

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/8175629>

Humane strategies for controlling feral cat populations

Article in *Journal of the American Veterinary Medical Association* · December 2004

DOI: 10.2460/javma.2004.225.1354 · Source: PubMed

CITATIONS

116

READS

1,124

2 authors:



Julie Levy

University of Florida

111 PUBLICATIONS 3,628 CITATIONS

SEE PROFILE



Patti Cynda Crawford

University of Florida

70 PUBLICATIONS 2,699 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



2008 AAFP Retrovirus Guidelines [View project](#)



Assessment of a GnRH immunocontraceptive as a tool for cat fertility control [View project](#)

17. World Health Organization. Rabies vaccines: WHO position paper. *Wkly Epidemiol Rec* 2002;77:109–119.
18. Meslin FX, Fishbein DB, Matter HC. Rationale and prospects for rabies elimination in developing countries. *Curr Topics Microbiol Immunol* 1994;187:1–26.
19. World Health Organization Expert Committee. *Report of the fifth consultation on oral immunization of dogs against rabies*. Geneva: World Health Organization, 1994;94:1–24.
20. World Health Organization Expert Committee. *Report of WHO consultation on dog ecology studies related to rabies control*. Geneva: World Health Organization, 1988;88:1–35.
21. Beran GW, Frith M. Domestic animal rabies control: an overview. *Rev Infect Dis* 1988;10:S672–S677.
22. Hugh-Jones ME, Hubbert WT, Hagstad HV. *Zoonoses: recognition, control, and prevention*. Ames, Iowa: Iowa State University Press, 1995.
23. Wright JC. Reported cat bites in Dallas: characteristics of the cats, the victims and the attack events. *Public Health Rep* 1990; 105:420–424.
24. Patrick GR, O'Rourke KM. Dog and cat bites: epidemiologic analyses suggest different prevention strategies. *Public Health Rep* 1998;113:252–257.
25. Patronek GJ. Free-roaming and feral cats—their impact on wildlife and human beings. *J Am Vet Med Assoc* 1998;212:218–226.
26. Dubey JP. Feline toxoplasmosis and coccidiosis: a survey of domiciled and stray cats. *J Am Vet Med Assoc* 1973;162:873–877.
27. D'Amore E, Falcone E, Busani L, et al. A serological survey of feline immunodeficiency virus and *Toxoplasma gondii* in stray cats. *Vet Res Commun* 1997;21:355–359.
28. Kapperud G, Jennum PA, Stray-Pedersen B, et al. Risk factors for *Toxoplasma gondii* infection in pregnancy: results of a prospective case-control study in Norway. *Am J Epidemiol* 1996;144:405–412.
29. Slater MR. Understanding and controlling of feral cat populations. In: August JR, ed. *Consultations in feline internal medicine*. Philadelphia: WB Saunders Co, 2000:561–570.
30. Lindsay DS, Dubey JP, Butler JM, et al. Mechanical transmission of *Toxoplasma Gondii* oocysts by dogs. *Vet Parasitol* 1997;73:27–33.
31. Fitzgerald BM, Turner DC. Hunting behaviour of domestic cats and their impact on prey populations. In: Turner DC, Bateson P, eds. *The domestic cat: the biology of its behaviour*. Cambridge, England: Cambridge University Press, 2000;151–175.
32. Risbey DA, Calver MC, Short J. The impact of cats and foxes on the small vertebrate fauna of Heirisson Prong, Western Australia I. Exploring potential impact using diet analysis. *Wildl Res* 1999; 26:621–630.
33. Terborgh J. Why American songbirds are vanishing. *Sci Am* 1992;1992:98–104.
34. Courchamp F, Langlais M, Sugihara G. Cats protecting birds: modeling the mesopredator release effect. *J Anim Ecol* 1999; 68:282–292.
35. MacDonald DW, Michael T. Alien carnivores: unwelcome experiments in ecological theory. In: Gittleman JL, Funk SM, MacDonald DW, et al, eds. *Carnivore conservation*. Cambridge, England: Cambridge University Press, 2001;5:93–122.
36. Mitchell JC, Beck RA. Free-ranging domestic cat predation on native vertebrates in rural and urban Virginia. *Virginia J Sci* 1992; 43:197–207.
37. George WG. Domestic cats as predators and factors in winter shortages of raptor prey. *Wilson Bull* 1974;86:384–396.
38. Churcher PB, Lawton JH. Predation by domestic cats in an English village. *J Zool (Lond)* 1987;212:439–455.
39. Cohen A. Weeding the garden. *The Atlantic Monthly* 1992; Nov:76–86.
40. Steinel A, Parrish CR, Bloom ME, et al. Parvovirus infections in wild carnivores. *J Wildl Dis* 2001;37:594–607.
41. Lee IT, Levy JK, Gorman SP, et al. Prevalence of feline leukemia virus infection and serum antibodies against feline immunodeficiency virus in unowned free-roaming cats. *J Am Vet Med Assoc* 2002;220:620–622.
42. Levy JK, James KM, Cowgill LD. Infectious diseases of feral cats in central California, in *Proceedings*. 80th Annu Conf Res Workers Anim Dis 1999;33.
43. Gibson KL, Keizer K, Golding C. A trap, neuter, and release program for feral cats on Prince Edward Island. *Can Vet J* 2002; 43:695–698.
44. Akucewich LH, Philman K, Clark A, et al. Prevalence of ectoparasites in a population of feral cats from north central Florida during the summer. *Vet Parasitol* 2002;109:129–139.



