AN ABSTRACT OF THE THESIS OF

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Title: Effect of Free-ranging Domestic Cats on Small Mammals

Abstract approved: Elmer J. Finck

Few studies have been published on the effect of free-ranging domestic cats (Felis silvestris) on small mammal populations. During the summer of 1995 in the Flint Hills region of eastern Kansas, I implemented a study to compare small mammal relative abundance in areas with known numbers of cats (home sites) and areas with no cats (control sites). I chose four farms with eight cats and four farms with eighteen or more cats as study sites. Eight control sites with no cats were also located in the same region. Small mammal relative abundance was censused with standard small mammal trapping procedures. Using a paired-sample t-test, I compared small mammal relative abundance at home sites to control sites. Farms with eight resident cats had a small mammal relative abundance at home sites that was not significantly different ($P > 0.05$) from control sites. Farms with eighteen or more resident cats had a small mammal relative abundance at home sites that was significantly lower ($P < 0.05$) than control sites. My study suggests that, in areas with high numbers of cats, small mammal relative abundance is being limited within the cats' home ranges.

EFFECT OF FREE-RANGING DOMESTIC CATS ON SMALL MAMMALS

A Thesis

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PREFACE

My thesis has been prepared in the style appropriate for the Journal of Wildlife Management. Running heading: Effect of domestic cats on small mammals

Key words: *Felis silvestris*, free-ranging domestic cats, small mammals, cat predation, Flint Hills region, and Kansas.

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INTRODUCTION

The domestic cat (*Felis silvestris*) was first imported to the United States over 170 years ago (George 1974). Cats have increased in popularity in recent decades, and as the human population has grown, so has the domestic cat population (Morris 1987). There are currently an estimated four hundred million cats worldwide. The most significant increase has been in the United States, where the cat population is estimated at seventy million (Legay 1986 *in* Jarvis 1990).

The domestic cat has become the most abundant pet in the United States. In a study of the feline population of Manhattan, Kansas, Nassar and Mosier (1982) estimated that cat populations could increase 18% a year. At that rate, 88% of the female cat population must be spayed to stabilize the cat population (Nassar and Mosier 1982). Adult female domestic cats are capable of producing three litters per year (Boddicker 1983). Cats are also one of the longest lived small domestic animals, reaching ages of 15 to 20 years (Comfort 1956). Many cat owners complicate the cat problem by allowing their domestic cats to roam free, which increases the rate of reproduction. Childs (1990) found that 31.6% of the households in Baltimore, Maryland, allow their cats to roam free.

Most countries are finding it difficult and expensive to control cat populations, because of human sentiment and the high reproductive capacity of female house cats (Hubbs

1951). Currently, there are few restraints on the rapidly growing cat population, and in many areas the domestic cat has become an important exotic predator (Boddicker 1983, Jurek 1994). Hall and Pelton (1979) indicated that the domestic cat is a significant predator that goes relatively unnoticed in many parts of the country.

Although domestic cats are abundant predators, quantifications of their impact have not been established, therefore little is known about their effects on wildlife populations (George and George 1979, Boddicker 1983, Kitchener 1991). Most past studies on domestic cats are limited to food habits and diet (Bradt 1949, Hubbs 1951, Eberhard 1954, Churcher and Lawton 1987). Other more recent studies have investigated cat behavior, home range and movements, and social interaction patterns (Fagen 1978, Apps 1986, Konecny 1987).

After lowering prey density in an area, "natural" predators move to new hunting areas with higher densities of prey, or risk possible starvation (Pearson 1966). This allows prey populations to reestablish. However, domestic cats continue to hunt in the same areas, because their diet is supplemented by their owners. Several studies have shown that cats continually return to and hunt in areas where they caught small mammals in the past (Laundre 1977, Leyhausen 1979, Liberg 1980, Panaman 1981).

Supplementally fed domestic cats affect small mammal populations more severely than do natural predators (Elton 1953, Davis 1957, Pearson 1966). Liberg (1982) reported that colonies of supplementally fed females are capable of depleting their hunting grounds of small mammals. Lactating female cats and their close relatives are efficient hunters, because they often exhibit shared parenting by providing kittens of relatives with small mammals to supplement their diets. Adult cats also teach kittens hunting behaviors with small mammals they have captured (Turner and Bateson 1988). Shared parenting behavior has been well documented in cat behavior studies (Macdonald and Apps 1978, Macdonald 1981).

Studies have shown that cats prefer small mammals for food (McMurray and Sperry 1941, Iverson 1978, Fitzgerald and Karl 1979). Cats prefer to hunt for live food and farm cats meet most of their energy requirements from their small mammal hunting activities (Toner 1956, George 1974, Liberg 1984). Free-ranging domestic cats require a large amount of small mammals to sustain their diet. In a study by Howard (1957), one cat consumed seventeen mice in twenty-six hours. In separate studies, Pearson (1964 and 1971), Christian (1975), and Erlinge et al. (1983) found cats to be efficient predators on microtine rodent populations, and the cats delayed the microtine cycle in areas of high predation. Domestic cats may be causing winter shortages of food for raptors and other carnivores, thus causing serious competition for prey resources (Davis 1957, George 1974, Erlinge et al. 1983, Paton 1991).

Langham (1990) stated that more studies are needed on the impact of domestic cats on small mammal populations. Since a limited number of studies have revealed the impact of free-ranging domestic cats on the small mammals of an area, the primary objective of my study was to investigate the relative abundance of small mammals within the home range of several groups of free-ranging domestic cats and confirm that the cats were affecting the relative abundance of small mammals found in these areas. I compared relative abundance of small mammals within cat home ranges to relative abundance of small mammals in control sites, where no cats were present. My null hypothesis was that relative abundance of small mammals would not be significantly different between home sites and control sites with the alternate hypothesis being relative abundance of small mammals would be significantly different between home sites and control sites.

STUDY AREA

The study sites were located near farms in the Flint Hills region of eastern Kansas (Fig. 1). Home and control sites were located in Chase, Greenwood, and Lyon counties (Fig. 2). The land is privately owned and is used primarily for cattle ranching.

The study sites were limited to roadside ditches near graveled county roads and ranch access roads because habitat was homogeneous in roadside ditches in the area, and cats often frequent roadside ditches (McMurray and Sperry 1941, Hall and Pelton 1979). Warner (1985) found that 73% of the radio locations on cats in his study were in edge cover, mainly roadside ditches, when the cats were not at farm buildings.

