Student Perception of Feral Cats and Their Effects on Campus Wildlife

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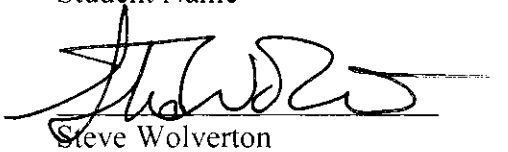

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Introduction

In many urban areas feral cat (*Felis catus*) populations are so large that they have become a nuisance. Trap-Neuter-Return (TNR) programs are committed to the humane management of feral cat populations and are common in many urban areas. TNR programs consist of establishing housing and feeding stations for feral cats; these sites are routinely inspected for new cats (Figure 1). When a new feral cat is found it is spayed or neutered, and then it is released back to the area from which it was collected. Despite the goal of TNR programs to encourage humane treatment of animals, feral cat management has come under close scrutiny by many conservation biologists (Brickner 2003; Longcore et al. 2009; Dauphiné and Cooper 2011 and references within) mainly because, as predators, feral cats have impacts on native wildlife (Loss et al. 2013). A debate has arisen because conservation biologists support euthanasia of feral cats to protect native small mammal and bird populations, which runs contrary to the principles adopted by proponents of TNR programs. Advocates of TNR programs reject the notion of feral cat euthanasia stating that it is entirely unethical. As a result, conflict arises between proponents of TNR and conservation biologists; however, supporters of neither side have fully investigated the ecology and evolutionary biology cats as well as the sociology of public perception of TNR programs, conservation goals, and feral cats. Each of these is critical for determining when and if TNR programs can mesh with the goals of native mammal and bird conservation.

The goal of this thesis is to understand student perception of the University of North Texas Feral Cat Rescue Group (FCRG) program, a TNR program on campus. In particular, the focus of this project is on role that ecological information has in shaping student opinions about cats and conservation. In this study both sides of the argument are discussed to provide a more holistic context for the free-ranging cat predation debate. Conservation publications are full of

research on this issue, yet public perception holds sway on the implementation of TNR programs in communities. Little has been published in peer-reviewed journals in strict defense of TNR programs, though there have been many informal publications through online newsletters, such as alleycatallies.org. In addition, supporters of TNR programs cite scholarly research in animal welfare to bolster their claims (sensu Hughes and Slater 2002a, 2002b; Scott et al. 2002; Levy et al. 2003; Natoli et al. 2006; Chu et al. 2009; Finkler et al. 2011a, 2011b).

In order to better understand student perceptions of the UNT TNR program and to gauge the impact that the conservation narrative has on perception, this study consists of a survey instrument that was administered to two undergraduate general science classes (Earth Science and Archaeological Science) at UNT. The UNT student population was sampled because 1) UNT represents a community that is regularly exposed to a TNR program, whether or not individuals are aware of it, 2) student perception and knowledge of this issue can be likened to the general public's as students from broad core science classes were surveyed, and 3) this issue is becoming increasingly important in the scientific literature and is of increasing concern to the general public in urban settings (Loss et al. 2013). Ultimately, understanding what people think about TNR programs is important because advocacy for and public policy made in regards to TNR are restricted to what people know and think about the issue. For example, there is a stark contrast between the opinion that feral cats are "pets that are outside," and feral cats are "predators on the landscape." In addition, understanding how people perceive of the ecological information about TNR programs is important because conservation biology is an inherently mission-oriented field (Soulé 1985). If conservationists who are concerned about the impacts of free-ranging cats are not actively building effective policy through engaging a well-informed public, then

conservation efforts in areas with feral cat populations will meet with mixed success at best and failure at worst.

Background

In order to understand the role of cats as pets in US society and to understand their ecological roles as predators, it is important to understand their evolutionary history because they were domesticated to catch prey. As such, the functional role of cats has changed over time from an economically oriented mutualistic relationship to a personally oriented emotional relationship. As a result, discussion of the debate between conservation biologists and TNR supporters must be couched in understanding of predator ecology, environmental ethics, and urban and political ecology.

Concerns of Conservation Biologists

... we often observe great differences in the natural tendencies of our domestic animals; one cat for instance taking to catch rats, another mice; one cat, according to Mr. St. John, bringing home winged game, another hares or rabbits, and another hunting on marshy ground and almost nightly catching woodcocks and snipes.

-Charles Darwin
On the Origin of Species

Feral cat predation and the negative impacts it has on native wildlife is the number one concern of conservation biologists in regards to the free-ranging cat debate. To the biologist, feral cats are an invasive species that are opportunistic and generalist hunters (Anderson and Erlinge 1977; Barrette 1997; Lowe et al. 2000). Commonly, cats prey on birds, lizards, rodents, and other mammals such as rabbits and squirrels (Coman and Brunner 1972; Woods et al. 2003; Hawkins et al. 2004; Balogh et al. 2011). Coleman et al. (1997) estimate that over a billion small mammals and hundreds of millions of birds are killed annually by household and feral cats.

However, more recently, Loss et al. (2013) estimate that, in the contiguous United States alone, cats annually kill 1.4-3.7 billion birds, and 6.9-20.7 billion mammals. Cats are also major contributors to the extinction and reduction of many threatened avian, reptilian, and mammalian species in Australia and New Zealand such as the tuatara (*Sphenodon punctatus*), the Little Barrier snipe (*Coenocorypha barrierensis*), and the Rufous hare-wallaby (*Lagorchestes hirsutus*) (Dickman 1996; Veitch 2001; Brickner 2003). Van Heezik et al. (2010) have shown that cat predation drives sink populations in birds. Balogh et al. (2011) demonstrate that in patchy environments, parks in the Washington D.C. metroplex where there is a high volume of outdoor cat activity, predators, most likely cats due to prey autopsy, are responsible for 79% of Grey Catbird (*Dumetella carolinensis*) post-fledgling mortality.

In addition to the effect of cat predation on wild animal populations, Dauphiné and Cooper (2011) identify four concerns: 1) cat welfare, 2) environmental impacts, 3) public and wildlife health, and 4) the propensity of feral cats to be a nuisance. Cat welfare is of concern because the average annual life of a feral cat is two years as opposed to ten in a household cat (Jessup 2004). Feral cats are more commonly exposed to agents of harm such as disease, predation, and vehicles. Lepczyk et al. (2010) go so far as to liken TNR programs to animal hoarding without walls because of the concentration of cats at feeding and housing sites. Environmental concern other than predation relate to bacterial runoff, or bacterial loading of water sources, from cat feces (Dabrtiz et al. 2006). Public and wildlife heath are entwined with bacterial runoff from cat feces. Certain animals have a higher likelihood of mortality, such as the Southern Sea Otter (*Enhydra lutris nereis*), due to the bacterial loading of water sources from cat feces such as *Toxoplasma gondii* (Kreuder et al. 2003). The nuisance factor, or cats viewed as pests by members of the general public, is a major public concern because it ties back into cat

welfare. Feral cats in colonies are more susceptible to abuse from disgruntled home owners, and colonies are continuously growing because irresponsible cat owners dump their cats off at known colonies (Castillo and Clarke 2003). The animal welfare issues associated with free ranging cats discussed here are recognized by People for the Ethical Treatment of Animals (PETA); they regard TNR programs as cruel to both cats and other wildlife and "cannot in good conscience oppose euthanasia as a humane alternative to dealing with cat overpopulation."