Humane strategies for controlling feral cat populations

Julie K. Levy, DVM, PhD, DACVIM, and P. Cynda Crawford, DVM, PhD

What Are Feral Cats?

The domestic cat has increased in popularity as a household pet in recent decades, surpassing the dog to become America's most numerous pet.¹ Despite the enhanced status of cats as human companions, millions of unwanted cats are admitted to animal shelters each year and most of these cats are euthanatized because homes cannot be found for them. Debate about the true impact of free-roaming cats on the environment, on feline welfare, and as a reservoir of feline and zoonotic diseases is ongoing, often emotional, and

fueled largely by a lack of sound scientific data on which to base credible conclusions. Separating the impacts of free-roaming, owned cats from those of unowned cats is also difficult.

Definitions of various cat populations defy universal acceptance and focus variably on ownership status, lifestyle, and degree of socialization. Cats may be defined as free-roaming if they are not confined to a yard or house, a definition based on confinement of the animal rather than ownership or degree of socialization. Strictly speaking, feral cats are defined as those that are untamed and evasive. They are either born in the wild and lack socialization or are abandoned to the wild and become untrusting of humans. Although feral kittens can be tamed into acceptable pets if captured at

From the Department of Small Animal Clinical Sciences, College of Veterinary Medicine, University of Florida, Gainesville, FL 32610. Address correspondence to Dr. Levy.

a young age, enormous effort is often required to tame older feral cats. The lines between loosely owned outdoor cats, tame strays, and feral cats are often blurred. Owned cats that wander or become lost may become stray cats. Stray cats that have lived in the wild for an extended time may become feral. Homeless cats may be adopted. Thus, individual cats may occupy different categories at various stages of their lives. For the purposes of this discussion, “feral cat” will be used to denote any unconfined, unowned cat, regardless of its socialization status.

How Many Feral Cats Are There?

The number of feral cats in the United States is unknown but is suspected to approach that of pet cats (73 million in 2000)¹ and contributes substantially to cat overpopulation.² Feeding of homeless cats is a common activity practiced by pet owners and those without pets of their own. In the suburban community of Alachua County, Fla (85,000 households, 216,000 residents), 12% of households acknowledged feeding a mean of 3.6 cats they did not own or approximately 36,000 feral cats.² County residents also owned an estimated 45,000 pet cats. This indicates that feral cats comprise at least 46% of the local cat population. These findings are similar to results of studies performed in Santa Clara County, Calif, where 10% of households fed a mean of 3.4 cats each³; in San Diego County, where 9% of households fed a mean of 2.6 cats each⁴; and in Massachusetts, where 8% of households fed a mean of 3.7 cats each.⁵ Together, these studies found that feral cats comprised at least 36% to 46% of the total cat population. Thus, feeding feral cats is a widespread activity that crosses socioeconomic strata. Almost half of those who feed cats do not own pets,² implying that efforts to involve those who feed cats in control strategies should extend beyond the pet-owning public typically served by veterinarians, animal control agencies, and animal welfare organizations. For purposes of estimating the size of a community’s feral cat population, it is reasonable to estimate 0.5 cats/household. County household statistics are available online at www.census.gov.

Although providing food for unowned cats is a common activity, few of those who feed cats take action to sterilize them. Sterilization of pet cats owned by feeders of feral cats was common (90%) in Alachua County, indicating high compliance with veterinary and animal welfare recommendations for neutering of pets not intended for breeding.² This is consistent with previous reports²⁻⁶ that 82% to 91% of pet cats are sterilized, although not always before producing a litter of kittens. Given the high rate of sterilization among pet cats, feral cats likely represent the single most important source of cat overpopulation (Table 1).

Although large cat colonies on public property, such as parks and institutions, often comprise the most visible and controversial cat populations, most feral cats live in small groups near the homes of people who feed them.⁷ In Alachua County, most cat colonies consist of a small group of 3 to 10 cats and are often described as a female with kittens and an occasional wandering male.⁷ This is consistent with results of a

Table 1—Projected annual contribution of owned versus feral cats to cat overpopulation.

Variable	Owned cats	Feral cats
Percentage female	50%	50%
Sterilization rate	85%	2%
Litters per year	1.5	1.5
Kittens per litter	4.0	4.0
Kittens per cat annually	0.45	2.9
US cat population	73 million	50 million
Kittens born annually	33 million	147 million

national survey⁸ that reported a mean colony size of 4 to 12 cats and a Hawaiian study⁹ that reported that 65% of colonies consisted of 1 to 10 cats. In most cases, cat colonies are located on private property, particularly at the residence or workplace of individuals feeding them.

Caretakers have reported a strong bond with the feral cats they care for, even though they do not consider these cats to be their pets.⁷ This differs from the traditional image of the human-animal bond, as many of these cats cannot be touched or held and do not live indoors with the caretaker. Nevertheless, cooperation of caretakers is imperative if cat population control programs are to be effective.