I located home sites approximately 400 m from the farm buildings so relative abundance of small mammals would not be influenced by spilled grain, rodenticides, increased habitat from farm buildings, etc. This distance was also important because predation by natural predators should not be influenced by the farm and should thus have been equal at both home and control sites, which is a major assumption of my study. Control sites were located in roadside ditches approximately 2.5 km from the farm so that cats from the farm did not travel to, and hunt at, the control sites.

Feral cats and transient male cats were never seen at the control sites. Leopold (1931) and Nilsson (1940) first

Fig. 1. Location of Flint Hills (shaded) and study areas (darkened area) in Chase, Greenwood, and Lyon counties, Kansas.

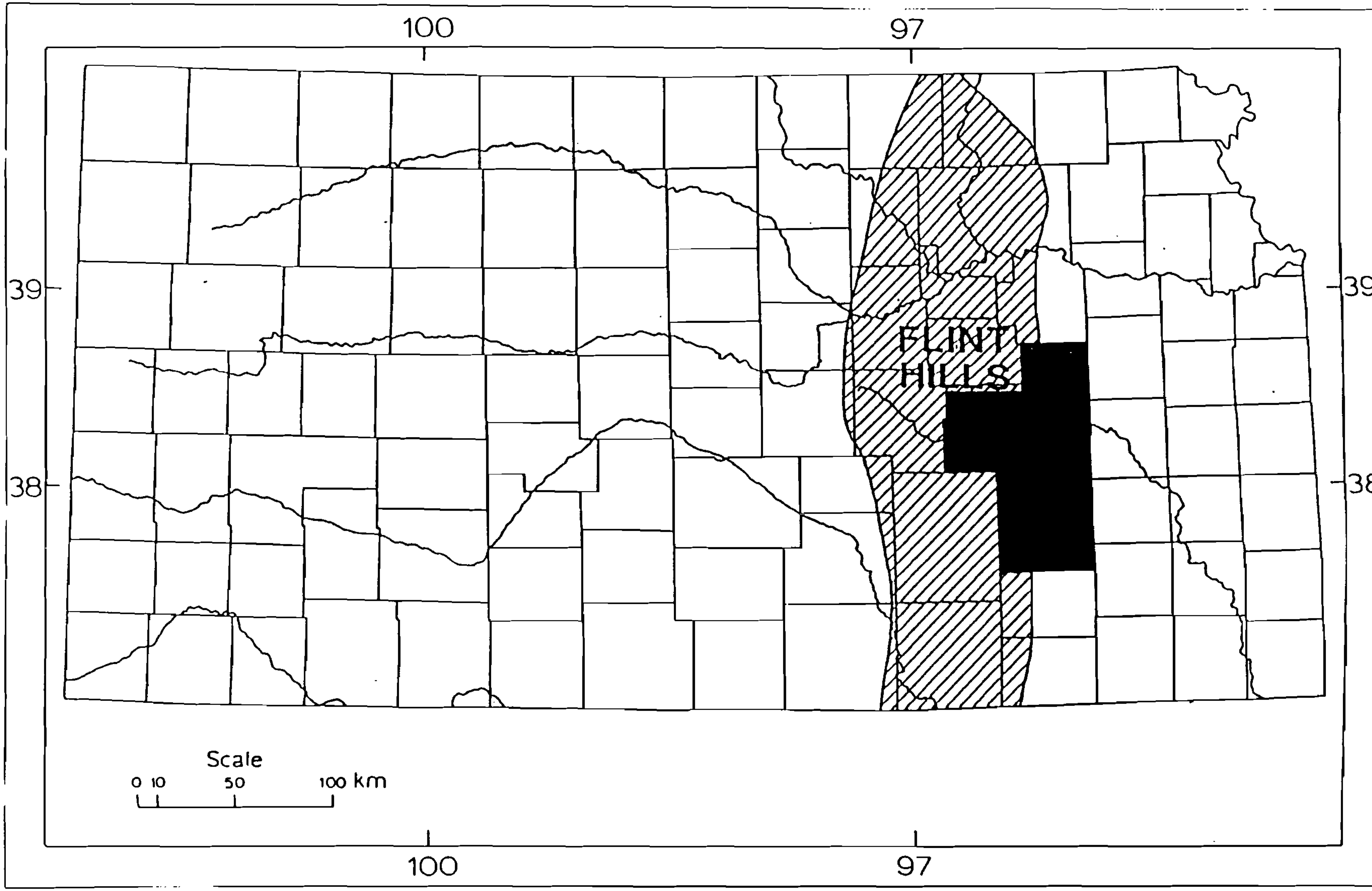
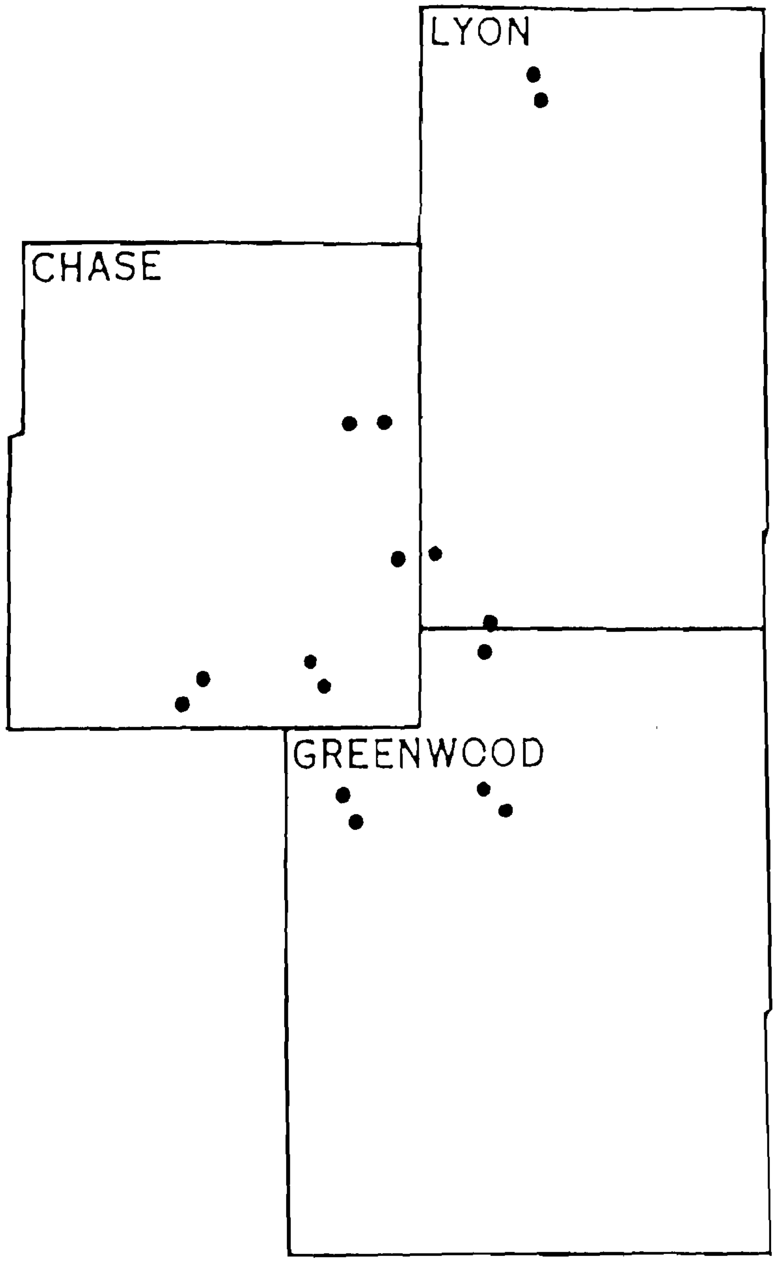