Concerns of Cat Welfare Activists

Now the number of mice is largely dependent, as every one knows, on the number of cats; and Mr. Newman says, "Near villages and small towns I have found the nest of humble-bees more numerous than elsewhere, which I attribute to the number of cats that destroy mice." Hence it is quite credible that the presence of a feline animal in large numbers in a district might determine, through the intervention first of mice and then of bees, the frequency of certain flowers in that district!

-Charles Darwin
On the Origin of Species

Arguments on the pro-TNR end of the free-ranging cat debate concern cat welfare, the nuisance factor, the efficacy of TNR programs at reducing feral cat populations, and predation and disease. As mentioned, peer-reviewed conservation articles that wholly support TNR programs are nonexistent. Rather, TNR proponents use welfare-oriented studies, in an ad-hoc fashion, to defend their position. Most importantly, TNR proponents are mainly concerned about protecting cat's lives. According to the pro-TNR perspective humane management of feral cat colonies is synonymous with the preservation of their lives.

In regards to the efficacy of TNR programs for humanely reducing feral cat populations, Scott et al. (2002) and Finkler et al. (2011a, 2011b) have found that when colonies comprise individual cats that are all spayed/neutered (particularly in higher socioeconomic areas) they are

less aggressive and less stressed due to an increase in body size and a decrease in cortisol levels, a stress hormone, that can be measured from hair samples. Hughes and Slater (2002a), Levy et al. (2003), and Natoli et al. (2006) have demonstrated that feral cat populations have decreased in size due to TNR programs on a Texas college campus (Texas A&M University), a Florida college campus (University of Central Florida), and in Rome, Italy.

Some TNR proponents claim that cat predation is a form of compensatory mortality, or that cats prey only on the weakest individuals in small mammal and bird populations, those that were going to die anyways (Alley Cat Allies 2011a). Bergstrom et al. (2009) have shown that the removal of cats from World Heritage Macquarie Island, a sub-Antarctic region island, have caused mesopredator release. Mesopredator release, refers to the explosion of species in lower trophic levels when the species that regulated it, belonging to a higher trophic level, is removed (Soulé et al. 1988). They refer to an example published by Holdgate and Wace (1961) and Holdgate (1967) who documented mesopredator release on Amsterdam Island, located in the Indian Ocean. Feral cats were eradicated on the island and an increase in the density of black rats (*Rattus rattus*) and house mice (*Mus musculus*) occurred, which was problematic because they prey upon the eggs of ground-nesting birds, thus, causing an equally (if not more) pernicious concern for conservation biologists.

Conservation biologists have responded forcefully to pro-TNR claims about feral cat welfare and ecology. For example, in a scathing review, Longcore et al. (2009) highlight 6 claims commonly made by TNR advocates, they are: feral cats only harm wildlife on islands (Alley Cat Allies 2005) feral cats fill a natural or realized niche (i.e. they are an integrated part of the ecosystem) (Gorman and Levy 2004), cats do not contribute to the decline of native species (Alley Cat Allies 2005), cats are not vectors or reservoirs of disease (Alley Cat Allies 2011b),

TNR eliminates colonies under prevailing conditions, and TNR colonies resist invasion (Berkeley 2004). Arguments on both side of the free-ranging cat debate rely on statements about cat ecology; therefore, it is important to review the evolutionary biology and the predator ecology of felids.

Cat evolution and domestication

Where did domestic cats come from? This simple question is given minimal attention in the free-ranging cat debate. Why did cats diverge from a common ancestor, when did they diverge, and where did they diverge? Before these questions can be tackled there is one that looms above it all: why is the origin of the domestic cat important in the free-ranging cat debate? Exploring the evolutionary history of the domestic cat sharpens understanding of free-ranging cat predation because it provides comprehension of the ecological role that led to the domestication of the cat and how that relationship has changed through time. It is critical to understand that humans have had a large role in shaping the domestic cat—after all these are *domesticated* animals. Or are they? Answering this question depends on understanding the process of domestication.

Domestication is a process that straddles biological and cultural spheres. Clutton-Brock (2012) describes the biological process of domestication as starting with certain members of a wild species that become accustomed to humans either through force or passively through exposure and close proximity. These founder individuals, then reproduce successively over time with little genetic admixture, which eventually leads to genetic drift that in turn leads to speciation. However, there is an intermediate threshold in this process that results in the subspecies. A subspecies is defined by Mayr (1969:269) as, "an aggregate of phenotypically similar populations of a species, inhabiting a geographic subdivision of the range of a species,

and differing taxonomically from other populations of the species." Because subspecies are geographically isolated, natural selection operates on each separately. The species *Felis silvestris* has many different subspecies (Mammal Species of the World recognizes 22 but the IUCN recognizes 5) for which geographic isolation and natural selection have played a role in shaping body size, fur color, and other characteristics (Clutton-Brock 2012).

Due to hybridization, or crossbreeding, of the different subspecies of *Felis silvestris* the relationship between the domestic cat (*Felis silvestris catus*) and its wild progenitors can be hard to tease apart (Johnson and O'Brien 1997). However, the most likely living ancestor of *F. s. catus* is *F. s. lybica*, the African Wildcat (see also Randi and Ragni 1991). If the domestic cat can so freely hybridize with its wild conspecifics is it really a completely domesticated animal? This assertion assumes that domestication is a pure function of genetic distance. However, according to Rindos (1980:752), who proposed a model for the advent of agriculture, "Domestication is the result of the evolution of a symbiosis." That is, Rindos (1980:753) frames domestication as a form of coevolution which is "... a type of evolution involving two genetically unrelated species... [that] occurs whenever the interrelationship of the organisms positively affects their potential for survival." Therefore, domestication is primarily founded on the *relationship* between human and domesticate. Commonly, the human/domesticate relationship is thought of as a direct relationship; however, regarding survival, the domestic cat is unique in this regard as its relationship to humans can be direct, indirect, or non-existent.

It is commonly held that the cat was first domesticated in ancient Egypt, around 1900-1800 BC (Clutton-Brock 1981; Vigne et al. 2004). More recent archaeological findings of direct human/cat interaction suggest an earlier origin in Cyprus, an island country in the Eastern Mediterranean Sea. Vigne et al. (2004) describe a cat skeleton in direct association with a human

burial at Shillourokambos, a Neolithic village with an occupation from around 8000-7000 BC. This fully articulated cat skeleton was identified as *F. s. lybica*, the African wild cat, and was dated around 8300 to 8200 ^{14}C years ago (roughly 7500-7200 BC).