Public Health

Rabies—Rabies, a disease that is primarily maintained and transmitted by wildlife, is of particular concern to public health officials. Since 1981, rabid cats have outnumbered rabid dogs in the United States, with 270 cases in cats reported in 2001.¹⁰ Although the dog is the primary vector of rabies worldwide, widespread vaccination of dogs and reduction of the stray dog population since the 1940s have greatly reduced the number of cases in dogs in the United States.¹¹ Today, more than 90% of cases of rabies occur in wildlife, primarily in raccoons, skunks, coyotes, foxes, and bats.¹² The most serious current pandemics of rabies in the southeastern and eastern United States were caused by illegal interstate translocation of raccoons and coyotes by the hunting industry.¹³ A total of 36 humans have died of rabies in the United States from 1990 to 2001, and 75% of these cases were associated with bat exposure.¹² Nine cases were associated with the dog/coyote strains of rabies; all but 2 of these exposures were believed to have occurred in foreign countries. Despite continued concern about the role of cats in human rabies exposure, the last case in a human associated with cats in the United States was reported in 1975.¹⁴ According to the CDC, depopulation of wildlife species that harbor rabies is an impractical rabies control tactic because of cost, repopulation, and public opposition.^{11,15} In contrast, vaccination of skunks and raccoons against rabies via trap-vaccinate-release programs and oral baited immunization has proven quite successful for providing long-lasting herd immunity, even when individual animals received only a single dose of vaccine and when only a portion of the population was immunized.¹⁵ Likewise, a single dose of rabies vaccine protected domestic cats against virulent challenge 4 years later.¹⁶ Although an ideal rabies con-

trol program for dogs and cats consists of an initial vaccine followed by boosters 1 year later and every 3 years thereafter,¹⁰ it is likely that even a single vaccine administered at the time of sterilization helps protect feral cats against rabies.

Bites—Although dogs account for 75% of reported animal bites to humans, rabies postexposure prophylaxis is more commonly administered after cat bites.¹⁷⁻¹⁸ Most cat bites are reported to be provoked from stray cats, with adult women more likely to be bitten than children and men.¹⁹⁻²¹ This indicates that cat bites can be reduced by reducing the stray cat population and avoiding direct handling of stray cats. Even when rabies is not involved, cat bite wounds often result in serious infections. They most frequently occur on the hands, and risk of infection is highest with puncture wounds.²¹ Public health recommendations include immediate cleansing of the wound, medical attention, and prophylactic treatment with amoxicillin-clavulanate. Most large-scale feral cat control programs follow guidelines that minimize the risk of cat bites and scratches. These include the use of humane traps for capturing and transporting cats and the administration of injectable anesthetics to cats in their traps so that they are never handled when they are awake.

FeLV, FIV, and feline coronavirus—Large epidemiologic studies indicate that FeLV and FIV are present in approximately 4% of feral cats, which is not substantially different from the infection rate reported for pet cats.²² As expected, male cats are 4 times as likely to carry FIV as female cats, primarily due to bite wounds incurred during territorial disputes. Infection with FeLV occurs at approximately the same rate in males and females, and the virus is most commonly spread from infected queens to their kittens. Interestingly, feral cats are significantly less likely to have antibodies against coronavirus (4% to 18%), the agent of feline infectious peritonitis, than are pet cats (59%).^a Coronavirus is primarily transmitted via a fecal-oral route. Feral cats' behavior of burying their feces may reduce the risk of transmission, compared with pet cats sharing a litter box in a multicat household.

Models of FeLV and FIV transmission in free-roaming cat populations indicate that neither virus impacts overall colony size, which is more influenced by environmental carrying capacity.²³ Furthermore, FeLV and FIV may become extinct sterilized in cat populations that have few aggressive interactions.²⁴ In a closed nonbreeding colony of 26 cats monitored over 10 years, all 7 FeLV-infected cats died within 5 years of diagnosis (median age, 7.2 years), resulting in extinction of the infection from the colony.²⁵ The remaining cats became immune as demonstrated by protective virus-neutralizing antibody titers. Median survival of FIV-infected cats was 12.5 years, and survival of uninfected cats was 8.6 years.

The American Association of Feline Practitioners (AAFP) recommends FeLV and FIV testing of all cats but states that a positive test result should not be used as the sole criterion for euthanasia.²⁶ The AAFP further recommends that all positive screening test results undergo confirmation. Because the accuracy of

positive tests decreases when prevalence is low, as is the case for FeLV and FIV, up to 50% of positive test results for feral cats might be expected to be false-positive. Confirmatory testing is often impractical since recommended confirmatory tests require use of a reference laboratory and it may be several days before results are available. The recent advent of FIV vaccination has added an additional complication to testing. The vaccine induces antibodies against FIV that cause false-positive results in the currently licensed FIV tests. Thus, it is problematic to differentiate FIV-infected cats from vaccinated ones.^b

