats, and I will use ideas from Donaldson and Kymlicka's theory to inform my arguments about the ethics of feral cat population management.

Unfortunately, Donaldson and Kymlicka have little to say about feral animals. In *Zoopolis*, they mention feral cats briefly in the chapter about how liminal animals are like human denizens. Donaldson and Kymlicka assert that feral cats are liminal because they live among us

and often depend upon us, but they do not live in our homes and we are not individually responsible for them. According to this argument, we owe feral cats approximately the responsibilities and privileges of human denizens in our society, but should not treat them as co-citizens like pet cats. Donaldson and Kymlicka would argue against trap-euthanize as a population control strategy because it harms the rights of individual animals and uses the animals as a means to our own human goals. They would also argue that we have a responsibility to help feral cats, potentially through the use of TNR, since they are denizens living in our community.

Interestingly, many of the prey species of feral cats would also be considered liminal by Donaldson and Kymlicka. Some small mammals and birds actually thrive living in and around human communities and have evolved a kind of dependence on humans. Others merely pass through human communities during migration or because human development has encroached upon their habitats. According to *Zoopolis*, liminal animals should be treated similarly to human denizens such as migrant workers, undocumented immigrants, and citizens of another country working or studying in the U.S. If the species that cats prey upon and the feral cats themselves are considered liminal animals, then Kymlicka and Donaldson would probably assert that these animals have similar rights and similar responsibilities from us. *Zoopolis*, however, does not dwell very much on circumstances in which the rights of one animal conflict with the rights of another. It would be difficult to predict how Donaldson and Kymlicka would react to the conflict between feral cats and their liminal prey species.

Although the principles explained in *Zoopolis* are helpful for working through the ethical dilemmas associated with feral cats, I disagree with Donaldson and Kymlicka that feral cats fit neatly into the liminal category. Even though these individual cats have not been socialized to humans, feral cats are domestic animals. Their species has undergone the long process of

domestication, and our species is why these cats are in our communities. These animals are also in some ways dependent on us for food and shelter in a way many liminal animals are not. Feral cats are an interesting case because individual cats span a large spectrum between very wild and very socialized to humans. Feral kittens are typically adoptable, but adult feral cats range from being friendly to humans to being completely unable to be socialized. Therefore, it is difficult to classify feral cats as strictly liminal because they fall into such a wide spectrum. Overall, I argue that feral cats are domestic animals and should be treated as co-citizens, not denizens, in Donaldson and Kymlicka's *Zoopolis* framework.

In *Zoopolis*, Donaldson and Kymlicka make parallels between certain categories of animals and groups of humans to better explain the relationships human society should have with specific animals. One way we may think about feral cats in this framework is as similar to humans who are homeless. These people are citizens, but they may not be able to fully participate in our communities in ways that other citizens can. They are often stigmatized despite being members of our society and have become homeless in the first place because of societal flaws. People who are homeless often need help securing food and shelter until they are able to financially support themselves once again. The parallel is far from perfect, but feral cats share certain similarities with people who face homelessness. These cats have become feral because of human negligence, but they are frequently stigmatized because of their situation. People seem to want both homelessness and feral cat populations to suddenly vanish, but often we do little as a society to prevent these problems in the first place or to make the lives of these individuals better. We have a responsibility as members of society to help better the position of those who are suffering, especially if we have failed to prevent that suffering from occurring. In this case of feral cats, this help would come in the form of shelter from harsh weather conditions

or predators and food to help sustain them if resources are scarce. The situation of feral cats does not neatly parallel the situation of any group of humans, but homelessness provides the closest analogy I can find to understand how feral cats fit into our society.

My own ethical argument about the management of feral cat populations modifies and complicates the ideas presented in *Zoopolis*. The feral cat conundrum certainly presents a wide range of complex ethical questions. Do humans have a responsibility to take action to prevent feral cat overpopulation? Is it ever ethically permissible to euthanize healthy cats? What if euthanizing cats saves the lives of birds and small mammals? What should we do if the rights of cats conflict with the rights of other animals? Though my viewpoint does not align precisely with Donaldson and Kymlicka's, their political theory framework helps inform my arguments about the ethics of feral cat management.