Driscoll et al. (2007) furthered research into the geographical origins of cat domestication to the Near East when they genotyped 851 short tandem repeat (STR) loci from members of *Felis silvestris*. From there, they were able to sequence 2604 base pairs of mitochondrial DNA from 742 cats. Using neighbor-joining phylogenetic analyses they were able to identify six clades, or main groups, into which individual cats were distributed. They state, "The composite STR genotypes of all known domestic house cats, fancy-breed cats, and feral domestic cats occurring in the wild populations all fell within a large monophyletic group (clade IV) that also included wildcats from the Near East." That is, according to their analysis the domestic cat sits firmly in an evolutionary group (the Near East group) that all share a common ancestor. Using a linearized tree method with Kimura two-parameter distances (see Russo et al. 1995; Lopez et al. 1997 for more details) they were able to estimate a mitochondrial gene (ND5 and ND6) sequence divergence rate of 2.24 billion base pairs per million years. According to their analysis this places the ancestor of Near Eastern cats (which includes *F. s. lybica* and the domestic cat) back 100,000 years before the discovery at Shillourokambos.

Whereas most domesticated animals are *deliberately* shaped for economic, cultural, or aesthetic reasons, the domestic cat is thought to share a more mutually beneficial, symbiotic or commensal, relationship with humans (Clutton-Brock 1981). Many domesticated animals are gregarious and in this regard the cat is unique because it is not an altogether social animal. Davis (1987:127 emphasis added) notes, "Cats are relatively solitary animals. Instead of relating to one another, they are fiercely territorial and form a strong association with their domain. A

'domestic' cat therefore is bonded to people's habitation rather than to humans themselves. In transferring odour from its scent glands by rubbing up against its owner's legs the cat is simply including them within its territory." Clutton-Brock (1999; 2012) hypothesizes that this commensal relationship could have sprung from the advent of agriculture in the Fertile Crescent, where cats would have kept grain silos pest free. Upon scrutinizing the phylogenetic tree in Figure 2, as time progresses there is an increased rate of divergence in the Near Eastern clade. This increased rate of divergence, around 10,000 years ago, lends considerable weight to the hypothesis that the modern domestic cat has roots in the start of agriculture at roughly that time. More clearly, with the dawn of agriculture Near Eastern wildcats were able to occupy a new niche through commensalism with humans, from which they radiated adaptively and biogeographically.

Today, in American society, the functional role that cats once had in early agricultural societies has been virtually eliminated. We, *Homo sapiens*, are an increasingly urbanized species (United Nations Population Fund [UNFPA] 2007; Forman 2008; Gehrt 2010). Cats are no longer, for the most part, the caretakers of our crop stores. Cats are our pets; in fact, they are the most abundant pet mammal in the United States according to the American Pet Products Association (APPA 2012). The disjunction between the social and biological factors of early cat domestication and the urban environments that pet cats now occupy is critical for understanding the context of TNR programs. It begs the question, are released domesticated cats adapted to the urban landscape?

Predatory Behavior and its Ontogeny

Conservation biologists are primarily concerned about the impacts of free-ranging cat predation on wildlife, but predation is a product of life history and evolutionary biology, which can be accurately described as felid behavioral ecology. To examine this topic in detail the question of why cats hunt must be answered. Second, the repertoire of strategies a cat uses must be assessed to understand its predatory relationship with prey species. Finally, how this behavior develops in kittens is critical because its onset is multifaceted and phenotypically plastic. Meaning, the onset of predatory behavior is sensitive to environmental stimuli and is variable. Essentially, it is important to understand why predatory behavior exists, how such behavior functions for cats, and how behavior develops during ontogeny.

One might assume that predatory behavior in cats exists related to the purpose of food acquisition. However, Adamec (1976) has shown that predatory behavior is independent of satiation (see also Leyhausen 1956; 1979). Adamec (1976:270) describes the interaction between killing and eating prey for the domestic cat as a set of rules that apply to environmental contingencies and are generalizable to all feline predators:

> (1) eat your own prey, since killing and eating reduces the efficiency and therefore the likelihood of a subsequent kill; (2) Capture new prey when eating food which is found and does not require killing, even if it means exacerbating regulatory deficit and requires further energy expenditure, unless the palatability of the food is exceedingly great; and (3) Eat food which is found and does not require killing... Rule 1 would be helpful in maintaining a kill as a food source against scavenging competitors when other prey are in the vicinity but not in the close proximity. The predominance of rule 2 over rule 3 would help to ensure a greater supply of fresh food if predatory opportunity arose while scavenging.

Therefore, cats kill prey when satiated as a way to maximize fitness in certain predatory contexts or as a possible contingency plan for the future. Beyond Adamec's description of killing and eating, it is also possible that domestic cats kill by accident through the process of play behavior (Biben 1979). Although the cause of this phenomenon is

debated, its occurrence is well documented and, therefore, germane to the free-ranging cat debate.

Feral dogs have also been known to kill wildlife through play and predatory behavior (Iverson 1978; Butler et al. 2004). So why then is predatory behavior in the domesticated dog not as big of a concern for conservation biologists? As discussed above, predatory behavior is the basis for the origins of cat-human interactions. Dogs, on the other hand, have a relationship with humans that evolved for a multitude of reasons, and they have a longer history of domestication (Germonpré et al. 2009). The traits selected for in dogs range from their ability to hunt to their social nature in terms of companionship. It is also possible that the impetus for their domestication could have been for their meat (Clutton-Brock 2012). However, canid social behavior allows for a more obedient domesticate (Clutton-Brock 2012). This originates from a main attribute in the social behavior of *Canis lupus*, the descendant of the domesticated dog, which is the hierarchical pack structure. Thus, it is natural for some canids in the pack to acquiesce to the dominance of another pack member. This is not so for the domesticated cat, which is a solitary predator. Cats that share resources and that live in groups only fraternize with close kin (preferably littermates) where there is no immediate social hierarchy (Macdonald et al. 2000). One morphological byproduct of domestication in dogs is floppy, or lop, ears. Such as those which developed in the domesticated fox (Trut 1999; Trut et al. 2009). During domestication animals tend to depend less on auditory stimuli because food acquisition is no longer solely dependent on prey acquisition and predator evasion is not a chief concern. Therefore, it is more adaptive to divert energy required for somatic maintenance elsewhere. Domestic cats appear not to make these same tradeoffs.

Domesticated cats are primarily auditory hunters and have approximately 20 muscles that control the independent movement of each of their ears (Tabor 1983; Fitzgerald and Turner 2000). Secondarily, cats are visual hunters that respond to prey that move at particular speeds and straight paths (Fitzgerald and Turner 2000). Domestic cats have two primary hunting strategies that are elicited by different prey encounters and environments. These hunting strategies are described as mobile and stationary strategies by Fitzgerald and Turner (2000). The mobile strategy is a stalking strategy during which it is advantageous to be constantly on the move. Corbett (1976) has shown that a stationary strategy is more advantageous when hunting rabbits. The cat sits and waits for the rabbit to leave its burrow and then pounces. These hunting strategies are not mutually exclusive and can be used during the same foraging expedition. Felids are largely regarded as nocturnal, but Fitzgerald and Turner (2000) show that domestic cats are also diurnal and suggest that this propensity may relate to their domestication and the exploitation of certain prey types that are active during the day, such as birds. These strategies, along with preferences for particular types of prey, develop in kittens during ontogeny.