Testing recommendations for pet cats are difficult to apply to feral cats for several reasons. The cost-to-benefit ratio of testing large numbers of animals to detect small numbers of infections is a common dilemma in herd health programs. Resources for treating feral cats are limited, and many programs have elected to focus on mass sterilization as the primary goal. For these reasons, most large sterilization programs for feral cats do not routinely test for FeLV and FIV, a policy accepted by the American Academy of Family Physicians.²⁷ Even without testing, it is possible that focusing resources on sterilization will have the additional benefit of reducing transmission of FIV (by reducing fighting) and FeLV (by reducing reproduction; Table 2)

Parasitism—Parasitism is the most common transmissible problem of feral cats. In Florida during the summer, 92% of cats presented for sterilization were infested with fleas and 37% had ear mites.²⁸ A study^a of 80 feral cats in California revealed that 54% carried intestinal ascarids, compared with only 4% of 70 pet cats. Tapeworms and coccidia were found in 26% and 13% of feral cats, compared with 4% and 0% of pet cats, respectively. More feral cats (20%) were seropositive for *Toxoplasma gondii* than pet cats (3%), which may represent exposure via hunting for feral cats. In another study,²⁹ *Bartonella henselae* was the most common infection identified in 553 (34%) feral cats in Florida. Two organisms formerly grouped under the classification of *Haemobartonella felis*, *Mycoplasma hemominutum* and *M hemofelis*, were present in 12% and 8% of these cats, respectively. Only 10% of the cats had antibodies indicating exposure to *T gondii*. These infection rates for *B henselae*, *Mycoplasma* spp, and

Table 2—Three models of vertical transmission of FeLV in a theoretical population of 2,000 feral cats: model 1, no cats are tested or sterilized; model 2, 50% of cats are tested and sterilized and cats with positive test results (FeLV+) are removed; and model 3, 100% of cats are sterilized without testing or removal.

Variable	Model 1	Model 2	Model 3
Percentage FeLV+	4%	4%	4%
Adults sterilized	0	1,000	2,000
Adults sexually intact	2,000	1,000	0
FeLV+ euthanatized	0	40	0
Adults FeLV+	80	40	80
Kittens born	6,000	3,000	0
Kittens FeLV+	180	90	0
Total FeLV+ cats	260	130	80

^a These models assume that 4% of feral cats are FeLV+ and that 75% of kittens born to FeLV+ queens will become infected.

T. gondii are not substantially different than those reported for pet cats.

Taken together, reports of transmissible diseases in feral cats indicate that, for many diseases, feral cats do not have a greater impact than free-roaming pet cats. Given that most pet cats are allowed outdoor access, it is difficult to separate the public health impacts (for both humans and cats) of the 2 groups of cats. Regardless, it is clear that widespread vaccination against zoonotic and feline diseases coupled with population reduction via sterilization will address many public health concerns surrounding domestic cats.

Feral Cat Control

Considerable controversy surrounds methods for controlling free-roaming cats, particularly identification of the option that is most practical, effective, and humane. Of primary concern is the welfare of the cats themselves. Some animal welfarists believe that the feral lifestyle is too fraught with potential risk to be acceptable and recommend preemptive euthanasia of cats on the basis of their lack of ownership rather than on evidence of current suffering. Others believe that the quality of life of feral cats should not be judged differently than those of other species existing in a wild state. The recent growth of the “no-kill” movement has caused some leaders to reexamine traditional beliefs that euthanizing large numbers of healthy animals to prevent potential suffering or as a method of population control can be compatible with the values of a humane society.

Although control of feral cats has emerged as one of the most hotly contested issues in animal control and welfare, the reality is that feral cats are mostly ignored by both governmental and private animal control agencies. Individual colonies of “nuisance” cats may be removed, but few agencies have comprehensive programs designed for a sustained reduction in the number of feral cats in their communities. The debate over feral cat control frequently hinges on the relative attributes of 3 approaches: removal of cats for adoption, life-long confinement, or euthanasia versus sterilization of cats followed by return to their colonies. Regardless of the solutions that are chosen, effective public policy dictates that programs focus on the large numbers of cats that inhabit communities and not simply on high-profile and controversial situations. Because the numbers of cats and the costs of dealing with them are great, planning for the best use of scarce resources and a herd health approach are essential.

Removal of cats—Feral cats have been extirpated from several uninhabited islands by means of poisoning, hunting, trapping, and introduction of infectious feline diseases.³⁰ Although effective, logistic barriers and public opposition would make such strategies in populated mainland areas unfeasible. Effective cat control programs must integrate environmental safety, affordability, sustainability, and public aesthetics. Any realistic plan to control feral cats must recognize the magnitude of the feral cat population, the need to engage in continuous control efforts, and the degree of public affection for feral cats.

Advocates for population control by cat removal

frequently cite adoption as a solution for the feral cat problem. While adoption of socialized cats, particularly kittens, is frequently facilitated by feral cat caretakers, it is not a practical large-scale solution. A large proportion of feral cats are simply too wild to be safely and humanely placed indoors with families. Additionally, although the number of homeless cats euthanized at animal shelters is declining because of increased sterilization of pets, there is still a large imbalance between available homes and the number of cats born each year. Current evidence suggests that approximately 2.5 to 3 million cats are euthanized annually at animal shelters.³¹ Approximately 75% of these are classified as adoptable but must be destroyed within a few days because there is not enough space to house them. This suggests that a large influx of feral cats removed from the environment would crowd shelters and increase euthanasia of both feral and friendly homeless cats.