First of all, I believe that euthanizing healthy cats is morally undesirable. Euthanasia means "good death" and implies that an individual will be painlessly killed to reduce his or her suffering. But feral cats often lead healthy, fulfilling lives and are not experiencing chronic pain. To kill these cats is to deprive them of a future potentially filled with satisfying experiences. The term "trap-euthanize" is highly problematic even when it describes a strategy in which cats are painlessly killed. We cannot pretend like "euthanizing" a healthy cat to manage a growing feral cat population is in that individual's best interest, so this method cannot rightfully be called euthanasia. It may help the human goal of population control, but it is an injustice to that individual cat. I argue instead that death harms a cat, even if it is a painless death. This argument aligns with those of ethical thinkers such as Frederike Kaldewaij, who argues against Peter Singer's belief that painless killing does not harm animals. Instead, Kaldewaij asserts that life is instrumentally and objectively valuable and should not be valued merely as a means to

satisfy desires (Kaldewaij 2006). Clare Palmer similarly argues that the widespread practice of painlessly killing animals in shelters needs to be critically reevaluated (Palmer 2006). The lives of sentient animals like cats have inherent value that is disregarded when we kill them to aid in our own goals. My argument aligns with that of some animal rights thinkers who believe that painless death violates the rights of an individual.

Furthermore, I argue that humans have special responsibilities to cats due to their history of domestication. Humans are responsible for breeding domestic cats into the animals they are today and for creating populations of feral cats in our communities by abandoning them or by failing to sterilize free-roaming pet cats. We are the reason feral cats exist, and killing them simply because we do not want them living among us is wrong. This argument brings in components from Clare Palmer's *Animal Ethics in Context*, which asserts that past injustices can call for increased present responsibilities (Palmer 2010). Palmer argues that our varying relationships and histories with animals can require different levels of assistance when these animals are suffering. While humans are often required to assist domesticated animals, they typically are not required to assist similarly suffering wild animals, even if these animals have the same capacities for pain. Feral cats would fall under the category of domesticated animals, and therefore humans are to assist them when they are suffering and are obligated not to harm them. A tricky element in this argument about past wrongs is that no one alive today directly domesticated cats; our ancestors did. Even so, I believe that humans have a special responsibility to cats that we do not have to other, undomesticated species. In my revision of *Zoopolis*, feral cats would be considered citizens of human societies simply because they are domestic animals. Because euthanizing healthy feral cats violates their rights and because of our special responsibilities to domestic species, I assert that we should not default to the trap-

ethanize method for cat population control if another viable option exists. Although TNR may not always be as efficient as trap-ethanize in reducing feral cat populations, I believe it is morally a more acceptable choice.

I also argue, however, that trap-ethanize is not always impermissible. In some cases, the scientific population models suggest that TNR will not work to control feral cat population sizes. If many thousands of cats have overpopulated a region that lacks the funds and manpower to implement TNR, if no other alternative such as relocation or shelters exist, and if the community does not support TNR, trap-ethanize may have to be used until populations are small enough for TNR to be effective at reducing population sizes. Overpopulation can lead to poor conditions and suffering for the feral cats, public health risks to humans and domestic animals, and ecological problems. Furthermore, TNR may not work in regions where people abandon unsterilized cats at high rates because the rate of incoming cats will exceed the natural death rate of the cats in the region. Scientific articles in which TNR has failed to reduce population sizes often cite abandonment as a major contributing factor. Trap-ethanize efforts may also be thwarted by these factors, but the increased death rate in this method may help manage population growth more efficiently. In these cases, trap-ethanize may work as an alternative to TNR. Donaldson and Kymlicka would likely disagree with me that healthy cats should ever be euthanized because that would violate their rights to life and treat them as a human instrument instead of beings with inherent value. But uncontrolled populations of feral cats will likely lead to suffering for the cats and wildlife in the area, and if TNR cannot stop population growth, then something else needs to be done. In these cases, I argue that trap-ethanize is a tragic, yet permissible, option when all other options fail.

Another hard ethical question about feral cat management is what to do when killing a cat may mean saving a bird, or many birds. When we are forced to weigh the life of a bird over the life of a cat, Donaldson and Kymlicka have few answers, especially since they consider both cats and the birds in our communities “liminal” animals. Even though I modify *Zoopolis* theory to consider cats as citizens and birds as denizens, it is uncertain whether it could be permissible to directly kill a cat to prevent the possible death of a bird. To me, the direct harm of killing a cat is worse than the indirect harm of letting birds die because I did not kill the cat. But, what if the bird is one of the last few left in an endangered species? And what if the loss of that species will cause an entire ecosystem to fall apart, inducing the deaths of other animals?

Here, the ethical questions become even more complicated. I believe that trap-euthanize could be permissible in ecosystems where TNR would work too slowly to prevent large scale damage to the environment and the possible extinction of endangered or endemic species. The deaths of cats through trap-euthanize should be considered a tragic, last resort in areas that are extremely environmentally sensitive. My argument departs from traditional animal rights theory because I assert that in certain theoretical circumstances, killing a healthy cat could be a permissible last resort. This argument draws from W.D. Ross’s theory of ethical pluralism in which humans have certain prima facie duties, but these rules are not absolute (Shafer-Landau 2012). Ethical pluralism allows a degree of moral flexibility when, all things considered, the situation warrants that we break from a prima facie duty. Ethical pluralism actually aligns with common sense, moral thinking that our society uses each day. For example, although citizens of the United States have a prima facie duty not to kill others, this duty may be lawfully violated in instances of self-defense and during warfare. In the case of feral cats, I would argue that we

have a prima facie duty not to kill healthy cats, but in certain extreme situations, painless killing may be warranted.