100
97
39
38
FLINT HILLS
Scale
0 10 50 100 km
100
97
39
38

Fig. 2. Location of individual study sites in Chase, Greenwood, and Lyon counties, Kansas.


LYON
CHASE
GREENWOOD

suggested that feral cats probably make up a very small number of individuals in rural areas and their occurrence would be infrequent. More recently, George and George (1979) and Berkeley (1982) agreed that feral cats would not occur frequently in such an area because of harsh winters, predation by larger carnivores, and lack of human structures for habitat. Calhoon and Haspel (1989) stated that shelter, not food, is the limiting factor for feral cats. If feral or transient cats do occur in the area, their impact would be minuscule.

The roadside ditches used for study sites are typical for and of the area. The areas are burned on an annual basis in April and May and some ditches are mowed in late summer. The soils of the area are composed of shallow silty clay loam and silty clay (Neill 1974). The climate of the study area is continental, represented by short spring and fall periods, while summers are long and hot, and winters are long and cold. Mean daily average temperatures range from 20.2° C in summer to 6.5° C in winter. The mean yearly rainfall is 80.4 cm and the mean yearly snowfall is 42.5 cm (Neill 1974). The major vegetation of the study areas was switchgrass (Panicum virgatum), Junegrass (Koeleria pyramidata), big bluestem (Andropogon gerardii), Indian grass (Sorghastrum nutans), little bluestem (Andropogon scoparius), blue false indigo (Baptisia australis), common ragweed (Ambrosia artemisiifolia), leadplant (Amorpha canescens), western ironweed (Veronia baldwinii), broomweed (Gutierrezia dracunculoides), wild alfalfa (Psoralea tenuiflora), purple prairie clover (Dalea purpurea), and Schribner's panicum (Dichanthelium oligosanthes) as described in Flora of the Great Plains (Great Plains Flora Association 1986).

MATERIALS AND METHODS

Mail Survey

In February 1995, I conducted a mail survey to establish possible study sites in Chase, Greenwood, and Lyon counties. This area of Kansas was selected for the study because it is sparsely inhabited by humans and habitats are relatively homogeneous. Letters were sent to 55 rural residents, after suitable locations were identified on county maps. Suitable locations were identified as houses that were located at least 2.5 km away from other houses or human structures. The distance of 2.5 km is approximately double the maximum distance traveled by female farm cats, according to previous home range studies (Dards 1978, Liberg 1984, Apps 1986, Konecny 1987).

Past studies have shown that females constitute most of the family groups living at farms and their home ranges are often small and overlapping (Baron et al. 1957, Fagen 1978, Macdonald and Apps 1978, Macdonald 1981). According to Liberg (1980), the house or structure of occupancy of the cat is the center for all individual cat home ranges. Females constitute most of the population, because young male cats are chased out of the colonies' home range once they reach approximately one year of age (Dards 1978).

Each letter contained a short questionnaire asking the home owner about the number of cats at the residence, the number of prey brought to the house per month, the number of stray cats seen per month, the sexes of their cats, and if the home owner provided supplemental food for their cats. Although cats were supplementally fed at all farms, exact amounts were not quantified for each farm. Feeding and hunting have been shown to be independent entities, so the quantity of supplemental feeding should not affect the amount of time spent hunting (Davis 1957, Leyhausen 1965, Krames et al. 1973, Adamec 1976).

Study Site Descriptions

After reviewing the mail survey questionnaires, farms were visited and study sites were picked that appeared to have homogeneous habitats. If a farm did not have habitats that were similar to the other study sites, it was excluded as a possible study site. A total of eight home sites and eight control sites (no cats) were established (Appendix A). Four home sites contained eighteen or more cats, and four contained exactly eight cats. The residences were grouped into these two group sizes, because large numbers of cats should have a higher probability of showing a significant impact on small mammal relative abundance at the study sites. The sites will be referred to throughout my thesis by the first two letters of the home owners last name. Sites Go., Nu., Te., and Wh. each had eighteen or more cats, while sites Bu., Ro., St., and Ta. had eight cats.

Small Mammal Trapping

During June and July of 1995, I censused relative abundance of small mammals with a 20-station trapline per site for four consecutive days. To limit trapping success error due to moon phase and changes in small mammal activity, I did not trap four days prior to or four days after a full moon (Wolfe and Summerlin 1989). Two Sherman live traps (7.6 by 8.9 by 22.9 cm) were placed within 1 m of each station with stations located at 15-m intervals. Traps were baited with peanut butter that was placed directly on the inside of the back door (Kaufman et al. 1988). Traps were checked every morning from 0600 to 1000. Small mammals were identified, sexed, grouped according to reproductive condition (scrotal male, nonscrotal male, lactating female, nonlactating female), marked by toe-clipping according to standards established by the American Society of Mammalogists (Ad hoc 1987), and released at the location of capture.

Small Mammal Statistical Tests

To compare small mammal relative abundance at sites, paired-sample t-tests at the 0.05 level (Zar 1984, SAS 1985), were run on home sites and control sites. Shannon-Wiener species diversity (H′) and Pielou species evenness (E) indices for small mammal relative abundance were computed for each of my study sites using the computer program BIODIV (Baev and Penev 1995). Shannon-Wiener and

Pielou indices were chosen because they are the most widely used indices for populations (Schemnitz 1980, Stiling 1992, Baev and Penev 1995). Indices for eight-cat home sites, eighteen-or-more-cat home sites, and control sites were then orthogonally contrasted and compared with a statistical analysis system (SAS) general linear model (SAS 1985).