Establishment of sanctuaries that confine unadoptable cats for life is another alternative for control of feral cats. However, most sanctuary programs that permanently house feral cats are filled to capacity almost immediately after opening. One of the largest sanctuaries in the country is Best Friends Animal Sanctuary in Utah. Although the sanctuary permanently houses approximately 400 feral cats with special needs, it also operates a **trap-neuter-return (TNR)** program because the number of feral cats in the community vastly outstrips the capacity of the sanctuary.^c The **National Humane Education Society (NHES)** found that its program to house feral cats in its sanctuary in hopes of taming the cats for adoption ultimately led to a decrease in overall cat adoptions because the cats never became tame.^d Instead, the sanctuary was overcrowded with unadoptable cats and closed to new admissions. In remedy, the NHES instituted the **Feral Cat Adoption/Relocation Program** in which outside agencies were solicited to accept cats for release in appropriate environments in exchange for stipends of up to \$25,000 for 50 cats.

A widely cited example of cat control by removal is ongoing at Bidwell Park in California. The **Chico Cat Coalition (CCC)** was formed in 1996 to remove approximately a dozen cats that inhabited the environmentally sensitive park. Cats are adopted or placed in a private barn sanctuary. Unexpectedly, the high visibility of the project encouraged more abandonment, and new cats and kittens are found regularly.^e In 7 years, the group has removed 633 cats from the park, of which 77% have been adopted. Most remaining cats are unadoptable and occupy the sanctuary, which is closed to cats from other locations. A contract with the city subsidizes the CCC's ongoing efforts to control cats by removal from the park. Although the Bidwell Park example demonstrates that removal of cats may be a solution for selected cat colonies that cannot remain in place, it also demonstrates that removal is not scalable to the capacity necessary for reductions in cat populations on a community-wide basis and is unlikely to be successful unless applied on a continuous basis.

TNR—A growing grass roots movement has promoted control of feral cat populations through steril-

ization. Trap-neuter-return seeks to sterilize large numbers of cats and return them to their colonies. Although the ultimate goal is extinction of the colony due to adoption of friendly cats and natural attrition, it may be more realistic to plan for large reductions in cat populations but not necessarily the eradication of all cats. Some programs are very comprehensive, including extensive veterinary care, colony registration, monitoring, and adoption of tame cats, whereas others focus solely on sterilization. Most programs are privately run by volunteers dependent on donations for operating costs, but municipal animal control agencies are increasingly opting for TNR on the principle that sterilization is ultimately more efficient and cost-effective than repeated extermination. The Animal Services Department of Orange County, Fla, reported reduced numbers of complaints about cats, fewer cat admissions to the shelter, and reduced operating costs following implementation of a free sterilization program for feral cats funded by the county.³¹ Several of the largest animal control agencies and shelters in the country have integrated TNR for feral cats into their overall animal control programs, including Maricopa County Animal Care and Control, Ariz; New York City Center for Animal Care and Control; San Francisco Society for the Prevention of Cruelty to Animals; and the American Society for the Prevention of Cruelty to Animals.

Is TNR effective?—A TNR program at a Florida university was highly successful in reducing the feral cat population during an 11-year period.³² Prior to initiating the program, feral cats were considered by campus authorities to constitute a nuisance. Periodic efforts to trap and remove the cats were made when their numbers prompted complaints about on-site noise and odor, but employees and students openly violated policies against feeding the cats and interfered with trapping efforts by university officials during removal campaigns. The TNR program instituted in 1991 incorporated sterilization, euthanasia of sick animals, and adoption of socialized cats and feral cats that eventually tamed enough to become pets. With the exception of 1 male cat, all 155 original cats were sterilized between 1991 and 1995, and no kittens were known to be born on campus after 1995. Adoptions accounted for 47% of the decrease in the cat population. Most (83%) cats still remaining on site in 2002 had been present for > 6 years. This compares favorably with the finding that only 42% of the pet cat population in the United States is more than 5 years old.³³ Of the cats that disappeared, died, or were euthanized for debilitating conditions, 61% had been present for at least 3 years. Newly arriving sexually intact socialized cats, apparently abandoned, periodically joined the colonies; their presence could have undermined the control program had they not been promptly captured and neutered. Migration of cats between colonies was common, and resident cats did not always prevent the immigration of new members. Overall, each of the 11 colonies on the campus decreased in size, and 3 colonies eventually became extinct. By the end of 2002, only 23 cats remained on campus.