One complication with my argument that TNR should be a default method, but trap-euthanize is sometimes acceptable, is that it can be very hard to define when an area should be considered environmentally sensitive enough that trap-euthanize should be used. Ecologists could make an argument that just about any location is environmentally sensitive, while TNR activists believe that feral cat colonies could never do enough harm to local ecosystems to justify trap-euthanize. Local communities would need to decide whether they are willing and able to implement TNR even though it may not be the most environmentally optimal solution. As I mentioned before, this decision may depend upon further research into the environmental impact of feral cats and how they vary from ecosystem to ecosystem. It seems likely that island ecosystems could be dramatically harmed by populations of feral cats, while urban, mainland areas will face less of a risk. Ethical complications about the intersection between animal ethics and environmental ethics such as this one do not often arise in *Zoopolis*, but are important to consider in real world scenarios.

Overall, I agree with the aspect of animal rights theory that suggests that animals should not be used only as a means to human ends, but as individuals with intrinsic value. I believe that healthy cats should not be euthanized if other options exist, and I believe that the killing of small animals because of feral cat predation is a loss that humans are largely responsible for. I do not think that we should default to killing feral cats to protect the lives of small mammals and birds. If TNR reduces feral cat population sizes over time, we can still help prevent the deaths of future birds and small mammals without needing to directly kill cats. I also argue, however, that trap-euthanize can be permissible under certain circumstances in which TNR would not work or the

feral cats would cause extreme environmental destruction. Although I value the lives of individual cats, in some hypothetical cases I assert that trap-euthanize may be our only real option.

In the ongoing debate about TNR, many advocacy organizations and individuals would disagree with me that TNR should be the default method for feral cat population control. Many of these individuals are environmentalists who are concerned about the ecological impact of feral cats through their role as predators. I agree that environmental ethics need to play a role in feral cat management decisions, but I disagree with ecocentric ethics that do not place value on the lives of individual animals. I believe that individual cats have rights that should not be violated, but ecosystems do not. Ecosystems can be hurt, but they cannot experience pain. They are critically important because they provide countless services to us and to other animals, but they do not have rights in themselves. Sentient animals that are a part of ecosystems do have rights and are morally considerable. I reject the idea of euthanizing cats because of their potential to harm ecosystem functions *unless* the damage is extremely severe and will cause so many animal deaths that saving the lives of cats is no longer worth it. Even so, killing cats violates their rights through direct harm, but allowing feral cats to live only indirectly violates the rights of their prey animals. Trap-euthanize can be a tragic alternative to TNR when the harm caused to prey animals is so morally unacceptable that it makes the killing of cats permissible.

My ethical approach to the problem of feral cats borrows many ideas from animal rights theory, builds off of Donaldson and Kymlicka's theory in *Zoopolis*, and includes aspects of ethical pluralism. I agree with animal rights theory that animals have inherent value and have rights that should not be violated. I believe that *Zoopolis* provides an excellent framework that answers some of the questions that traditional animal rights theory does not address involving

our relationships with specific categories of animals: domestic, liminal, and wild. I disagree with Kymlicka and Donaldson, however, that feral cats should be considered liminal animals. Feral cats span a spectrum of socialized to un-socialized, but their species has undergone a process of domestication that makes humans responsible to them in ways that we are not to liminal animals. With this approach to animal ethics, I argue that TNR is a more ethically desirable option for population control than trap-euthanize, which involves the painless killing of healthy cats.

This argument seems to align with animal rights theory, but my approach has an important caveat: theoretically, trap-euthanize can sometimes be the best option for a community. In cases where TNR cannot work to manage cat population sizes or in environmentally sensitive areas, trap-euthanize can be a permissible, yet undesirable, option. This component of my argument aligns with ethical pluralism because I assert that the death of a few cats can sometimes be justified if it saves the lives of many prey animals and preserves an ecosystem that would otherwise be destroyed. Animal rights theorists would reject the idea that trap-euthanize is ever permissible; ecocentric ethicists would reject the idea that TNR should be a default method. I believe my solution, however, addresses the problem as realistically and fairly as possible given the complications of the feral cat problem.