Kittens depend heavily on their mother for nourishment. Weaning is the process by which parental investment declines and kitten independence increases (Martin 1984, 1985; Deag et al. 2000). Feral kittens are first introduced to prey by their mothers around 30 days after birth, which is roughly when the weaning process begins (Ewer 1968; Baerands-van Roon and Baerands 1979; Moelk 1979; Deag et al. 2000). Weaning is a crucial time for the development of predatory behavior for two reasons. First, early weaning forces an increase in play and predatory behavior, for which play behavior is a possible supplement to predatory behavior (Caro 1979; Caro 1980a; Bateson and Martin 1999; Bateson 2000). For example, Tan and Counsilman (1985) have shown a strong correlation between early weaning and killing behavior in an experiment

with laboratory mice as prey. Second, the types of prey that mothers bring back to the nest are preferentially selected by the offspring in future foraging outings (Kuo 1930; Caro 1980b; Bateson 2000). Although predation strategies develop early during ontogeny, environmental contingency plays an important role in predation strategy in adult cats. That is, predation behavior is phenotypically plastic.

Phenotypic plasticity is defined as "variation in the phenotype of individuals with similar genotypes due to differences in environmental factors during development" (Allendorf and Luikart 2007:538). Predatory behavior in the domestic cat is phenotypically plastic because not all cats are necessarily formidable predators from the start, and many exploit a diverse range of prey and predatory tactics. However, as Bateson (2000:17) clearly points out,

> Despite this individual variation among young cats, however, most eventually become competent predators, albeit with different preferences and specialisations for particular types of prey... Adult predatory skills are improved by experience with prey when young, by watching the mother dealing with prey when young and, possibly, by the effects of competition between littermates in the presence of prey... Kittens that have never killed a rat, for example, can become rat-killers merely by watching another cat kill a rat... The main point here is that given set of adult behaviour patterns – in this case predatory behaviour – is affected by several different types of experience.

He goes on to describe this process in terms of the systems theory concept of equifinality where multiple possibilities can explain an observed outcome. Predatory behavior in the domestic cat is achieved through multiple routes, depending on the cat and on the context of predation.

In summary, understanding predatory behavior in cats is important for gauging the impact of TNR programs on wildlife. Predatory behavior develops at different times in the lives of different cats, and preferences for diverse predation strategies and types of prey vary by cat and context. One thing that is very clear, is that despite their relationship with humans as pets and in terms of their evolutionary biology, cats are predators.

The Cat Welfare Ethic and the Conservation Ethic

Thus we favor certain animals because they fill the superficial role of surrogate kin. It is the most disarming reason for nurturing other forms of life, and only a churl could find fault.

-E.O. Wilson
Biophilia

In 1949 Aldo Leopold published *A Sand County Almanac* and called for a new relationship with the environment, a land ethic, when he said, "There is as yet no ethic dealing with man's relation to land and to the animals and plants which grow upon it. Land, like Odysseus' slave-girls, is still property. The land-relation is still strictly economic, entailing privileges but not obligations" (Leopold 1949:203). He defines an ethic in the philosophical realm as "a differentiation of social and anti-social conduct" and in the ecological realm as "a limitation on freedom of action in the struggle for existence" (Leopold 1949:202). Leopold (1949:203) goes on to apply this concept to ecological settings when he states, "An ethic may be regarded as a mode of guidance for meeting ecological situations so new or intricate, or involving such differed reaction that the path of social expediency is not discernible to the average individual." He points out that individuals are members of larger bodies, communities, and rely on each other's actions; "the land ethic simply enlarges the boundaries of the community to include soils, waters, plants, and animals" (Leopold 1949:204).

I borrow Leopold's (1949) definition of an ethic as a "mode of guidance," meaning that an ethic can be *generally* thought of as a set of rules that exist, due to preexisting attitudes and behaviors, to increase fitness in both a social and evolutionary sense. Furthering this understanding, Callicott (1989:69) states, "ethics are utilitarian, a means to an end – not an end which we may choose, but an end which is given by nature itself, remorselessly imposed by the principle of natural selection. If *inclusive fitness* is the given end of organic activity, and if social

integration is in some cases the means hitherto, then ethics, and other modalities of social restraint as means to the formation of a society, are *generally* derived."

Proponents of TNR programs that wholly object to euthanasia of feral cats hold a cat welfare ethic, which is nested within a larger domestic animal ethic that is nested in an even larger animal welfare ethic. The animal welfare ethic, simply put, is a mode of guidance that ensures the wellbeing of animals (sensu Rolston 1988). Therefore, the cat welfare ethic is a mode of guidance that ensures the wellbeing of cats. Conservation biologists hold a conservation ethic, which is a mode of guidance that helps maintain biodiversity. The irony of the free-ranging cat debate is that both sides care about the conservation of organisms. However, the reasons proponents of either side care differ. Those who hold the cat welfare ethic have formed bonds with cats, value their companionship, and maintain that cats have the right to lead full lives. Those who hold the conservation ethic have formed a bond with the maintenance of, and appreciation for, different organisms and their ecological roles, and maintain that the conservation of species is central to the future of humanity (Wilson 1984).

Conservation biology is replete with these sorts of ethical dilemmas. For instance, how does one validate the introduction of a new species to exterminate an invasive species (Lodge et al. 2003)? However, Anderson (2010:194 emphasis added) points out that, "...judicious elimination of some animals is necessary to save whole ecosystems or ways of life. A world of rigidly applied animals-rights laws would be a world of catastrophic die-offs of human and animal populations. Once again, *rigid deontological morality is destructive*." More aptly applied to this situation, putting cats before a threatened ecosystem or whole species would be irrational. However, in many cases, mostly on continents, TNR programs have not proven to endanger whole species or ecosystems.

Conservation biologists see free range cat predation as jeopardizing the integrity and function of ecosystems for long periods into the future. Cat welfare proponents see the wildlife impact of cat predation as negligible in the present. Along these lines, Wilson (1984:123) states that, "To choose what is best for the near future is easy. To choose what is best for the distant future is also easy. But to choose what is best for both the near and distant futures is a hard task, often internally contradictory, and requiring ethical codes yet to be formulated." The addition of time to the free-ranging cat debate influences both sides and strengthens the position of conservation biologists who may or may not be able to demonstrate contemporary ecosystem-scale effects of feral cat predation. That is, it is somewhat easier to support the cat-welfare position if values center on short-term benefits of pet companionship and individual cat welfare; it is more difficult if cumulative ecological impacts are addressed.

The free ranging cat debate is entrenched in deeply held and contrasting environmental ethics, on one side valuing ecosystems above cats and on the other valuing animal/cat welfare lives above conservation implications. However, the predatory impact of cats varies by context. As a result, compromise between adherents of these contrasting perspectives is difficult to achieve. One strategy is to provide members of the general public with information about the animal welfare and the conservation implications of free-ranging cat populations. Does new information about free ranging cat populations lead to more concern about ecosystem conservation? Alternatively, does such information solidify established ethical perspectives?