Another study⁷ of 132 unrelated cat colonies in

North Central Florida revealed that most colonies consisted of a small family group of cats located on the caretaker's property. The caretakers were encouraged to present the cats for free sterilization and were provided humane traps for transportation. While 920 cats were present at the beginning of the study, that number was reduced by 26% to 678 a year later, even though not all cats in the colonies had been sterilized by that time. The southern Florida resort community of Ocean Reef turned to large-scale TNR in 1995 after years of cat control by removal failed to reduce the overall population.¹ The Ocean Reef Community Association constructed a Feral Cat Center, including a clinic and holding area for sick and adoptable cats. From 1995 to 2002, 1,376 feral cats were admitted to the program. Of these, 35% were adopted, 22% died or were euthanized, and 3% were being held at the Center. Only 40% of the cats were returned to their colonies, resulting in a decrease in overall population from approximately 2,000 cats to 500 cats.

Failures of TNR to control cat colonies also exist. A 1-year study³⁴ of TNR programs in 2 southern Florida parks revealed that the presence of highly visible, well-fed cat colonies encouraged illegal abandonment of additional cats. While the original population of 81 cats declined by 20% during the observation year, the arrival of new cats prevented reduction of the colonies and 88 cats were present at the end of the study. Minimal territorial activity by the cats was observed, and aggressive encounters between cats were usually limited to enforcement of feeding order. Interestingly, predation was rarely observed in these fed colonies, and only 2 birds were documented to be caught during the 1-year observation period. This is the only published report of predation by cats in managed colonies and contrasts sharply with previous reports of greater predation by cats in unmanaged colonies and by free-roaming housecats.

These studies indicate that long-term reduction of feral cat numbers is feasible by TNR. However, the extended survival of feral cats following sterilization indicates that natural attrition would result in a slow rate of population decline. Adoption of socialized cats accelerates population reduction. These studies also refute the common belief that established colonies of cats will defend their territory and prevent the immigration of new arrivals. Immigration or abandonment of new cats may occur and could substantially limit the success of TNR if an ongoing surveillance and maintenance program is not effective. Both sanctuary programs and TNR have the potential to enhance abandonment of unwanted pet cats. The high rate of destruction of cats admitted to animal shelters may prevent some cat owners from choosing relinquishment to shelters in favor of release to colonies, in the misguided attempt to "give the cat a chance." Public education promoting responsible pet ownership, increased and earlier sterilization, improved pet retention programs, and expansion of "no-kill" animal sheltering should be promoted to reduce pet abandonment. In addition, sanctuary and TNR programs should be conducted discretely to avoid attracting public attention, other wild animals, and more cats.

Is TNR humane?—Although cats are a highly fecund species capable of producing multiple litters per year in almost any climate, a kitten mortality rate of > 50% prior to maturity contributes to the relative stability of cat populations.³⁵ Trap-neuter-return programs enhance the welfare of the species by preventing the birth of kittens that would be marked for early death in the wild. Data collected on 5,323 feral cats presented for sterilization indicate that while feral cats were homeless, the euthanasia rate for health reasons was quite low (0.4%) and unexpected deaths during sterilization surgery occurred at a low rate (0.3%).³⁶ In another study,³⁷ the body condition of adult feral cats presented for sterilization was generally lean but not emaciated. One year after sterilization, these cats were significantly heavier and had higher body fat, indicating that feral cats, like their tame counterparts, experience enhanced fat accumulation following sterilization. Although TNR may not meet the gold standard of care desired for pet cats, it appears that sterilized feral cats can enjoy an extended period of good quality of life while their population dwindles by adoption or natural attrition. As such, it is not necessary to perform prophylactic euthanasia of feral cats simply because they do not share a human address.

Is TNR legal?—To date, there are no laws at the state or federal levels that regulate TNR of feral cats. Although the Endangered Species Act and the Migratory Bird Treaty Act do not specifically address TNR, it has been suggested that these laws could be used both to promote TNR to reduce environmental impacts of cats³⁸ or to initiate legal action against cat caretakers, veterinarians, and public officials if it can be shown that their involvement with feral cats ultimately leads to the impairment of protected species.³⁹ However, such legal action has not yet occurred, even though TNR programs have been active for more than a decade. In Florida, state law empowers the Fish and Wildlife Commission to remove cats from public lands when cats are shown to menace wildlife but does not prohibit TNR in general.³⁹ Local ordinances are in effect throughout the country that variably prohibit TNR or define requirements for its implementation. In several jurisdictions, TNR is adopted as public policy and is carried out by use of tax revenues.

The Role of Veterinarians in Feral Cat Control

The number of cats euthanatized in animal shelters has decreased from approximately 5.4 million in 1990 to 2.5 to 3 million today.³¹ Concurrently, the number of dead cats found on roads, a marker of the total outdoor cat population including both outdoor pets and feral cats, has decreased by 90% since 1992.⁴⁰ Veterinarians have been instrumental in reducing both of these numbers by educating clients to keep their cats indoors and by sterilizing most pet cats. Today, 82% to 91% of pet cats are sterilized, although not always before producing a litter of kittens. The result of this high sterilization rate is that owned cats produce only 22% of the kittens necessary for zero population growth of cats.⁴¹ Feral cats produce approximately 80%

of the kittens born each year and are the most important source of cat overpopulation (Table 1).

Currently, euthanasia in shelters is the leading cause of death of cats. Many veterinarians, shelter workers, and humane societies have long accepted this as a sad necessity for which there was no humane alternative. More recently, however, some veterinarians have questioned whether the veterinary community would be as complacent if an infectious disease resulted in the same loss of life. As in the case of infectious disease outbreaks, veterinarians have emerged as leaders in novel strategies to end cat overpopulation. More than 1,000 members of the California Veterinary Medical Association sterilized 170,334 feral cats between July 1999 and May 2002 in a \$9.5 million project funded by Maddie's Fund.⁷ Several veterinary schools house programs for feral cat sterilization, serving both their communities and the need for students to gain more surgical experience.

Increasingly, community collaborations have been developed for integrated sterilization, adoption, and pet retention programs to achieve "no-kill" animal control. In these communities, no animals that are adoptable or treatable are euthanatized; only those that are too ill to rehabilitate or that have unmanageable behavioral problems are euthanatized. The cornerstone of these success stories is aggressive sterilization, including programs for feral cats. The unprecedented success of communities as diverse as San Francisco and Tompkins County, NY, in achieving a "no-kill" status has prompted other regions, such as Los Angeles, New York, and the entire state of Utah, to pledge to end the destruction of adoptable cats and dogs within a few years. Large-scale TNR for feral cats is a core strategy in these campaigns.

Regardless of the vantage point from which feral cats are viewed, nearly all stakeholders agree that something should be done to reduce their numbers. The real debate begins when specific strategies are offered to accomplish this goal. Opponents of TNR suggest a 3-pronged approach for removing feral cats from the environment, including adoption, sanctuary, and destruction. Although TNR programs frequently incorporate adoption for friendly cats, the imbalance of available homes, massive size of the feral cat population, and feral nature of the cats make large-scale adoption an unrealistic solution alone. Likewise, care-for-life in sanctuaries is recognized as the most expensive and least efficient method of population management.^c Most sanctuary programs that permanently house a large number of feral cats also have an active TNR program because the sanctuaries are filled to capacity. Although TNR opponents list destruction of cats as a last resort, large-scale removal of cats to animal control facilities would likely result in euthanasia of nearly all of the feral cats.

In summary, there are several options available for integrated nonlethal feral cat control, and no single solution is likely to be appropriate for all situations. Adoption is an ideal outcome for socialized cats and should be employed whenever feasible. Placement in sanctuaries or relocation of colonies may be required for unadoptable cats that must be removed from their colony sites because of welfare or environmental con-

cerns. Sterilization and return to the colony is a third alternative and represents the most cost-effective and scalable strategy. Those who care for feral cats often have a strong human-animal bond and will not cooperate with programs that threaten these cats. Engaging cat feeders in solutions for feral cats will undoubtedly be more productive and economical than warring against them.

^aLevy JK, James KM, Cowgill LD. Infectious diseases of feral cats in central California (abstr), in *Proceedings. 80th Annu Conf Res Workers Anim Dis* 1999;33.

^bLevy JK, Crawford PC, Slater MR. Antibody responses to FIV vaccination (abstr). *J Vet Intern Med* 2004;18:386.

^cBrown B, Best Friends Animal Sanctuary, Kanab, Utah: Personal communication, 2003.

^dTaylor J, National Humane Education Society, Charlestown, WV: Personal communication, 2002.

^eHargrove J, Chico Cat Coalition, Chico, Calif: Personal communication, 2003.

^fHershey S, Feral Cat Center at Ocean Reef, Key Largo, Fla: Personal communication, 2003.

References

1. 2001–2002 national pet owner survey. Greenwich, Conn: American Pet Products Manufacturing Association, 2002;xii–xix.

2. Levy JK, Woods JE, Turick SL, et al. Number of unowned free-roaming cats in a college community in the southern United States and characteristics of community residents who feed them. *J Am Vet Med Assoc* 2003;223:202–205.

3. Johnson KJ, Lewellen L, Lewellen J. National Pet Alliance survey report on Santa Clara County's pet population. *Cat Fanciers' Almanac* 1994;Jan:71–77.

4. Johnson KJ, Lewellen L. San Diego County survey and analysis of the pet population. Available at: www.fanciers.com/npa. Accessed Apr 16, 2002.

5. Manning AM, Rowan AN. Companion animal demographics and sterilization status: results from a survey in four Massachusetts towns. *Anthrozoos* 1992;5:192–201.

6. Mosier JE, Williams LW, Nassar R. Study of feline and canine populations in the greater Las Vegas area. *Am J Vet Res* 1981;45:282–287.

7. Centonze LA, Levy JK. Characteristics of free-roaming cats and their caretakers. *J Am Vet Med Assoc* 2002;220:1627–1633.

8. Clifton M. Seeking the truth about feral cats and the people who help them. *Animal People* 1992;Nov:1,7–10.

9. Zasloff RL, Hart LA. Attitudes and care practices of cat caretakers in Hawaii. *Anthrozoos* 1998;11:242–248.

10. Jenkins SR, Auslander M, Conti L, et al. Compendium of animal rabies prevention and control. *J Am Vet Med Assoc* 2002;221:44–48.

11. Hanlon CA, Childs JE, Nettles VF, et al. Recommendations of a National Working Group on Prevention and Control of Rabies in the United States. *J Am Vet Med Assoc* 1999;215:1612–1619.

12. CDC. Cases of rabies in human beings in the United States, by circumstances of exposure and rabies virus variant, 1990–2001. Available at: www.cdc.gov/ncidod/dvrd/rabies. Accessed Sep 27, 2003.

13. Translocation of Coyote rabies—Florida 1994. *Morbidity Mortal Wkly Rep* 1995;44:580–581, 587.

14. Sung JH, Hayano M, Mastro AR, et al. A case of human rabies and ultrastructure of the Negri body. *J Neuropathol Exp Neurol* 1976;35:541–559.

15. Rosatte RC, Power MJ, MacInnes CD, et al. Trap-vaccinate-release and oral vaccination for rabies control in urban skunks, raccoons and foxes. *J Wildl Dis* 1992;28:562–571.

16. Soulebot JP, Brun A, Chappuis G, et al. Experimental rabies in cats: immune response and persistence of immunity. *Cornell Vet* 1981;71:311–325.

17. Moore DA, Sischo WM, Hunter A, et al. Animal bite epidemiology and surveillance for rabies postexposure prophylaxis. *J Am Vet Med Assoc* 2000;217:190–194.

18. Hensley JA. Potential rabies exposures in a Virginia County. *Public Health Rep* 1998;113:258–262.

19. Patrick GR, O'Rourke KM. Dog and cat bites: epidemiologic analyses suggest different prevention strategies. *Public Health Rep* 1998;113:252–257.

20. Wright JC. Reported cat bites in Dallas: characteristics of the cats, the victims, and the attack events. *Public Health Rep* 1990;105:420–424.

21. Dire DJ. Cat bite wounds: risk factors for infection. *Ann Emerg Med* 1992;21:1008.

22. Lee IT, Levy JK, Gorman SP, et al. Prevalence of feline leukemia virus infection and serum antibodies against feline immunodeficiency virus in unowned free-roaming cats. *J Am Vet Med Assoc* 2002;220:620–622.

23. Courchamp F, Suppo C, Emmanuelle F, et al. Dynamics of two feline retroviruses (FIV and FeLV) within one population of cats. *Proc R Soc Lond B Biol Sci* 1997;264:785–794.

24. Bahi-Jaber N, Langlais M, Pontier D. Behavioral plasticity and virus propagation: the FIV-cat population example. *Theor Popul Biol* 2003;64:11–24.

25. Addie DD, Dennis JM, Toth S, et al. Long-term impact on a closed household of pet cats of natural infection with feline coronavirus, feline leukaemia virus and feline immunodeficiency virus. *Vet Rec* 2000;146:419–424.

26. Levy JK, Richards J, Edwards D, et al. Feline retrovirus testing and management. *Compend Contin Educ Pract Vet* 2001;23:652–657, 692.

27. AAHA endorses AAFP position on feral cats. *DVM Magazine* 2004;35(Aug):44–45.

28. Akucewuch LH, Philman K, Clark A, et al. Prevalence of ectoparasites in a population of feral cats from north central Florida during the summer. *Vet Parasitol* 2002;109:129–139.

29. Luria BJ, Levy JK, Lappin MR, et al. Prevalence of infectious diseases in feral cats in northern Florida. *J Feline Med Surg* 2004;6:287–296.

30. Nogales M, Martin A, Tershy B, et al. A review of feral cat eradication on islands. *Conserv Biol* 2004;18:310–319.

31. Hughes KL, Slater MR. The effects of implementing a feral cat spay/neuter program in a Florida County Animal Control Service. *J Appl Anim Welf Sci* 2002;5:285–298.

32. Levy JK, Gale DW, Gale LA. Evaluation of the effect of a long-term trap-neuter-return and adoption program on a free-roaming cat population. *J Am Vet Med Assoc* 2003;222:42–46.

33. U.S. pet ownership and demographics sourcebook. Schaumburg, Ill: AVMA, 2002;20.

34. Castillo D, Clarke AL. Trap/neuter/release methods ineffective in controlling domestic cat “colonies” on public lands. *Nat Areas J* 2003;23:247–253.

35. Nutter FB, Levine JF, Stoskopf MK. Reproductive capacity of free-roaming domestic cats and kitten survival rate. *J Am Vet Med Assoc* 2004;225:1399–1402.

36. Scott KC, Levy JK, Crawford PC. Characteristics of free-roaming cats evaluated in a trap-neuter-return program. *J Am Vet Med Assoc* 2002;221:1136–1138.

37. Scott KC, Levy JK, Gorman SP, et al. Body condition of feral cats, and the effect of neutering. *J Appl Anim Welf Sci* 2002;5:209–219.

38. Gorman S, Levy J. A public policy toward the management of feral cats. *Pierce Law Rev* 2004;2:157–181.

39. Hatley PJ. Feral cat colonies in Florida: the fur and feathers are flying. *J Land Use Environ Law* 2003;18.

40. Clifton M. Roadkills of cats fall 90% in 10 years—are feral cats on their way out? *Animal People* 2003;Nov:1.

41. Johnson K. Are owned cats causing an overpopulation crisis? Available at: www.fanciers.com/npa/owned-cats.html#table. Accessed Oct 31, 2003.