Summary of My Argument

Science and ethics combine to provide a compelling case for TNR. This method of population control is both humane and has the potential to reduce feral cat population sizes. It helps promote animal welfare by caring for cats that humans have abandoned and helps reduce environmental impacts by reducing feral cat populations over time without the tragedy of killing domestic cats. The available evidence suggests, however, that in some communities TNR will

not work, and in others it will not work quickly enough to prevent devastating environmental consequences. In these situations, trap-euthanize could be a last resort option to implement until TNR would work or until the threat to ecosystems was sufficiently reduced. Even so, TNR should be the default method of feral cat population management in most communities.

Chapter 5: Key Considerations

Prevention

Although TNR is the most ethical method for reducing feral cat population sizes, it does not eliminate all of the problems associated with feral cats. If implemented effectively, TNR will cause populations of feral cats to shrink over time, but many of the problems associated with feral cats will still exist during this period of population decline. Small mammals and birds will still die from predation; ecosystem functions may be altered by the presence of feral cats; and humans and pets may be at risk for contracting zoonotic diseases from feral cats in our communities. The best solution to these problems is not TNR, but prevention.

If we could prevent populations of feral cats from developing, we would not have to worry about their impact on wildlife, their possible public health risks, the funds and labor needed to implement population control methods, or the moral issues associated with euthanizing healthy cats. How could we prevent these populations from existing in the first place? First, pet owners would need to be better informed about the necessity of spaying or neutering their free-roaming pets in order to prevent overpopulation of feral cats. If education would not work to encourage more people to spay or neuter their cats, then perhaps stricter laws requiring this sterilization should be implemented. Furthermore, some pet owners choose not to sterilize their pets because of costs. Low-cost spay and neuter clinics may provide families that could not otherwise afford it with the means to sterilize their cat, thereby preventing feral kittens from being born. One of the largest obstacles to controlling populations of feral cats, however, is pet

cat abandonment. If families continue to abandon their unsterilized cats, it is very difficult for TNR to keep up with the rate of incoming cats. Ultimately, we need to create a culture in which it is morally unacceptable to abandon domestic cats. This change will be no easy task and my thesis does not explore how it might occur, but a cultural shift would greatly help reduce the problems and animal suffering associated with feral cat populations. Preventing populations of cats from developing would be ideal, but it will not help us manage the feral cats that already exist. For these reasons, I believe that TNR combined with preventative measures is currently the best, most ethical method for controlling feral cat populations.

Alternative Sterilization Methods

Some veterinarians advocate using alternative sterilization methods to help control feral cat populations. For example, Dr. Robert McCarthy, a veterinarian at Tufts University, proposes that using Trap-Vasectomy-Hysterectomy-Return could actually be more effective than either TNR or trap-euthanize (McCarthy et al. 2013). This method, however, is not currently used by most veterinarians because does not have many of the benefits associated with spaying and neutering. By eliminating sex hormones, spaying and neutering cats helps reduce roaming, spraying, and yowling behaviors that often annoy community member (HSUS 2015). These procedures can also benefit cats by decreasing the rates of mammary cancer and uterine infections among female cats (ASPCA 2015). When male cats fight, they are also at increased risks of spreading Fe-LV and FIV, and neutering male cats helps mitigate these tendencies to fight for territory and access to female cats (HSUS 2015).

Other scientists have proposed that nonsurgical sterilization could be an effective alternative to spaying and neutering cats through TNR. One study published in *Theriogenology*

assessed the effectiveness of GonaCon, an immunocontraceptive vaccination (Levy et al. 2011). The study tested only 15 cats and gained mixed results about the drug's effectiveness as a contraceptive, as 93% of cats were infertile for the first year after the injection but then infertility dropped off sharply over the next couple years. The authors of Levy et al. 2011 conclude that the vaccine is a great candidate for further research and development. One important problem with nonsurgical sterilization is that it is currently not life-long; feral cats would need to be recaptured and re-vaccinated periodically, a difficult and labor-intensive task. For now, it seems that spaying and neutering feral cats is the best option for controlling their populations using sterilization. TNR is a well-founded method supported by many veterinarians as best current strategy for humanely controlling populations of feral cats.

The Vacuum Effect

An important argument often used to support TNR is that there will be a vacuum effect if cats are removed entirely from their territory, as in the case of trap-euthanize. TNR supporters such as Alley Cat Allies argue that immediate removal of cats from a resource-rich territory will encourage other cats to immigrate to those areas, ultimately perpetuating the problem and causing more cats to be killed (Alley Cat Allies 2014). Sterilized cats, on the other hand, will keep other cats out of their territory and prevent overpopulation of cats in that area. Although the vacuum effect has been documented in other carnivore species such as raccoons and opossums (Ji et al. 2001; Rossate et al. 2007), I have not found any published studies that specially examine it in feral cat populations. The Lazenby study I have already mentioned that studies the culling of feral cats in Tasmania, however, may document the vacuum effect because culling seemed to lead to a population increase in two sites (Lazenby et al. 2015). With small

samples sizes and short term duration, however, this article alone is not enough to confirm that the vacuum effect exists. Perhaps people who practice TNR have seen the vacuum effect in action, but it has not yet been definitively illustrated in the scientific literature. This phenomenon should be studied in feral cats to see if it plays a major role in the effectiveness of TNR or trap-euthanize. If the vacuum effect exists among feral cat populations, TNR may prove more effective than trap-euthanize in preventing new cats from immigrating into a defined area. It will not reduce populations of cats on a larger scale, but will change where they are located and help regulate the sizes of specified populations.