In order to examine the influence of the impact of new information on perceptions of TNR programs, wildlife conservation, and the free ranging cat debate, students in large survey core science classes were surveyed at UNT. The goal of the survey, which is described in the following section, was to provide detailed information on cat welfare and wildlife conservation

related to the UNT FRCG program in order to determine if perceptions in an urban community shift with new information. Use of the survey entails adopting a few assumptions: 1) that students represent a community whose members regularly encounter cats that are part of a TNR program; 2) that students represent a cross-section of the general public; 3) that perceptions relate to information; and 4) if students have established values about pets, many are not well-informed about the conservation concerns of TNR programs. Regarding the first assumption, UNT students are at a minimum geographically associated with TNR stations at UNT whether or not they are aware of the program. In terms of the second assumption, large core-science classes that draw students from a variety of majors were surveyed, thus capturing respondents with a diverse set of educational goals and interests. In general, the UNT student body is dominated by students from low-middle class backgrounds primarily from Dallas and Fort Worth and the surrounding suburbs. Regarding the third assumption, we designed the survey instrument to expose students to different types of information on free ranging cat populations, TNR, and wildlife conservation at different points during the survey process to specifically determine whether or not their perceptions shift during the survey period. The fourth assumption relates to conservation ethics in general, which we view as growing in importance but not well entrenched in the environmental ethics of most Americans.

Methods and Materials

A quasi-experimental pre-test/post-test design was used for the survey. The survey was designed to expose UNT students first to TNR programs and their cat-welfare benefits, portraying the pro-TNR side of the free ranging cat debate. After soliciting survey responses (see below), respondents were next exposed to a second narrative statement stating the perceived risks of TNR programs from the wildlife conservation side of the debate. This survey was

granted approval by the University of North Texas Institutional Review Board on March 6, 2012 (see Appendix A for the full survey). We sampled students from a UNT Earth Science class on Thursday March 15, 2012 at approximately 3:00pm (GEOG 1710; n = 100), and a UNT Archaeological Science class on Tuesday March 27, 2012 at approximately 11:10am (ARCH 2800; n = 178). Data on seven demographic characteristics were collected: age, gender, major(s), childhood in an urban or rural area, type of current residence, history of cat ownership, and how many cats are cared for currently (Table 1). The following prompt was then displayed via overheard projection and read aloud:

> Cats that are not pets are known as feral cats. Trap-Neuter-Return (TNR) is a national program committed to the humane management of feral cats. It is implemented in urban areas as well as on many campuses, including UNT. In urban areas it is common for people to abandon cats. At UNT, the program operates by providing small green houses for shelter and also provides food for these animals. The houses are often checked for feral cat occupancy. If a new feral cat is found, it is trapped, then neutered or spayed (a surgery making the animal incapable of breeding), and finally released to the area where it was trapped. The point of the program is to humanely minimize or halt feral cat population growth. However, in an urban setting, including college campuses, cats are constantly abandoned, which provides a continual supply of feral cats. Ideally, the program attempts to avoid the killing of these animals.

Respondents were then asked to fill out the first portion of the survey consisting of 5 questions about their opinion of the TNR program using a Likert scale (Appendix A: Part 1). After completing the first section, respondents were showed and read a second prompt:

> Cats are an invasive species. Therefore, within urban and rural areas cats are not a naturally occurring species. Other native species have not evolved with the domestic cat. Cats are efficient predators; they hunt even when they are not hungry. Research has shown that cats are a danger to wildlife, including native and migratory bird species. Birds help maintain insect populations and disperse seeds. Feral cat predation poses a potential threat to wildlife. One solution is to keep domestic cats indoors. Euthanasia may be an appropriate alternative to *feral* cat management (emphasis in the original).

Respondents were then asked to fill out a second portion of the survey consisting of 4 questions, also using a Likert scale (Appendiz A: Part 2).

We found that students responded most effectively to one of the prompts: "I support the TNR program;" however, other prompts indicate embedded environmental values. In this study

we assess shifts in support for the TNR program based on exposure to the narrative statements provided above. In order to understand how much students know about the TNR program implemented on campus and to ascertain how impactful conservation-oriented information is at shaping perception, Wilcoxon Signed-Rank tests were run for responses to "I support the TNR program" in parts 1 and 2 of the survey. Comparisons were made for all respondents, male and female respondents separately, and male and female respondents who both knew and did not know about TNR programs in general to determine if established knowledge about TNR programs affected shifts in opinion. The Wilcoxon test assesses if and how (+/-) responses significantly change (e.g. if perception significantly changes) between the first and second parts of the survey.

Results

The original sample size (n = 278) was corrected (n = 275). During the process of data entry, it became obvious that questions three and four on the second portion of the survey were confusing for some respondents who left notes beside the questions; these questions are not considered here but likely provide more detailed information on environmental ethics. Respondents who left any demographic question blank, any question blank on the first part of the survey, or questions 1 or 2 blank on the second part of the survey were excluded from the analysis (n = 3).

Demographic characteristics of respondents in the sample are provided in Table 1. Of the sampled population 65% (n = 179) did not know that TNR programs exist, and 35% (n = 96) knew that they exist. Of those who knew about TNR programs, only 21% (n = 20) knew that the UNT FCRG operated on their campus. Overall, only 7% of the sampled population knew that

the FCRG existed. Despite that the FCRG has been active on the UNT campus for approximately 15 years and that feral cat houses and feeding facilities visible in many areas of campus, greater than 90% of the respondents were unaware of the program.

To see if perceptions of TNR programs change with exposure to perceived risks highlighted by wildlife conservation biologists Wilcoxon Signed-Rank tests were run using 5 response categories (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, and 5 = Strongly Agree) from questions 5 on the first part of the survey and question 2 on the second part of the survey (i.e. I support the TNR program). Table 2 provides the results for the three sets of Wilcoxon Signed-Rank tests, which were run between the sample as a whole, the sample aggregated between males and females, and the sample grouped into males and females who did and did not know about TNR programs. Significant results were obtained for every test but one males who knew about TNR programs. For each group other than males with previous knowledge of TNR programs, exposure to conservation-related information on feral cats led to less favorable impression of TNR programs. Effect size is reported to properly assess the effect of sample size for each Wilcoxon Signed-Rank test (Cohen 1988).

Discussion

This project had two goals: 1) to understand how much students know about TNR programs, and 2) to understand how effective conservation-oriented information is in shaping perception within the UNT student population. The second goal had three subgoals: 1) to see how perception changed in the sample as a whole, 2) to see how perception changed between males and females, and 3) to see how perception changed between males and females who either knew or did not know about TNR programs to begin with.

Results indicate that 7% of the sampled population knew about the UNT FCRG, and 35% of the sampled population knew that TNR programs exist in the first place. The conservation information that was given about the negative effects of TNR programs had some interesting effects on participants. Many students were not inclined to disagree with this program at first. Also, conservation-oriented information does not drastically switch perception in the students sampled, but conservation information on this issue plays a moderate role in negatively shaping perception about the UNT FCRG in the sample as a whole and between males and females (Figure 3).