Habitat Analysis

During the late summer of 1995, habitat analysis was conducted at each of the study sites. Using the percent canopy coverage of the tallgrass prairie index (Daubenmire 1968), habitats were analyzed and compared between control and home sites. I used a 0.5-m x 0.5-m Daubenmire frame with ten random drops per study site ditch to estimate the percent grasses, forbs, rock, and bare ground. I conducted a total of 160 Daubenmire frame percent canopy estimations. After home and control sites for all farms were grouped, four paired-sample t-tests were run to calculate whether there was a significant difference ($P = 0.05$) between control and home site habitats (Zar 1984, SAS 1985).

Cat Sex Ratios

Chi-square tests were run to compare sex ratios at farms with eighteen or more cats and at farms with eight cats. Tests were also run to compare sex ratios between farms.

RESULTS

Mail Survey

Thirty-five residents responded for a mail response of 64%. The residents owned an average of 5.8 cats.

Habitat Analysis

Paired-sample t-tests revealed that habitat was not significantly different ($P > 0.05$, $df = 7$, t crit. = 2.365) for the home and control sites (Fig. 3). Results of paired-sample t-tests were (t cal. = 0.58) for grasses, (t cal. = 0.22) for forbs, (t cal. = 0.54) for rock, and (t cal. = 0.73) for bare ground.

Small Mammal Data

Two hundred nine small mammal captures were made during 2560 trap nights. Trapping success was 8%. One hundred fifty-two individual small mammals were caught representing eight species (Table 1) (Wilson and Reeder 1993).

Paired-sample t-tests revealed that small mammal relative abundance for home and control sites was not significantly different ($P > 0.05$, $df = 3$, t crit. = 3.182, t cal. = 2.83) at eight-cat farms (Fig. 4). Small mammal relative abundance for home and control sites was significantly different ($P < 0.05$, $df = 3$, t crit. = 3.182, t cal. = 5.14) at eighteen-or-more-cat farms (Fig. 5).

Species diversity indices for communities of small mammals were not significantly different between home sites with eight cats ($P > 0.05$, $df = 1$, $F = 0.27$), home sites with eighteen or more cats ($P > 0.05$, $df = 1$, $F = 2.13$), and

Fig. 3. Mean percent canopy coverage of tallgrass prairie for percent grasses, percent forbs, percent bare ground, and percent rock at home and control sites in Flint Hills region, Kansas, 1995.

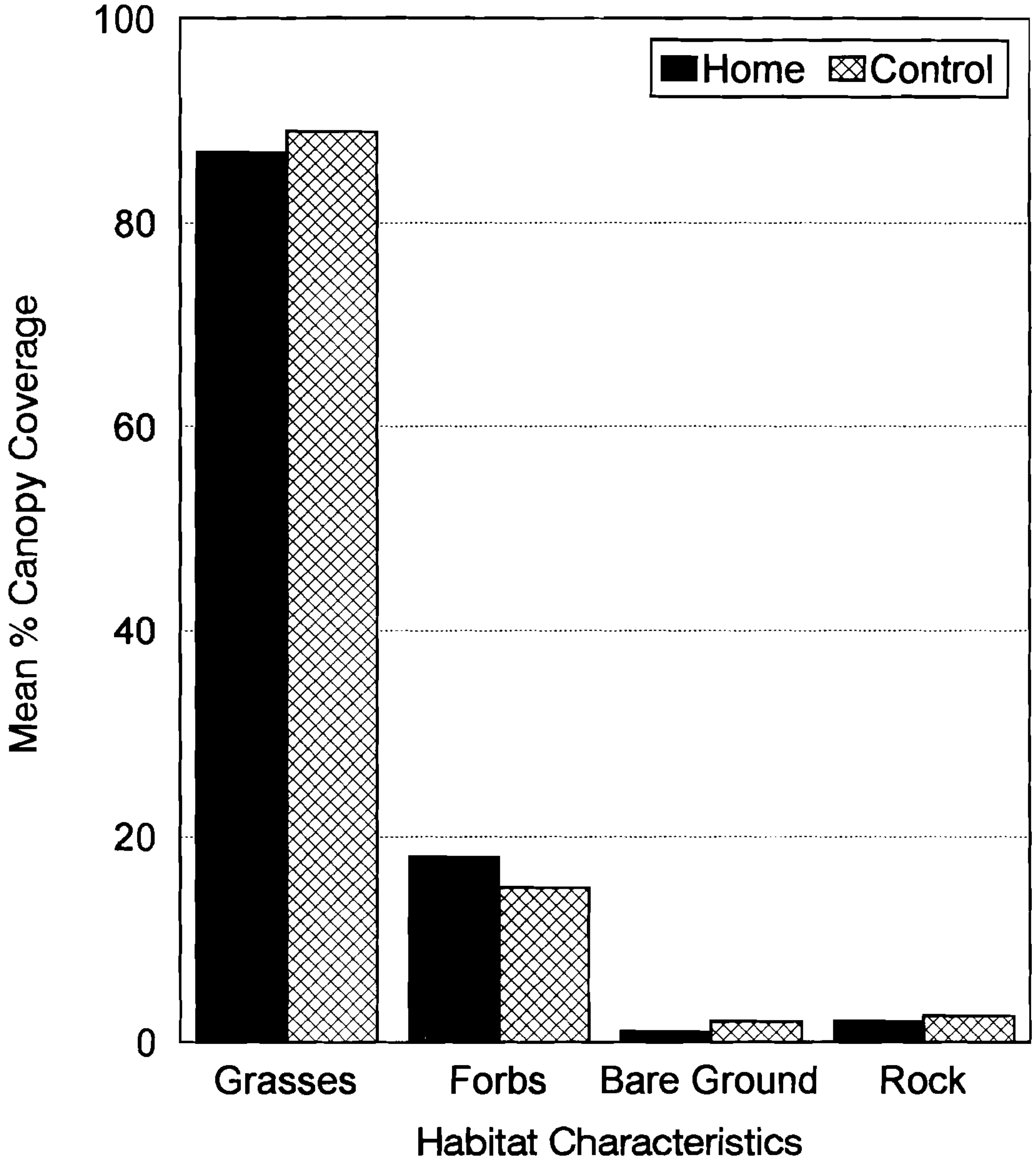

100
80
60
40
20
0
Home
Control
Mean % Canopy Coverage
Grasses
Forbs
Bare Ground
Rock
Habitat Characteristics

Table 1. Total captures of small mammals, excluding recaptures, in 2560 trap nights during June and July 1995 in Chase, Greenwood, and Lyon counties, Kansas.