Feasibility: Community Support and Economic Considerations

Many of the scientific studies which assess TNR and trap-euthanize do not consider the role of community support in the likely success of a population control method. It is critical, however, that community members support a population control method in order for it to be effective. In most TNR programs, community members provide the manpower, funds, and resources necessary to trap the cats and provide food and shelter for them. It is also likely that communities would not support programs in which cats are trapped and inhumanely killed, making these programs less likely to succeed because they would not be funded or assisted by community members. Community support is a key component to TNR effectiveness because no matter what the science and ethics tell us, the efforts of community members will ultimately determine whether a population control method will work.

Studies have been conducted to assess the attitudes of community members toward free-roaming cats and population management strategies. One such study surveyed people in Ohio by telephone to analyze their perceptions and attitudes toward free-roaming cats (Lord 2008). Lord

found that cat owners were significantly more likely than other citizens to support TNR and to use tax money to support low-cost spay and neuter clinics in their communities. The study also showed that people who lived in rural, urban, and suburban communities differed significantly in their responses to questions about whether free-roaming cats are a problem in their areas, whether TNR was a good way to control cat populations, and whether tax money should be used to support low-cost spay and neuter clinics.

Another study published in the *Journal of Wildlife Management* used a mail survey to assess perceptions of TNR among homeowners from rural or urban regions of Illinois (Loyd and Miller 2010). This study showed that people from urban areas were more likely to support TNR than people from rural areas, and TNR was preferred by a larger percentage of women than men. Most of the responders to the survey had not personally experienced any issues with feral cats in their areas. The study also suggested that people who believed in a rights-based approach to valuing wildlife were more likely to support TNR than people who adhered to other value systems. Overall, these two studies suggested that it is important to understand how community members think and feel about free-roaming cats in order to increase the likelihood that a population control method will succeed.

New articles from across the United States suggest that communities often rally behind the cause of TNR. For example, a no-kill movement in New York City started in 2003 by the nonprofit organization Mayor's Alliance for NYC's Animal has decreased euthanasia rates at animal shelters from 32,000 per year to 6,000 per year over a ten year period (Hoffman 2014). A 2014 New York Times article notes that about 5,500 volunteers help with TNR efforts in the city, which has helped decrease shelter intakes by 35% from 2009 to 2013 (Shutler 2014). Support from community members in New York City has helped TNR thrive and saved

thousands of cats from death in animal shelters. In Gainesville, Florida, community support has also helped the TNR program Operation Catnip effectively manage populations of feral cats in the city and on the University of Florida's campus (Levy 2015). Operation Catnip, founded by Julie Levy of the University of Florida's College of Veterinary Medicine, has provided medical care for over 45,000 cats since 1998. This program has recently been in the news for its new program funded by PetSmart Charities that will train veterinarians and veterinary students across the United States in TNR methods (Levy 2015). Operation Catnip has been successful because of community support through volunteer efforts and charitable giving that trap-euthanize programs would lack.

In Indianapolis, a nonprofit TNR program called IndyFeral, which is now a part of the Foundation Against Companion-Animal Euthanasia (FACE), has been embraced by the city as an effective strategy for managing free-roaming cat populations. A 2007 special resolution of the Indianapolis City-County Council recognized and endorsed IndyFeral for its role in reducing animal control intakes and thereby saving tax-payer money, gaining overwhelming community support, and using humane methods to reduce free-roaming cat populations (City-County Council 2007). Between 2004 and 2007, the 37% reduction in animal control intake of cats and 29% reduction in euthanasia can be attributed to the efforts of IndyFeral employees, volunteers, and cat caretakers (Tudor 2007). These reductions saved taxpayers an estimated \$63,900 in 2007 and \$287,550 from 2005 to 2007 based on an estimated cost to animal control of \$150 per cat impounded and euthanized (Tudor 2007). It appears that TNR can be an economically favorable alternative to lethal control methods because it saves community animal control programs money and is often supported by grants and charities. The success of IndyFeral demonstrates that while

lethal control methods may not gain public support, communities do unite to fight cat overpopulation humanely through TNR.