Most notably, there was a statistically significant change in opinion for females who both knew and did not know about TNR programs to begin with (Figure 4), but not for males. It was shown that in males who knew about these kinds of programs there was no statistically significant change in opinion, unlike males who were uninformed about these kinds of programs whose perceptions shifted negatively (Figure 5). In a meta-analysis of gender differences in human-animal interactions, Herzog (2007) found that negative attitudes about the use of animals (i.e. consumption and utilization of animal products through meat, leather, etc...) are slanted towards women. That is, to some degree women tend to dislike consumption and use of animals more commonly than men. He also found that attachment to animal companions (pets) is only slightly slanted, if at all, towards woman with a low to nonexistent effect size. That is, women are probably not much more attached to pets than men. In contrast, Herzog determined that participation in grassroots animal activism is overwhelmingly slanted towards woman. However, he concludes that statements such as "women support animal rights more than men" are deceptive because there is more variability within sexes than between them.

Though it has not been shown in the literature, it is often assumed that women are the majority of participants in TNR programs. This assumption may be valid considering that women are more likely to be a part of grassroots animal activism (Herzog 2007 and references within). However, this observation tends to lend itself to a stereotype for all women. Although, Herzog (2007) found that attachment to animal companions is not gender specific. Interestingly, Daly and Morton (2003) showed that among elementary school boys and girls, girls were more bonded to cats than boys, but there was no difference in how they bonded with dogs.

The study presented here shows that, on the whole, women at UNT are more likely to be affected by conservation-oriented information and that men, overall, are not. Though women are more likely to be affected by conservation information, they are also more likely to agree with TNR programs with or without conservation information. Yet even with preconceived notions about TNR programs women are more likely to slightly change their opinion when presented with new information. Contrastingly, men with preconceived notions about TNR programs are not apt to changing their opinion, in fact males who know about TNR programs showed an inverse response when confronted with such information, solidifying their support for the programs (Figure 4).

These results are relevant to the free-ranging cat debate because the value systems associated with the cat welfare ethic are often stereotyped in women. But as Herzog (2007) pointed out there is more intra-gender variability than there is inter-gender variability in how people interact with animals. The fact that women tend to be more involved in grassroots animal activism bears important implications for the conservationist agenda. It is possible that when this information is geared towards the welfare of both prey and predator species in the free-ranging cat predation debate it will elicit a stronger pro-conservation response in women. Thus, it is

critical that women appear to bond more closely with cats *and* to shift their perceptions when presented with new information about conservation concerns related to free-ranging cats.

Conclusion

This project set out to understand how much students know about the UNT FCRG and the way in which it operates (TNR), and how information in favor of a conservation biology perspective shapes student perceptions about the UNT FCRG and its mode of operation. Not many students know about the way in which this program operates, and even less is known about the local FCRG. Overall, students overwhelmingly agree with the goals of TNR programs. Conservation-oriented information has the power to negatively shape perception, but only moderately. Females are more likely to change their perceptions of this program based on conservation information but are more centralized in their positive attitude toward it. Men, however, are not as affected by conservation-oriented information but show a greater range of responses to TNR programs.

We have seen that this debate is grounded in two ethical systems: the conservation ethic and the cat welfare ethic. These ethical systems are driven by values that help to guide each system to their desired outcome. For cat welfare proponents it is the value for a cat's life and for conservation biologists it is the value for the diversity of life. Acknowledgement and respect for both of these systems is necessary for headway to be made in this debate. More importantly public knowledge of this debate is critical for progress to be made because this debate is carried out by what can be thought of as special interest groups. Therefore, understanding public perception can help predict how TNR programs might change in the future and the kind of information the public needs to catalyze such a change.

Cats are predators whose functional role has drastically changed from economically commensal with humans to emotionally commensal with humans. The evolutionary basis of their predatory behavior cannot be doubted. Policy and personal perspectives that deny these facts are, indeed, poorly informed. Though, policy and personal perspectives that fail to recognize the value of an organism's life are also poorly informed.

Based on these potentially conflicting value systems, policy that takes both sides into account must be forged. Unquestioned mass euthanasia of cat colonies is an unreasonable battle to wage for conservation biologists. The question of where to draw the line in regards to animal welfare/rights policy is central to the debate. What animals are protected, from what are they protected, and why? According to Rachels (2004), the question is not "where do we draw the line" rather there is "only an indefinitely long series of lines." Therefore, scholars and policy makers must think of ample directives regarding the impacts of free-ranging cats very plainly, such as: In what situations is it permissible to euthanize feral cats on the basis of the impacts of predation? There must be certain criteria met for this to occur. Threatened wildlife need to be documented in the area, and "no kill" shelters must not exist in the area. Also, methods using only the quickest and least painful form of euthanasia need to be used (the use of pentobarbital). More troubling, how can the impacts of feral cat predation be mitigated and while maintaining TNR programs that protect animal welfare? A possible solution might include conducting a survey that identifies the most susceptible areas for bird predation, with prevention of housing and feeding sites in those areas. Of course, cats have varying home ranges, which is also of concern, even in protected areas (Turner and Mertens 1986). Perhaps cat home range studies should be done within so many months of the creation of a TNR program. Above all, accessible and accurate data need to be kept so as to evaluate the effectiveness of each TNR program, as

Loss et al. (2013) have suggested. Every TNR program should be evaluated in accordance to its purpose, which is to humanely minimize the size and animal welfare impact of feral cat populations. If these programs do not minimize feral cat populations, then steps needed to more effectively accomplish that goal need to be assessed. Otherwise, we are simply perpetuating and compounding the ecological and animal welfare problems that accompany large feral cat populations.

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Table 1: Raw data from demographic portion of survey.

	Gender	Avg Age	Have ever Had a Cat		Currently Care for Cat	Avg Cats Cared For	Residency			Upbringing		
			Yes	No			Apartment	Dorm	House	Urban	Rural	Both*
Total	275	21.2	162	113	90	1.81	84	111	80	189	79	7
Males		22	62	46	32	1.75						
Females		20	100	67	58	1.84						

*This group was not given as a choice in the survey but was written in by respondents.

Table 2: Results of the three sets of Wilcoxon Signed-Rank tests.

Statistic	Whole Sample	Gender		Know About TNR		Did not Know About TNR	
		Male	Female	Male	Female	Male	Female
Z	-5.57	-2.09	-5.41	-.690*	-3.53	-2.13	-4.22
p	.001	.040	.001	.490	.001	0.034	.001
r	.34	.20	.42	.11	.48	0.26	.40

*indicates only non-significant value

Figure 1: Feral cat housing site by the Environmental Science building on the UNT campus.