Species	8-Cat Home	8-Cat Control	≥ 18-Cat Home	≥ 18-Cat Control	Total
Peromyscus maniculatus	30	31	8	38	107
Sigmodon hispidus	10	4	2	4	20
Microtus ochrogaster	2	3	2	3	10
Cryptotis parva	4	0	0	0	4
Chaetodipus hispidus	0	0	1	3	4
Neotoma floridana	0	0	1	2	3
Spermophilus tridecemlineatus	0	1	0	1	2
Rattus norvegicus	1	0	0	1	2
Total	47	39	14	52	152

Fig. 4. Total small mammals captured, excluding recaptures, for home and control sites for eight-cat farms in Flint Hills region, Kansas, during June and July, 1995.

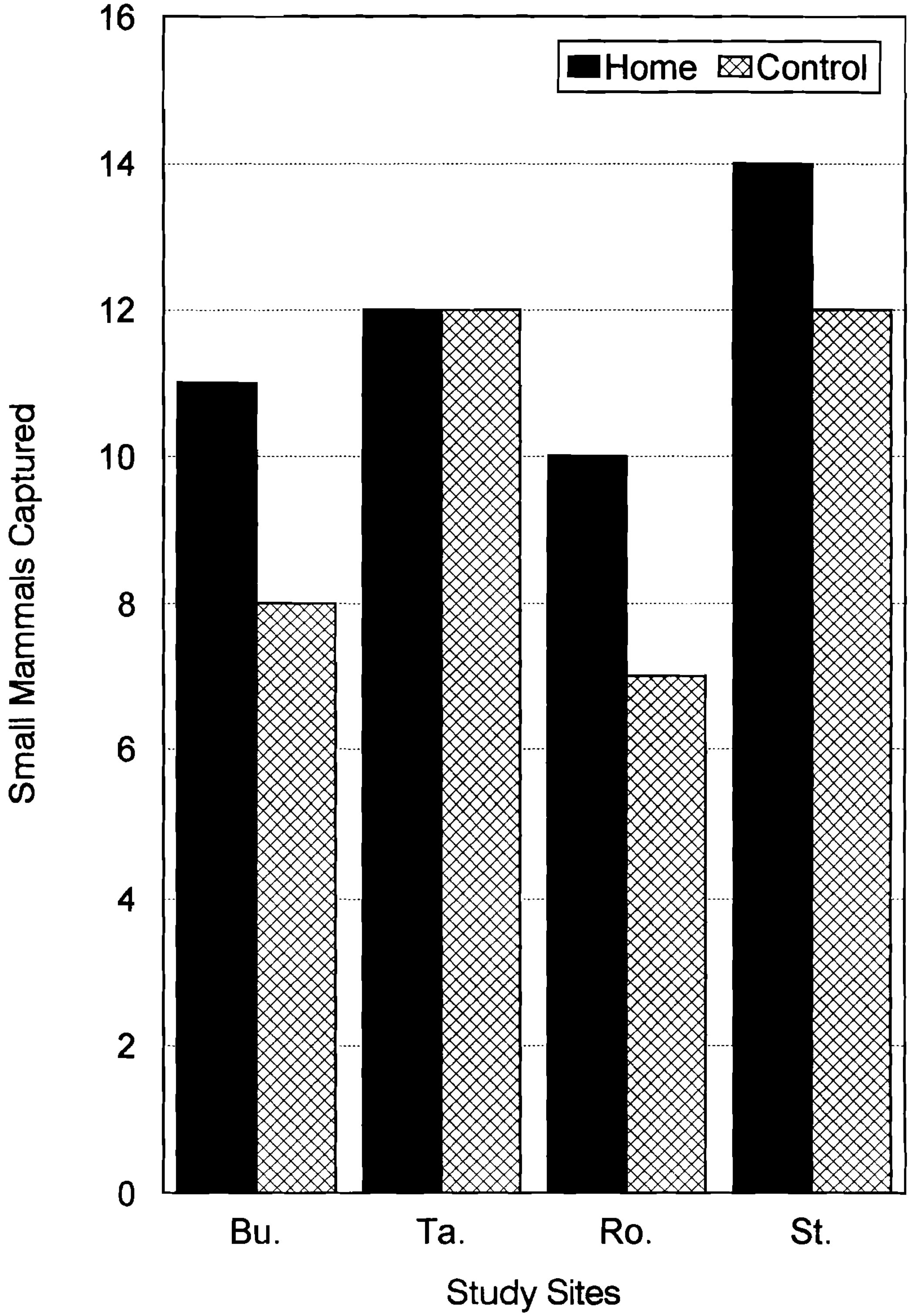
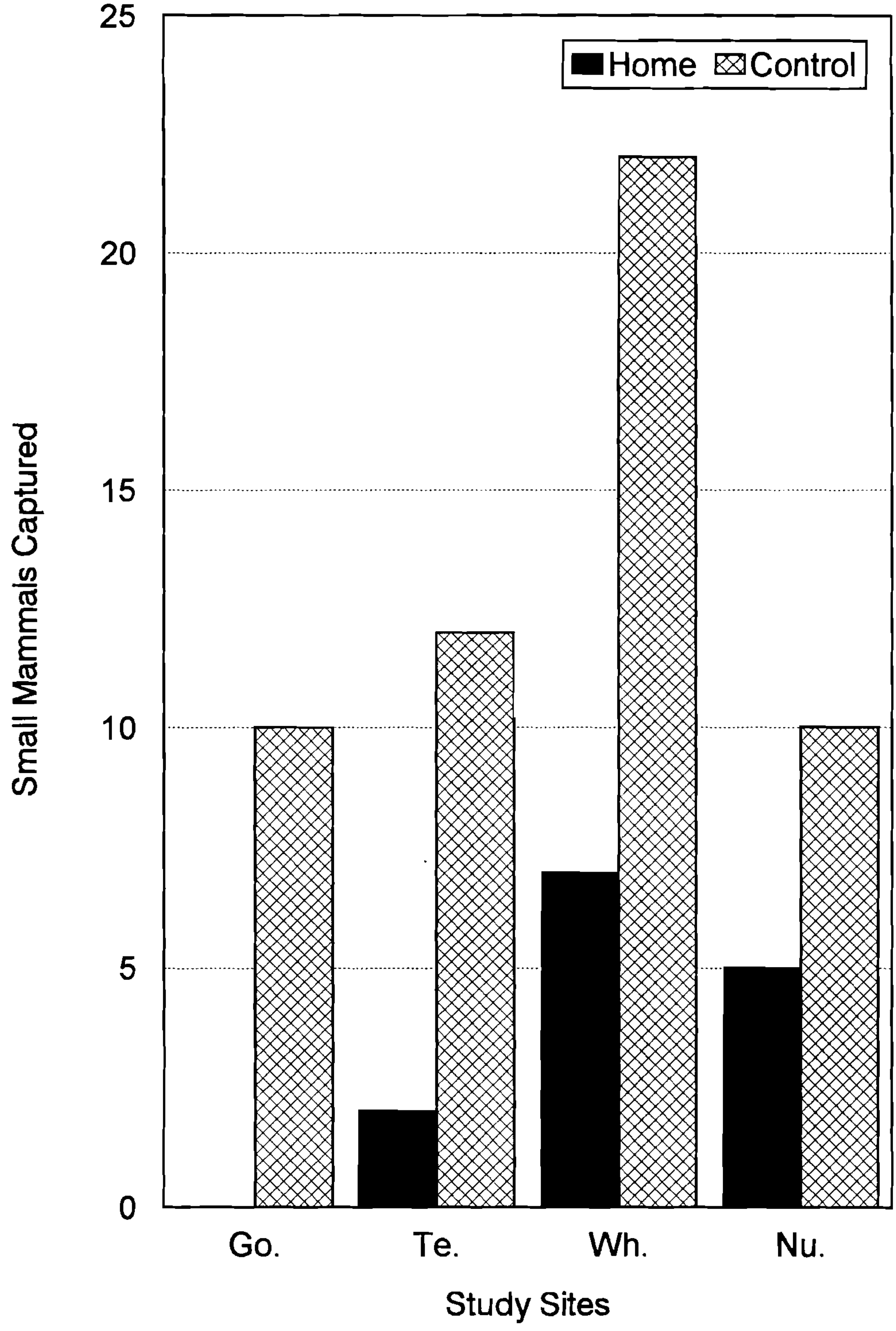