Chapter 6: Implications for Greencastle

Wide eyes, flashes of fur through the bushes, piles of Meow Mix on the sidewalk – I found my first evidence of the campus cats soon after I moved into my dormitory during my first year at DePauw. Missing my cat at home, I was intrigued by the homeless and free-roaming cats on campus and wanted to learn how to help them. The Putnam County Humane Society closed during my first year at DePauw due to insufficient funding, so I wanted to find some other way to help animals in Greencastle. What I did not know was that a student organization at DePauw focused on helping campus cats already existed; it just was not recognized by DePauw Student Government.

The DePauw Campus Cat Allies (DCCA) was founded in 2012 by DePauw student Olivia Carmel '13 and Dr. Ellen Bayer, an English professor (personal communication with Marina Lazic, April 2, 2015). With the help of local veterinarian and DePauw alumna Dr. Lee Roberts, the DCCA implemented a TNR program on DePauw's campus to help combat concerns related to the free-roaming cats in Greencastle. The club built relationships with two low-cost spay and neuter clinics: FACE in Indianapolis and Stop Pet Overpopulation Today (SPOT) in Cloverdale. Over the next couple of years, Roberts, Bayer, community members, and students helped with TNR efforts around DePauw's campus. DePauw University, however, would not allow the club to place shelters on campus for homeless cats, which became a problem because many cats had claimed their territory around the Union Building. During the harsh winter months, it is important to provide outdoor cats with shelters so that they do not die of exposure. A representative from DePauw University refused to meet with the DCCA in 2012 but forbade

them to place shelters on campus, although he agreed that spaying and neutering the cats was permitted.

When Olivia Carmel graduated in 2013, Marina Lazic '16 took responsibility for leading the DCCA and working toward an agreement with DePauw University. The DCCA was recognized by DePauw Student Government in the fall of 2014 and has received several hundred dollars in funding for TNR in Greencastle. As the club was recruiting new members and getting organized, a beloved campus cat died of exposure in January 2015. This healthy, neutered cat lived next to the Union Building and died during a particularly cold winter night. After this incident, the DCCA and other community members wrote letters, emailed, and called DePauw University demanding shelters for the remaining campus cats. DePauw Facilities conceded and has allowed shelters near the Union Building since January 2015, but still has not implemented a formal policy about campus cats. Currently, the DCCA is creating a presentation to explain the merits of TNR to DePauw Facilities and to ask for official recognition of the TNR program on campus. With funds from DePauw Student Government, help from FACE and SPOT, and donations from community members, DePauw University need not contribute financially to a TNR program. The DCCA, however, needs DePauw's endorsement of the program permitting them to place shelters on campus, feed campus cats, and sterilize them.

As my time in the DCCA and my thesis research drew to a close, Lee Roberts encouraged me to visit FACE in Indianapolis to learn more about a large-scale spay and neuter clinic heavily involved in TNR programs. My visit to FACE transformed what I had learned all year staring at my laptop into a living, breathing, meowing reality. FACE Low-Cost Spay/Neuter Clinic opened in 1999 in Indianapolis to help decrease the number of dogs and cats euthanized in shelters by making pet sterilization more affordable (FACE 2014). In 2011, a

Neighborhood Cat Program was implemented to organize TNR efforts throughout the city, and in 2012 IndyFeral, an organization focused on helping feral cats, joined forces with FACE. In 2013 alone, the staff veterinarians completed 18,180 spay or neuter surgeries, including those of 3,815 community cats (FACE 2013). Over ten years of FACE's efforts, the number of cats received by animal control decreased from 5187 in 2004 to 2725 in 2014 (personal communication with Lisa Tudor, April 6, 2015). Of the 1280 community cats brought to FACE in 2014, 655 were adopted, 280 were placed in barns as barn cats, and only 320 of them were returned to their neighborhoods. The adoption and barn cat programs available at FACE help dramatically reduce the number of feral cats in neighborhoods, while the sterilization of returned cats helps prevent breeding. Because of its success in Indianapolis, FACE continues to grow and may need to expand its facility soon if it gains enough funding.

As I walked through the doors of the fairly small, brick building in Indianapolis, I was met with a low roar from the thirty people and their dogs or cats in the waiting room and the distinctive smell of an animal shelter. I met with Lisa Tudor, Director of the Community Cat Program, to learn more about FACE and to discuss my thesis. Tudor explained that the goal of her efforts in FACE and Indy Feral is to work towards creating a no-kill city (personal communication, April 3, 2015). Places like FACE, she declared, help empower people to actively choose compassion over lethal forms of population control that they may not understand in the first place. With increased awareness about companion animal overpopulation, people can be educated about sterilizing their pets and helping homeless dogs and cats in their region. In most areas, no programs meant to control companion animal populations exist. Catch and kill, Tudor explained, will not work because the community will not support it; it will not sustainably reduce cat populations because of the vacuum effect; and it takes such an emotional toll on

shelter workers and community members who have to witness the deaths of healthy animals each day. TNR, on the other, gives communities a cause to rally behind and a method that can work.