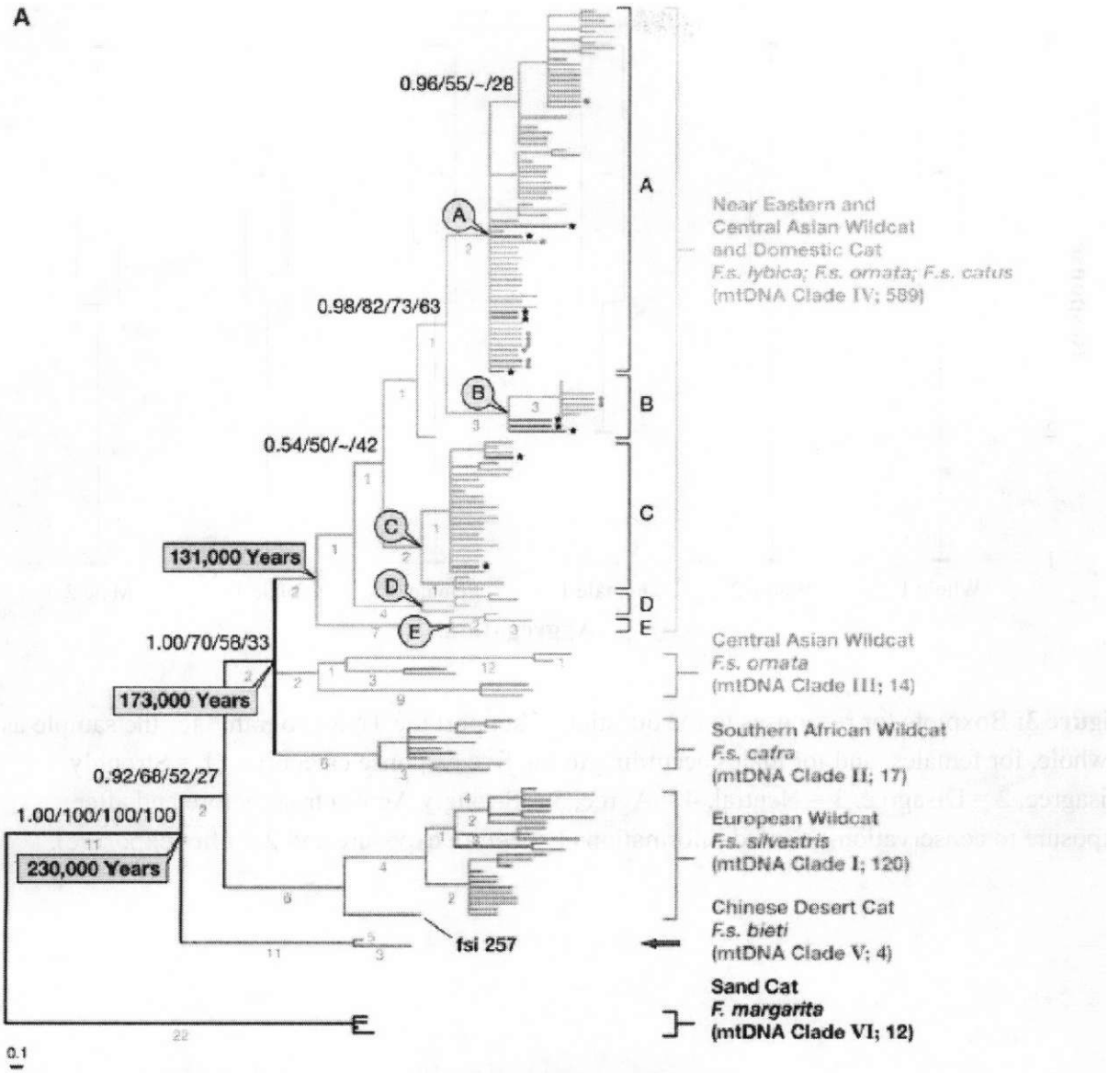

Figure 2: From Driscoll et al. (2007:522). Phylogenetic tree showing divergence times and the six clades in *Felis silvestris*.

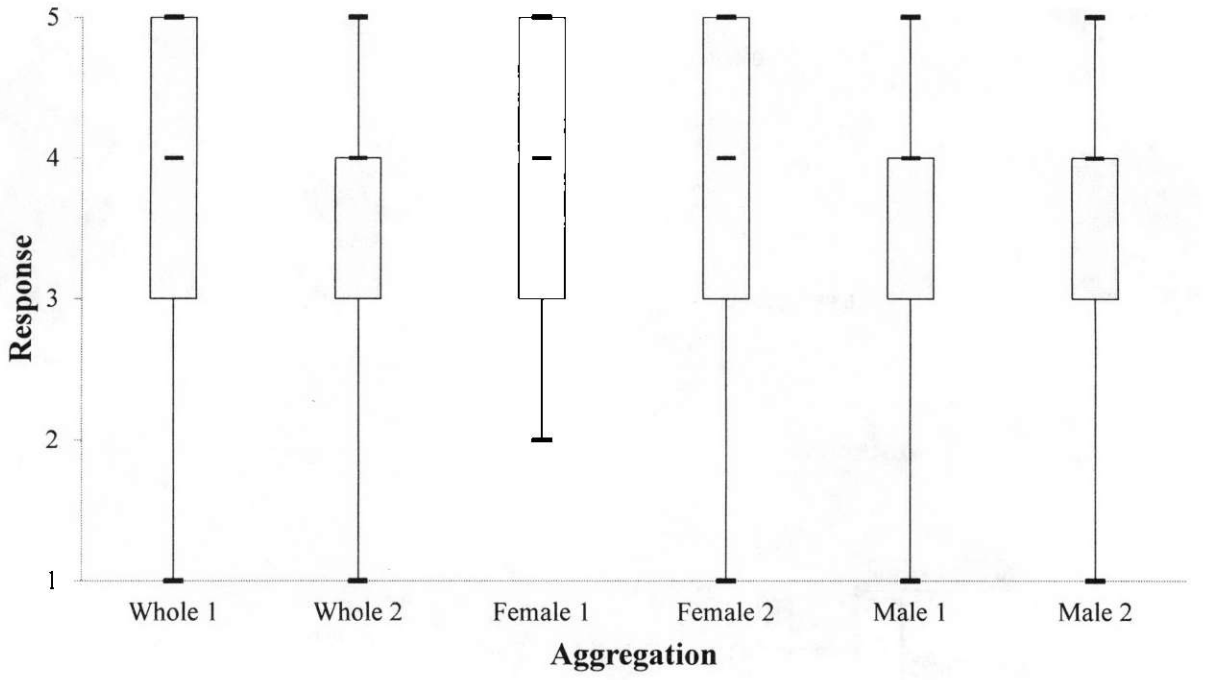

Figure 3: Boxplots for responses to the question "I support the TNR program" for the sample as a whole, for females, and for males according to the five response categories (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) from before and after exposure to conservation-oriented information (1 = before exposure and 2 = after exposure).