Home
Control
Small Mammals Captured
0
2
4
6
8
10
12
14
16
Bu.
Ta.
Ro.
St.
Study Sites

Fig. 5. Total small mammals captured, excluding recaptures, for home and control sites for eighteen-or-more-cat farms in Flint Hills region, Kansas, during June and July, 1995.



Home
Control
25
20
15
10
5
0
Small Mammals Captured
Go.
Te.
Wh.
Nu.
Study Sites

control sites ($P > 0.05$, df = 1, F = 1.41) (Table 2). Species evenness indices were not significantly different between home sites with eight cats ($P > 0.05$, df = 1, F = 0.88), home sites with eighteen or more cats ($P > 0.05$, df = 1, F = 3.36), and control sites ($P > 0.05$, df = 1, F = 2.31) (Table 2).

Cat Sex Ratios

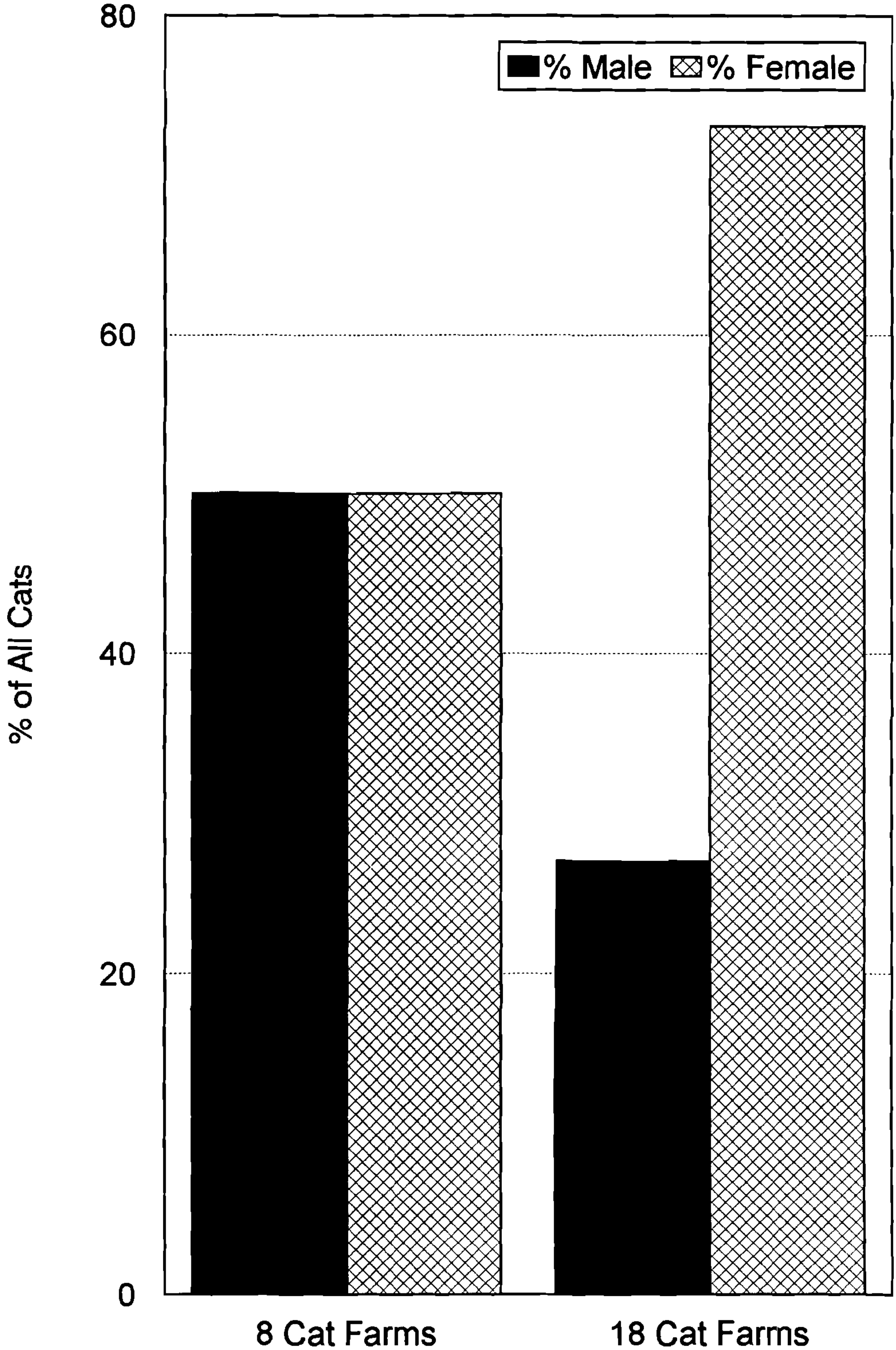
The cat sex ratio at eight-cat farms did not differ significantly from 1:1 (Chi-square analysis, df = 1, $P > 0.05$, X^2 crit. = 3.841, X^2 cal. = 0). The eight-cat farms had a total of sixteen males and sixteen females (Fig. 6).

The cat sex ratio at eighteen-or-more-cat farms did significantly differ from 1:1 (Chi-square analysis, df = 1, $P < 0.05$, X^2 crit. = 3.841, X^2 cal. = 18.77). The eighteen-or-more-cat farms had a total of twenty-six males and sixty-eight females (Fig. 6).

Table 2. Small mammal diversity (Shannon-Wiener's H') and community evenness (Pielou's E) in relation to house cat densities at sites in the Flint Hills region of Kansas, 1995.

	Shannon Diversity H'		Pielou Evenness E	
8-Cat Sites	Home	Control	Home	Control
Bu.	0.54	0.74	0.85	0.67
Ro.	1.22	0.00	0.88	0.00
St.	0.80	0.57	0.73	0.52
Ta.	0.96	0.87	0.87	0.79
$\bar{X}$	0.89	0.55	0.83	0.50
$\geq$ 18-Cat Sites				
Go.	0.00	0.64	0.00	0.58
Te.	0.00	0.47	0.00	0.68
Wh.	1.35	1.06	0.98	0.66
Nu.	0.50	0.06	0.72	0.88
$\bar{X}$	0.35	0.69	0.43	0.70

Fig. 6. Cat sex ratio for eight-cat farms compared to cat sex ratio for eighteen-or-more-cat farms in Flint Hills region, Kansas, 1995.



80
60
40
20
0
% of All Cats
% Male
% Female
8 Cat Farms
18 Cat Farms

DISCUSSION

Habitat Analysis

In a study of habitat selection by small mammals in north-central Kansas, Kaufman and Fleharty (1974) suggested that the life form of vegetation was more important than the particular species of plants in determining the distribution of small mammals in an area. As all habitat classes were not significantly different ($P > 0.05$), I am confident that habitat differences between home and control sites did not significantly affect small mammal relative abundance between sites. Therefore, any significant differences in small mammal relative abundance between home and control sites could be attributed to predation or to some other factor besides habitat.

Small Mammals at Eight-Cat Farms

Relative abundance of small mammals was not significantly different ($P > 0.05$) between home and control sites for farms with eight resident cats. Despite predation occurring at each of the farms' home sites on a frequent basis, the sites all had similar relative abundance of small mammals at both home and control sites. Predation was evident by the number of small mammals observed captured by the landowner. Although predation is no doubt occurring (landowner, personal communication), it is not intense enough to effectively limit small mammal populations over the entire area. Eight cats may not be a sufficient number of cats to effectively hunt all the roadside ditches and other habitats in the cats' home ranges.

Shared parenting behavior has been shown to increase the intensity of hunting among communal female relatives (Macdonald and Apps 1978, Macdonald 1981). Cats at eight-cat farms may not hunt as intensively, because there are fewer litters of kittens born, and thus there is less pressure to hunt for small mammals to supplement the diets of lactating females and their kittens.

At eight-cat farms there may not be selective pressures to be a "super cat". A "super cat" is an individual that is an extremely efficient and constant predator on small mammals (Churcher and Lawton 1989). Less competition at the supplemental feeding station for available foods may decrease the aggressiveness of the cats (Macdonald 1981) at the eight-cat farms. The cats may become "lazy cats" and show a reluctancy to hunt. This reluctancy may have a genetic basis or may be transferred to their offspring as a learned behavior.

The age of a cat also affects the "laziness" of a cat (Tabor 1983). As old cats become lazy and young cats may not have mastered their hunting skills, a small cat population comprised of old cats and juvenile cats would have very little effect on the small mammal populations of an area. If only two or three cats are effective hunters at a farm, they may not limit the populations of small mammals in the area.

There should be less pressure for hunting areas at eight-cat farms than at eighteen-or-more-cat farms, because the cats should spread out and hunt in different areas to avoid conspecifics (Leyhausen 1965, Laundre 1977). Therefore, these areas should not be hunted as intensively, because fewer cats are hunting in the same areas.

In a small population of cats the ratio of females to males will not be as large (personal observation and Fig. 6). Males generally hunt less frequently on small mammals (Leyhausen 1979) than females. Therefore, if there are more males and fewer females in a population, then the amount of predation on small mammals exhibited by the cat population should be lower.

Small Mammals at Eighteen-or-More-Cat Farms

Small mammal relative abundance was significantly different ($P < 0.05$) between home and control sites at farms with eighteen or more cats. At the Go. home site, no small mammals were caught in four consecutive nights of trapping, while the Go. control site was not significantly different from other control sites. Although not as dramatic as the Go. home site, the Nu., Te., and Wh. home sites, all had extremely low numbers of small mammals, when compared with their respective control sites. Observations by landowners confirmed that their cats were actively hunting and capturing large numbers of small mammals, as cats often brought their catches to the house (landowner, personal communication). While checking traps at the home sites, cats were often observed hunting in or near the roadside ditch of the trapline. As home sites had a much lower number of small mammals than the control sites, the data suggest that cats were having a major effect on the small mammal populations within the cats' home ranges.

Eighteen or more cats may be a sufficient population to limit small mammal numbers in the home ranges of the cats. More cats hunting in close proximity to one another will reduce small mammals in an area. On several occasions, cats were observed hunting in close proximity to one another with apparently little aggression towards conspecifics that were closely related as suggested by Macdonald (1981).

Cats employ many different hunting strategies that are effective against certain species of small mammals. Cats will use sitting and waiting, mobile searching, stalking, pouncing, ambushing, and scent trailing strategies to capture species of small mammals (Leyhausen 1979, Tabor 1983). Cats may become specialists on certain species of prey (Tabor 1983). If there is a large cat population, then more hunting strategies for small mammals may be developed and used in a population. This increase in hunting strategies and specialization may help to increase the extent to which a cat population can limit small mammal populations.

The shared parenting concept should apply on farms with high numbers of cats. There will be a greater probability of several litters of kittens being produced on farms with large cat populations, because there is a larger proportion of females in large cat populations (Fig. 6). The relatives of a lactating female will actively hunt to supplement the lactating female's diet, as well as her kittens' diet. Shared parenting behavior should cause an increase in predation.

Individual cats are variable in their hunting behavior patterns. Much of the variability is a result of age, but it may be learned from the parent or genetically programmed in the individual (Panaman 1981, Churcher and Lawton 1987). Laundre (1977) suggests that in large populations of supplementally fed cats, selective pressures may be exerted upon individuals because of competition for food. The selective pressure for aggression at the supplemental feed trough may also increase the cats' aggressiveness and hunting tendencies. This selective pressure exerted on high cat populations may result in individuals that are more active and capable of becoming "super cats". The more cats there are in a population, the greater the probability of having some "super cats" in the population.

If the population does contain "super cats", then offspring of these cats could be genetically programmed or taught to be "super cats". Offspring will learn effective hunting methods and behaviors from their parents, and thus continue to heavily prey on small mammals of the area in the future.

Diversity and Evenness at Study Sites

As my study sites showed no significant differences ($P > 0.05$) in species diversity or species evenness for small mammals, data suggest that cats are not using certain species disproportionately. Rather, cats are probably preying on the most abundant small mammals of the area.

The most abundant small mammal species at my study sites was the deer mouse (Peromyscus maniculatus). Past studies have shown that deer mice are fire positive species, while other species have variable responses to burning (Reynolds 1980, McGee 1982, Kaufman et al. 1988). Therefore, I attribute the high abundance of deer mice and low abundance of other species to the effect of burning.

MANAGEMENT IMPLICATIONS

My study supports the findings of other studies that suggest that free-ranging domestic cats are a significant limiting factor on small mammal populations in rural areas. Although my study dealt with the unique homogeneous habitats and sparsely human-populated areas of the Flint Hills region of eastern Kansas, the results of my study can be applied to most rural areas of the United States. If applied to areas with increased human habitation and thus increased densities of cats, as found in most other rural areas of the United States, the ramifications of cats limiting and severely affecting small mammal populations should no doubt show an increase in magnitude. As cat densities increase and available habitats for small mammals decrease and become increasingly heterogeneous and fragmented, major declines in small mammal populations can be expected. This decrease in small mammals will reduce the forage base and predatory opportunities for threatened species of raptors and for all natural predators in general. This decrease in available forage could cause extreme competition among natural predators and upset the natural food webs and energy flow through ecosystems.

Although cat numbers are sometimes reduced by winter storms, diseases, natural predators, automobiles, and humans, the cat population continues to increase at an alarming rate. Parmalee (1953) suggests that sportsmen have been trying to control cat populations for years with a shoot-on-sight policy. According to Proulx (1988), the general public must be educated and made aware of the effect that free-ranging domestic cats are having on our natural systems. Some form of cat control is needed if we are to limit and control the impact of free-ranging domestic cats.

Wildlife agencies have been uninvolved in domestic feline issues (Beck 1974, Hall and Pelton 1979). State agencies, federal agencies, and private organizations, must begin to look at the problem of free-ranging domestic cats and develop ethical means of managing and controlling cat numbers. Cat owners concerned about the effect of their cats on wildlife populations, have tried different methods to decrease their cats' hunting activity and success. Concerned cat owners have tried negative reinforcement training, increased feeding, and the use of cat bells. However, these methods have proven unsuccessful (Paton 1991). Some ideas that should be considered are: mandatory birth control programs for cats, spaying and neutering programs, cat eradication programs, a limit to the number of cats that can be owned, and general cat owner education programs.

Funding for research is needed and should be made available for future studies on the effect of exotic predators, such as free-ranging domestic cats, on native prey populations. Future studies with larger sample sizes are needed to more accurately assess and quantify predation on wildlife by free-ranging domestic cats. Several questions brought up by my study should be further investigated. These questions include:

1. How many cats does it take to significantly effect small mammal populations in an area?
2. What role does genetics play in forming different levels of hunting and killing aggression in cats?
3. Will the offspring of non-predatory "lazy cats" show similar reluctancy to be good predators?
4. Will the offspring of "super cats" be extremely effective predators when they mature?
5. Is the level of predation exhibited by a cat dependent upon genetics, learning, environmental factors, social factors, or some combination of these?

If wildlife organizations continue to ignore free-ranging domestic cats, which are major exotic predators, ecosystems will continue to be thrown out of balance and problems will continue to arise. The problem of free-ranging domestic cats is real and should become a major priority of wildlife organizations in the immediate future. If given the proper consideration and management, the problems caused by free-ranging domestic cats can be reduced in the United States before they reach the disastrous epidemic proportions found today in many parts of the world.

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APPENDICIES

Appendix A. Legal land descriptions of study sites in Chase, Greenwood, and Lyon counties, Kansas.

Bu. control: NE 1/4 S 12, T 22S, R 8E, Chase, Co.

Bu. home: SW 1/4 S 18, T 22S, R 9E, Chase, Co.

Go. control: NW 1/4 S 3, T 23S, R 10E, Greenwood, Co.

Go. home: SE 1/4 S 11, T 23S, R 10E, Greenwood, Co.

Nu. control: SE 1/4 S 28, T 19S, R 9E, Chase, Co.

Nu. home: SE 1/4 S 26, T 19S, R 9E, Chase, Co.

Ro. control: SW 1/4 S 29, T 20S, R 10E, Lyon, Co.

Ro. home: S 1/2 S 27, T 20S, R 10E, Lyon, Co.

St. control: SE 1/4 S 7, T 22S, R 11E, Greenwood, Co.

St. home: SW 1/4 S 32, T 21S, R 11E, Lyon, Co.

Ta. control: W 1/2 S 19, T 22S, R 8E, Chase, Co.

Ta. home: S 1/2 S 7, T 22S, R 8E, Chase, Co.

Te. control: NW 1/4 S 27, T 23S, R 9E, Greenwood, Co.

Te. home: SW 1/4 S 35, T 23S, R 9E, Greenwood, Co.

Wh. control: NW 1/4 S 32, T 15S, R 11E, Lyon, Co.

Wh. home: SW 1/4 S 5, T 16S, R 11E, Lyon, Co.

Appendix B. Numbers and sexes of cats at individual home sites.

Study Site	Males	Females
Bu. site	3	5
Go. site	5	33
Nu. site	8	10
Ro. site	6	2
St. site	4	4
Ta. site	3	5
Te. site	8	10
Wh. site	5	15

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Signature of Major Advisor

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