Lisa Tudor, like everyone I met at FACE, knows that TNR works. They have seen it work to reduce euthanasia rates and intakes in Indianapolis animal shelters. They have heard testimonies from community members in various neighborhoods about how cat populations have plummeted with the help of IndyFeral. They have noticed fewer free-roaming cats on the streets throughout the years since the program was founded. The problem, however, is a lack of peer-reviewed, scientific evidence that TNR works. In my months of research, I only found a handful of scientific studies have examined the effectiveness of TNR, and only two of these studies lasted at least ten years. Many of the studies on the Alley Cat Allies website are almost fifteen years old or do not directly address whether TNR reduces cat population sizes. People seeking to discredit TNR can easily point to the lack of scientific research about its effectiveness and claim that TNR advocates have no proof.⁴ But, as Lisa Tudor exclaimed while we chatted in her office filled with cats, “We know it works!” Now, we just need to prove it. Tudor told me that FACE keeps careful records of its community cats and their ultimate destinations, but that information has not been published or documented in a peer-reviewed, scientific study. I presented some of this data in Chapter 5, and it does provide compelling evidence of TNR effectiveness. Tudor mentioned that with how busy the FACE staff and volunteers are with their day-to-day practice, however, they are not able focus on the publication of their data as much as she would want.

Unfortunately, I have seen throughout my research that anecdotal evidence is not enough to convince the scientific community, news reporters, and the general public that TNR will work.

⁴ There are also no empirical studies suggesting that trap-euthanize is effective, though the model-based scientific studies tend to favor it over TNR.

Individuals and organizations not directly involved in TNR often turn to scientific evidence when choosing a population management system for local cats. For this reason, I believe organizations that already practice TNR need to make the publication of their data a priority. If TNR has proven effective in their communities, the world needs to know. Scientists should team up with programs like FACE to conduct long-term studies on the impacts of TNR on free-roaming cat populations, shelter intakes, and euthanasia rates. Careful records need to be taken during every step of the process, especially before the program is implemented, to show how TNR reduces cat populations over time. This evidence should be published in peer-reviewed journals so that TNR can gain credibility and be heralded as an effective, as well as humane, solution. Researchers will need the funds and time to conduct these studies, but I argue that they are one of the most important ways to show that TNR actually works to reduce feral cat populations.

As I drove back to Greencastle after my visit to FACE, I reflected on how what I had learned could apply to the free-roaming cat populations on DePauw's campus and in the surrounding town. It is clear to me now that TNR is currently the best population management solution for Greencastle. The populations of cats in town are not large enough that TNR could not work to help control their growth. This region of Indiana is not particularly environmentally sensitive, especially compared to many of the island ecosystems often examined in the scientific literature. Furthermore, Greencastle has the support system that TNR will need to be successful. There is a team of invested community members, students, and faculty and staff committed to humanely helping the cats in the area. These individuals could help fund the TNR effort, provide the necessary labor, and monitor the cats for any potential problems such as disease or injury. DCCA's relationship with FACE and SPOT clinics can provide the affordable sterilization

procedures, vaccinations, and medical assessments needed to implement a standard TNR program as well. Overall, my research has convinced me that TNR is the population management solution that Greencastle should embrace to help control its cat populations. I also have a series of recommendations for the Greencastle community that should help better establish the TNR program here and sustain it into the future.

Recommendations for Greencastle and DePauw University

In order for TNR to thrive in Greencastle, better lines of communication need to be established between community members, DePauw students involved in the DCCA, and DePauw's administration. Members of the DCCA could then be more proactive in helping community members with their TNR efforts, the administration could be aware of how the TNR program is impacting cats in the area, and hopefully the harsh feelings created by situations like the cat's death from exposure could be avoided. First, however, DePauw University's administration would need to officially recognize the TNR efforts on campus and permit shelters and feeding as part of this program. DePauw could use its role in TNR efforts to establish better relationships with the community and could even use this "humane campus" as a selling point for potential students. Better collaboration between members of the Greencastle community, DePauw students, faculty, and staff, and DePauw's administration could help this community become more cohesive while implementing a humane solution that will benefit humans and cats alike. Since DePauw University currently does nothing to control populations of cats on and around campus, being part of a solution would be a bright alternative.

Once the Humane Society of Putnam County reopens, the DCCA should also establish a TNR program that works with the animal shelter to ensure that healthy feral cats are not

euthanized. If feral cats are taken to the shelter, they should be forfeited to the DCCA to either be rereleased into their neighborhood or sterilized and then released. Ear-tipping sterilized cats and educating community members about what an ear-tipped cat is could prevent feral cats from being taken to the shelter in the first place. This program should benefit the Humane Society by decreasing its intake of unadoptable cats and decreasing its rate of euthanasia.

I would also argue that Greencastle as a community needs to be better educated about the importance of sterilizing pets, the problems with abandoning unwanted pets, and the benefits of TNR. Perhaps this public education could increase awareness of the problem and work to build a community in which cats' lives are valued. As Lisa Tudor argued, education and awareness about the problems associated with homeless pets can actually help empower people to choose compassion. I would need further research to learn how this public education could best be implemented, which the scope of my project did not allow. Perhaps public talks about free-roaming cats and TNR, literature given out door-to-door or at veterinary hospitals, or social media could help educate Greencastle community members and students, empowering them to make a difference for the cats on campus and in town.

I also suggest that student research be conducted in Greencastle to help us learn more about the cats in the area and public attitudes regarding them. Students interested in the biological aspects of the feral cat problem could try to answer questions related to cat populations and how they have changed over time. How many free-roaming cats exist in Greencastle? Are these populations growing, shrinking, or remaining stable? How is TNR affecting feral cat populations over time? Students could get in touch with community members who already work with the cats to begin creating a comprehensive database of the free-roaming cats that are part of TNR colonies or that are seen in town. This database could be used to track

cats individually in different areas of town, assessing how long the cats live, where they tend to roam, any medical problems, and how TNR efforts affect the overall numbers of cats over time. Feral cats and free-roaming pet cats could potentially even be radio-collared to examine their home ranges and how TNR affects them. Students could perhaps conduct predation studies by surveying pet owners and caretakers about how many and what kinds of prey animals their cats bring home. Most importantly, however, careful records of TNR efforts and the numbers of cats in Greencastle should be recorded to assess how TNR affects the cat populations over time. A long term study suggesting that TNR has worked could be very important to the scientific community, as few studies that reach this conclusion exist.

For students more interested in social science, it would be interesting to conduct surveys that examine perceptions and attitudes toward free-roaming cats among various categories of Greencastle residents. These studies could help answer questions about whether the Greencastle community would support TNR programs and in which areas they may need more education. For example, what do Greencastle residents, students, DePauw faculty and staff, and other categories of people think about the free-roaming cats in the area? What do they know about feral cat population control methods? Would they be more willing to support TNR programs or lethal control? Using a well-designed survey, DePauw students could begin to better understand what the larger community believes about free-roaming cats and how they should be controlled. This information can help members of the DCCA and other involved in TNR learn how to best educate the community about TNR and cater to the beliefs and desires of Greencastle residents. In combination with field research, this sociological research could help us gain a better understanding of the free-roaming cat situation in Greencastle from a variety of perspectives.

TNR is already being used in Greencastle to humanely prevent population growth of the free-roaming cats in town and on campus. With better communication between groups, support from DePauw University, collaboration with the Humane Society, and increased education about sterilizing pet cats, this TNR program could do even more to help our community. DePauw students could play a part in this vision by engaging in the DCCA or Humane Society and by conducting research to help us learn more about the population dynamics of the free-roaming cats in town and the perceptions of Greencastle residents about feral cats. In this way, the Greencastle community could come together and work toward a sustainable solution to managing populations of free-roaming cats.

Conclusion

As I reach the close of my project, I realize that my research is just the beginning of an effort to understand the feral cat conundrum and work towards a sustainable, humane solution. I chose to focus mainly on scientific and ethics literature to reach my conclusion about TNR's effectiveness, but this strategy leaves out many other important aspects of the feral cat problem. A more thorough project would need to examine cost-effectiveness, community support, and public policies much more than I was able to given my time limit. In fact, it may have been more effective to start my research with FACE and the people who actually implement TNR and work outward, providing an idea of the true feasibility and experiences of TNR. The academic focus of my project, however, reveals an important truth. The available scientific literature on its own does not give us straight answers about the feral cat conundrum. In order to prove that TNR works, we need to turn successful TNR programs into data that is published in peer-reviewed,

scientific journals. These results, along with the clear ethical strengths of TNR, could prove that this program is currently the best solution for cat population management.

My project began with a series of questions about feral cats and has ended with even more. This knowledge is exciting because it will open opportunities for future DePauw students to explore various aspects of TNR and feral cats more specifically than I did and gives them a solid background in the available literature. Perhaps my thesis can lay the ground for students and community members to incite real change in Greencastle, leading to a more informed, compassionate community. If nothing else, this thesis has given me the chance to examine a complex, fiercely debated problem and use an interdisciplinary combination of research, conversations, and careful consideration to reach a conclusion that I have found is both humane and effective. Although TNR may not be the right decision for every community, I believe that it is currently our best hope for solving the feral cat conundrum.

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