APPENDIX A

Part One

Please answer the following general questions about yourself:

1. **Age**_____
2. **Gender:**
   a. female b. male
3. **Major(s)**_____
4. **What kind of area were you raised in?**
   a. urban area b. rural area
5. **Where do you live?**
   a. Dorm b. Apartment c. House
6. **Have you ever had a pet cat?**
   a. Yes b. No
7. **How many cats do you care for?** _____

Please answer the following questions after a brief introduction to the TNR program (only circle one answer for each question or statement):

1. **Did you know these kinds of programs existed?**

   a. Yes b. No
2. **Did you know this program existed at UNT?**

   a. Yes b. No
3. **It is important to me that feral cats are treated humanely.**

Not at All Important	Slightly Important	Moderately Important	Very Important	Extremely Important

4. **Feral cats have the right to live.**

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

5. **I support the TNR program.**

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

Do Not Proceed Until the Next Prompt

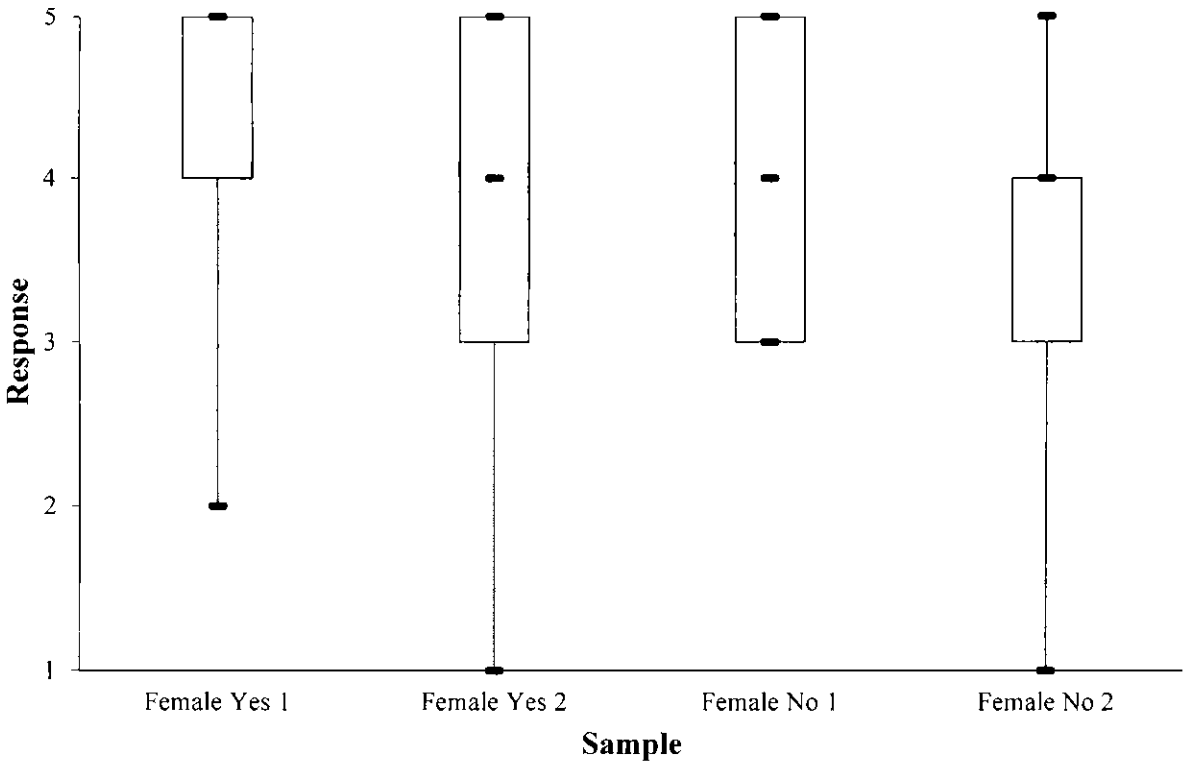

Figure 4: Boxplots for responses to the question "I support the TNR program" for the sample aggregated into females who knew about TNR programs to begin with (Yes) and who did not (No) according to the five response categories (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) from before and after exposure to conservation-oriented information (1 = before exposure and 2 = after exposure).

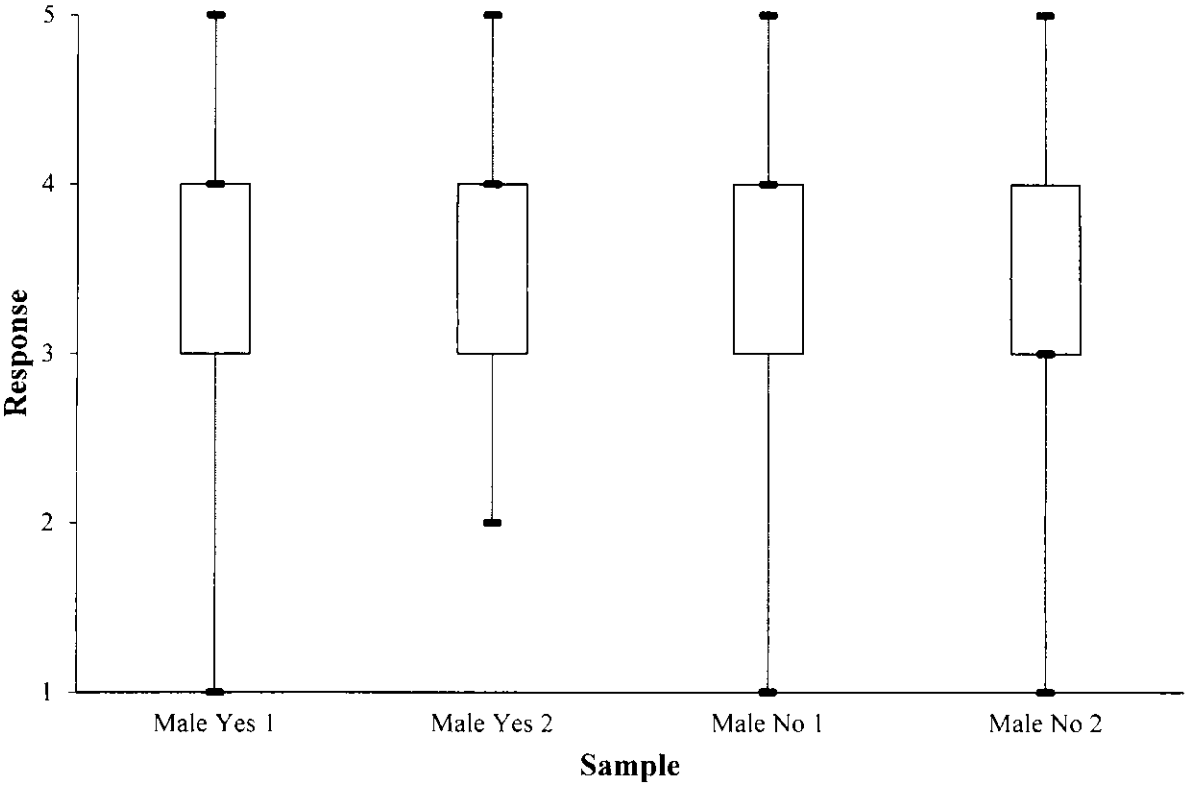

Figure 5: Boxplots for responses to the question "I support the TNR program" for the sample aggregated into males who knew about TNR programs to begin with (Yes) and who did not (No) according to the five response categories (1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree) from before and after exposure to conservation-oriented information (1 = before exposure and 2 = after exposure).

Part Two

Please answer the following questions after an introduction to a biological perspective (only circle one answer for each question):

1. **How acceptable is it to euthanize feral cats to protect wildlife?**

Not at All Acceptable	Slightly Acceptable	Moderately Acceptable	Very Acceptable	Extremely Acceptable

2. **I support the TNR program.**

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

3. **It is unethical to support one species' existence over another.**

Not at All Ethical	Slightly Ethical	Moderately Ethical	Very Ethical	Extremely Ethical

4. **It is better to say that all species have the right to *try* to live instead of all species have the right to live.**

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree