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HOME RANGE, ACTIVITY PATTERNS AND RESOURCE UTILIZATION OF FREE-RANGING URBAN CATS, FELIS CATUS

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HOME RANGE, ACTIVITY PATTERNS AND RESOURCE UTILIZATION OF FREE-RANGING URBAN CATS, *FELIS CATUS*

by

CAROL HASPEL

A dissertation submitted to the Graduate Faculty in Biology in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York.

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Abstract

HOME RANGE, ACTIVITY PATTERNS AND RESOURCE UTILIZATION OF FREE-RANGING URBAN CATS, FELIS CATUS

by

CAROL HASPEL

Adviser: Professor Robert E. Calhoon

Home range, activity patterns and resource availability of free-ranging cats, Felis catus, were studied in two urban subhabitats (multiple-dwelling versus brownstone rowhouses), in three seasons (Fall, Spring, Fall), by gender and with regard to food supplementation. The area of multiple-dwellings had significantly more abandoned buildings and garbage than the brownstone area but supplementary food from humans occurred equally in both. Twenty-four percent of the residents admitted to feeding cats (2.82% daily, 20.9% occasionally). They collectively supplied the cats with an estimated 25 kg of food daily, enough to support 7.55 to 9.26 cats/ha. It is estimated that in New York City 205,860 people derive the benefits of pet ownership by being daily cat feeders. Sources of shelter, medical help and adoption were quantified. Mean cat population was significantly different in the two areas. Estimated mean population size in the multiple-dwelling area was 80.30, a density of 4.88 cats/ha, in the brownstone area 34.06, a density of 2.03 cats/ha. Neither season nor additional supplementary feeding had an effect on population size. Home range size of male cats was significantly greated than females (2.62 ha versus 1.77 ha). Females were found in the center of their range significantly more and showed significantly less variability in home range size than males. There was no significant difference in home range size with regard to neighborhood or season. Feeding cats did not result in a change in their home range size although cats tended to concentrate at feeding stations. Male activity was not dependent on neighborhood, nor did it change with season, however, it increased with additional supplementary feeding. Females in the multiple-dwelling area reduced their activity in spring and with supplementary feeding; females in the brownstone area behaved more like males. The difference in female activity by neighborhood is believed to reflect the difference between sexually intact and neutered individuals. Cat activity diminished in fall and increased in spring. Nightly cat activity continually increased from 2200 hours to a peak at sunrise, however, females, brownstone cats and cats receiving additional supplementary feeding curtailed their activity in the early morning.

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CHAPTER 1

INTRODUCTION

Historical Perspective

Since its domestication, approximately 5,000 years ago (Beadle, 1977; Robinson, 1980), the domestic cat has been a companion to people. Throughout this history, its status has repeatedly changed; it has been worshipped as a god and feared as a devil (Beadle, 1977). The cat has served as a friend and ally, but despite this close association with man, little is known of its ecology. Cats have been more often the subject of research in physiology, anatomy, genetics, or behavior, but rarely ecology. The ecological information that does exist is often anecdotal, recorded by pet owners and animal naturalists. Although this information is often accurate and astute, it lacks the authenticity of scientific research. This is not to suggest that there are no ecological data; there is just a paucity of it.

The work of Leyhausen (1979) stands out as a model of both experimental and field research. His work encompasses not only the domestic cat but the felids in general. Much of his effort has been directed at unraveling the mechanisms in hunting and feeding, courtship and mating, and aggression and defense. The works of Hubbs (1951), Davis (1957), George (1974), Jones (1977), Van Aardie (1978), Fitzgerald (1980), Davis & Prentice (1980), Liberg (1984) and Childs (1986) explored feeding ecology. Knappe (1959-1960) studied activity patterns; Dards (1978, 1981), Macdonald and Apps (1978), Liberg (1980), Tabor (1981), Warner (1985), and Apps (1986) home range; and Schneider and Vaida (1975), Oppenheimer (1980) and Brothers et al. (1985) demographic patterns. These researchers have begun to piece together a picture of the domestic cat's ecology, however, much more information is needed.

Very few habitats have been explored and usually these have been remote and rural areas. Jones (1977), Van Aardie (1978), Brothers et al. (1985) and Apps (1986) studied island populations; Davies & Prentice (1980) reported on cats in Queensland, Australia; while Davies (1957), George (1974), Macdonald and Apps (1978), Fitzgerald (1980), Liberg (1980, 1984) and Warner (1985) examined rural or farm cats. Thus, while some of the habitats were exotic, all of them had one thing in common, sparse human populations. Even though such habitats are comparatively remote, the data is relatively easy to collect and interpret. Although this is a valid consideration it has left significant gaps in our knowledge of the species.

Urban areas, with their dense human populations and elaborate man-made structures, are traditionally avoided by ecologists. For example, with the exception of some of

Leyhausen's (1979) work and that of Oppenheimer (1980), Dards (1978, 1981), Tabor (1981) and Childs (1986) nothing is known of the ecology of urban cats. Urban field studies can contribute information about the species and about the urban environment, and in so doing serve a dual purpose. The importance of studying urban species is well illustrated by the cat's role in the transmission of toxoplasmosis. Cats are known vectors of toxoplasmosis, a neurological disease, caused by the parasite *Toxoplasma gondii* and which is particularly dangerous to the human fetus as well as young children (Frenkel, 1974). Although the extent to which the cat is involved in the transmission of this disease is not yet known, Stagno et al. (1980) documented a case history which strongly suggested a link between a free-ranging pet cat and a group of seven children. They found, for an extended family in Dothan, Alabama, that 10 out of 30 people had seropositive titers for toxoplasmosis. This outbreak was confined largely to the preschool children. Of the 11 children, seven were seropositive and six had acute toxoplasmosis. After a thorough investigation of the eating and living habits of the family it was concluded that the family's seropositive pet cat was responsible for the outbreak of the disease. The cat and her kittens were allowed to defecate at random in the sandy front yard in which the children played. Spoons and other digging tools were among the children's toys; only the children who had a history of geophagia had evidence of the disease. The only inconclusive aspect of this investigation was a failure to recover the oocytes from the soil; the front yard and street in front of the house had been graded by bulldozers, in order to solve a drainage problem, before soil samples could be collected.

These findings are not reported here to suggest that all urban cats are carriers of toxoplasmosis or that cats pose a critical public health hazard. The benefits of pet ownership (Katcher & Beck, 1983) and perhaps even the benefits derived from being a feeder of stray cats may outweigh any public health risk. However, we need more information about the species with which so many people share their environment.

It is for the above reasons that an urban field study of free-ranging cats was undertaken. Increased knowledge of the species in the urban environment will also permit comparisons of how this species adapts to different habitats. In addition, this study evaluates the amount of and distribution of resources available to cats and the kinds and frequencies of interaction between cat and human populations. Specifically, I examined, by season, neighborhood and sex, home ranges, activity patterns and resource utilization and evaluated the effect that supplementary feeding by humans has on these behaviors.

Home Range Considerations

Home range, as defined by Burt (1943), is an area in which an animal conducts its daily activities; it excludes areas covered during occasional exploratory sallies. Many parameters influence a species home range but the habitat (its type and quality) is especially important (Brown 1962).

Habitat

The urban habitat is paradoxical; although it is, with its many buildings and passageways, structurally complex, it is not biologically complex. Many researchers report the urban environment to have an abundance of food and subsequently large population sizes (Orgain & Schein, 1953; Beck, 1973; Fox et al., 1975; Dards, 1978, 1981; Oppenheimer, 1980; Tabor, 1981; Childs, 1986) but limited species diversity (Lancaster and Rees, 1979).

Lancaster and Rees (1979) compared species diversity of birds along a gradient of urbanization in Vancouver, B.C., and found an inverse relationship between species diversity and urbanization. They reported that the few cavity-nesting, ground-feeding granivorous or omnivorous species were favored and had large population sizes. They estimated that there was a surplus of food with the sources being garbage, handouts, and grain spillage.

Other researchers, working in different habitats, have also examined food as an environmental parameter and the effects it has on home range. Miller & Getz (1977) in their study of population dynamics of Peromyscus and Clethrionomys in New England suggested that there was an inverse relationship between food availability and home range size. Mares et al. (1976, 1982) demonstrated for Tamias striatus (Eastern Chipmunk) that home range size changed inversely with food abundance. However Van Orsdol et al. (1985) found for lions that home range size was correlated to food availability only during periods of food scarcity.

Another quality of the environment recently investigated is heterogeneity. Bowers & Smith (1979) studying Peromyscus maniculatus in three xeric communities, each with different distributions of water, found sexual differences in home range size, as well as body weight to be positively correlated with the distribution of water.

Availability of water also affects the home range of the African lion. Schaller (1972) found that lions on the plains have to shift their home range in the dry seasons while forest dwelling prides do not.

Season

For many species, home range changes with seasons. Migratory and grazing animals shift their ranges seasonally and sometimes predators make a corresponding shift (Schaller, 1972). Mundinger (1975) studying Carpodacus mexicanus (House Finch), from Manhattan to Milford, Connecticut, found that the birds migrate as far south as Philadelphia in winter but return to their "home areas" to breed.

Severe weather can create food scarcity which may result in home range enlargement. George (1974) found extensions in home range of three dependent-farm cats in fall and winter.

Sex

Gender influences home range in many species. Much of the literature reports sexual differences in home range size, with males most often having the larger range (Brown, 1962). Explanations such as the seeking of receptive females (Dards, 1978) and body size (McNab, 1963; Harestad & Bunnell, 1979) are suggested, but the work of Bowers & Smith (1979), as described above, shows the heterogeneity of the environment also to be a possible explanation. Ghigleri (1985) suggested that sexual differences in home range size in Chimpanzees is a reproductive strategy in a species in which females raise the young exclusively.

Published Estimates of Cat Home Range

The home range of Felis catus has been studied formally and informally. Hubbs (1951) while studying the food habits of feral cats in the Sacramento Valley, California, found a cat density of one in 8 hectares. George (1974), also studying the food habits of cats, found that for a population of three, dependent, farm cats in rural Illinois the combined range included selected spots within 7.1 hectares of fields and 1.25 hectares of woods, plus smaller extensions into five adjoining fields in fall and winter. In a continuation of this study George (1978) increased the number of cats to seven (although never more than six at a time) and found that the cats roamed over only 8.9 hectares. All the cats were neutered and no sex differences in home range were reported. Macdonald and Apps (1978) while studying social behavior of semi-dependent farm cats found male cats to range over 60 hectares while females used between 2 and 7 hectares.

Liberg (1980), Tabor (1981), Dards (1978, 1981), Brothers et al. (1985), Warner (1985) and Apps (1986) specifically studied home range behavior in cats. Liberg (1980) examined rural cats in Sweden and found very large home ranges. The males had home ranges 2 to 4 kilometers across, while the females had ranges of 30-40 hectares. Warner (1985) examined rural cats in Illinois and found males ranged over 228 ± 100 hectares and females 112 ± 21 hectares. Apps (1986) studying cats on Dassen Island found that males had a home range of 41 hectares and females 19 hectares; while Brothers et al. (1985) found a male cat on Macquire Island to have a home range of 44 hectares.

Dards (1978) working in a commercial urban environment, Portsmouth Dockyard, Hampshire, England, found a mean home range size for males of 8.4 hecatares and 0.84 hectares for females. Although Dards' work was done in an urban setting it was non-residential.

Liberg (1980), Tabor (1981) and Dards (1978, 1981) all observed that females were more likely to live in groups and to wander only slightly from the core region of their range, while males wandered singly and much more broadly, periodically visiting various groups of females. What accounted for these reported sexual differences was not explored.

From the above results, one might conclude that although the rural environment generally fosters larger home ranges than does the urban environment, feeding a cat (i.e. such as George's, 1974, pet cats) modifies the environmental effect. A reduction in home range size in cats which are fed was also expressed by Davis (1957). He suggested the use of food supplements as a buffer to prevent cats from straying from the farm during seasons of prey scarcity.

Availability of Garbage and its Effect on Cat Home Range

As is true of all habitats, the urban environment has unique characteristics. One such characteristic is the continuous availability of garbage. Urban researchers have documented that urban species will consume garbage (Jackson, 1951; Beck, 1973; Fox et al., 1975; Dards, 1978, 1981; Lancaster and Rees, 1979; Childs, 1986), but except for Orgain & Schein (1953) and Schein & Orgain (1953) no one has quantified the nutritional impact of garbage on a species.

Orgain and Schein (1953) and Schein and Orgain (1953) explored the physical environment of the urban rat and found that both harborage and food, in the form of garbage, were in excess for the Norway rat. They found 150 grams of garbage per rat per day in their study area and that this was enough to supply each rat with one and a half times its basic food requirement. Rats fed on the garbage thrived, preferring bread and meat leftovers. These studies were designed to explore population sizes; the results indicated that not only was availability important, but also the distribution of garbage was important in controlling population size. When 40% of rats using the feeding stations were removed, it took only two weeks for the population to rebound, suggesting that inferior members of the population had not had access to the feeding stations, which they now utilized. Populations size was limited by limiting distribution of the available garbage.

Lancaster and Rees (1975), as described earlier, found a direct relationship between bird population size and availability of garbage, human hand-outs, and grain spillage. Oppenheimer (1980) found a positive correlation between free-ranging cat population sizes in Baltimore and the percentage of rental dwellings. She concluded that tenants were less orderly in discarding their garbage than home owners and that high cat population size corresponded to garbage availability. Jackson (1951) found, for a population of cats in Baltimore, that only 6.7% of the fecal scats were composed of rodent remains and that the remainder was made up of garbage-like material. Childs (1986) reported that cats eat only a small portion of the rats they catch, he suggested garbage as their primary source of food. Beck (1973), in his study of free-living urban dogs in Baltimore, found garbage accumulation to be associated with increased activity. Dogs were observed to tip over garbage cans and rip open paper and plastic garbage bags.

Miller & Getz (1977) and Mares et al. (1976, 1982) suggested that there is an inverse relationship between home range size and availability of food. The reduction in home range size when a cat is fed, as well as the small home range size of urban cats as compared to rural cats, both suggest this relationship. However, other than the study of Beck and Marden (1977), who studied humans, the author knows of no study which specifically examines the affect of garbage availability on the home range of an urban species and specifically none with regard to free-ranging cats. It was an aim of this study to examine the availability of garbage, a clearly defined food source in the urban environment, and its effect on the home range of the domestic cat.

Availability of Supplementary Feeding by Humans and its Effect on Cat Home Range

In addition to garbage as a food source, urban animals sometimes receive food supplementation from human benefactors. It is not uncommon to see people feeding pigeons or leaving food out for "stray" cats. Tabor (1981) and Dards (1981) both suggested that food supplementation maybe the primary food source for free-ranging urban cats in England. However, I know of no study where the impact of such feeding on the home range of an urban species has been studied. One of the primary purposes of this study is to examine the effects of supplementary feeding on the home range and activity patterns of free-ranging cats particularly with regard to differences in sex, season and neighborhood. In addition, this study sought to quantify the amount, type, frequency and distribution of the food supplementation urban cats receive.

Activity Patterns

Activity varies both on a circadian and seasonal basis and is influenced by many factors such as: sex (Knappe, 1959-60; Brown, 1962), habitat (Brown, 1962; Schaller, 1972; Van Dyke, 1986), population size (Calhoun, 1962; Hickman, 1980), age (Knappe, 1959-60; Ringelman and Flake, 1980), ambient temperature (Gosling et al., 1980), hour of day (Robitaille and Jacques, 1976; Brown, 1962), social factors (Regal and Connolly, 1980) and food availability (Schaller, 1972; Beck, 1973; Zielinski et al., 1983).

Brown (1962) stated that most small mammals show peak activity associated with sunrise and sunset, and briefly reviewed the literature on small mammal activity.

The hourly aspect of cat activity was investigated by Knappe (1959-60). He studied more than 100 house cats in four years found that age and time of day affect the amount of activity. Kittens, 3 to 7 weeks of age, were most active in the daytime at 0700, 1100, 1500, and 1900 hours. This schedule seemed to be related to feeding arousal, however by 2 months of age spontaneous activity occurred at sunrise, 0315-0630 hours, and was not related to eating.

Kunz and Todd (1978) while measuring daytime observability of a population of cats in Athens, Greece, found lowest observability between 1030 and 1330 hours and after 1830 hours. The low observability in late evening they attributed to decreased visibility near sunset. The midday low observability they correlated to increased human activity. Fox et al. (1975) found for a group of feral urban dogs in St. Louis that they emerged from their sleeping quarters around 2315 to 2400 hours and remained active until 0630 hours and then retired for the day. Free-living dogs were seen during the day, the feral dogs were not; the author suggested that this schedule allowed the feral dogs to avoid human contact.

Studying free-living urban dogs in Baltimore, Beck (1973) found activity in summer to be highest from 0500 to 0800 hours and 1900 to 2200 hours and to be inversely correlated with temperature. He believed the crepuscular activity pattern for free-living pets was related to the hour before and after the owner's work schedule, while that of truly feral dogs was related to sunrise and sunset.

Winter activity had similar peaks, however, the dogs remained active until 1130 instead of 0900 hours. Severe cold lessened street activity but snow on the ground did not.

Beck (1973) also observed that food availability shifted activity. Dog activity increased on evenings prior to garbage collection, a time of food abundance. In 1977 Beck and Marden examined the activity patterns of human "street dwellers" and found that garbage availability affected activity patterns. Street dwellers increased their foraging time the day after garbage collection, a time of relative food scarcity, instead of increasing their home range size.

Schaller (1972) in his study of African lions found changes in activity patterns with habitat. Plains lions, where cover was slight, hunted mostly at night, while forest dwelling lions hunted often in daytime, particularly in the dry season. Seasonal shifts in activity he related to availability of prey. In dry season, prey congregated near water holes and lions shifted hunting hours into daytime hours to take advantage of the congregations of prey. He also found peak activity to be after 1700 and before 0800 hours, although the lions readily hunted, fed or mated at all times of the day. At dusk they exhibited a brief, local flurry of activity, mostly involving grooming and eliminating but they did not disperse until before 2200 hours. The lions roamed most before 2200 hours and toward sunrise. Peak eating occurred after dark and before dawn.

As other aspects of an urban species ecology, activity patterns have rarely been studied (Beck, 1973; Fox et al. 1975; Kunz and Todd, 1978). In addition, despite the acknowledged importance of food in regulating activity patterns, I know of no study, other than Beck and Marden (1977), in which the activity patterns of an urban species have been studied with regard to garbage availability or food supplementation by humans. Both of these variables were examined in this study with specific regard to the free-ranging cats' activity patterns. One aim of this study was to explore the activity patterns of the urban cat with regard to season, sex and neighborhood and to evaluate the effects of garbage availability and supplementary feeding on these patterns.

Research Overview

To excute my plan a study was designed in three parts. Parts one and two were designed to explore home range and activity patterns respectively while part three explored resource availability and utilization.

The experimental design was based on the results of a one year pilot study. It entailed the trapping and tagging of cats in two adjoining neighborhoods in Brooklyn, New York and the subsequent surveying of the population. In conjunction with the field work a telephone survey was conducted to evaluate the impact of the human population on the cats' ecology.

The results of this research are reported here in an order that permits the clearest explanation of the findings; it does not reflect the order in which the work was conducted.

CHAPTER 2

BENEFITS FOR ALL, THE HUMAN COMPONENT IN THE ECOLOGY OF URBAN CATS

The results of an ecological study of an urban species can not be interpreted properly unless one also examines the availabilibity and distribution of resources provided either directly or indirectly by the human inhabitants. In addition to natural sources of food and shelter, the urban environment offers large quantities of food in garbage and feedings provided by humans and many man-made sources of shelter. A telephone survey was conducted within the study area, in order to evaluate people's habits and attitudes with regard to free-ranging cats. This chapter reports the results of that survey.

Methods

A study area of 33.19 hectares was established in the Prospect Heights section of Brooklyn, New York. The shape and the size of the study area were determined after a one year pilot study conducted in the area. The purpose was to define an area of high cat density and yet have two distinguishable regions through which the cats could move freely. This was accomplished in the area depicted in Fig.1. The major difference between the two regions (sectors) was the type of housing that existed there. Sector

A contained multiple dwellings while sector B consisted predominantly of brownstone row houses, Table 1.

A telephone survey was selected as the means of contacting residents in the study area; mail surveys have low respsonse rates and door-to-door was not appropriate to the area or to the availability of time. A sample population of 400 was selected at random, without regard to sector, from a telephone directory that was ordered by address. Every telephone listed within the study area was assigned a number and a random number table was used to select the subjects to be used in the survey. The selection process was continued until 400 numbers were selected (not including repetitions). The author contacted the residents via the telephone and requested their participation. The survey was not considered complete until all telephone numbers on the list had been contacted. The survey was conducted between July and December 1983.

Of the 400 households in the sample 270 had active working telephones, 177 or 66%, of these households agreed to participate in the survey. The 130 who were not reached had their telephones either disconnected or their telephone number had been reassigned outside the study area.

The telephone directory listed 1129 different phone numbers (assumed households) in the study area, however, the 1980 census information indicated 2563 households within the study area. The source of our sample was limited to those people who had a listed telephone and thus represents, at most, only 44% of the households. Thus, the sample for our survey must be thought of as representing a specific subset of the population, that portion of the population that had listed telephones. Maintaining an unlisted telephone number is often recommended for individuals who might be considered more vunerable to crime, i.e. single individuals, females or elderly. Thus our sampling procedure, by the necessity of its design, omittted a segment of the population and so the results reported here can be made with inference only to the population studied.

The questionnaire was designed in two phases. The first phase was a pilot survey. Fifty residents were randomly selected from an adjoining area and were called and requested to participate in the survey. The purpose of this procedure was to establish an appropriate protocol in addressing the residents as well as to test the appropriateness of the questions particularly with regard to wording, choices of response and scope. From this pilot questionnaire the final form of the questionnaire was constructed, a copy of which is provided in Appendix A. The desire to gather information in four main areas guided the construction of the questionnaire. These four areas were: type, quantity and frequency of resources the humans provide for the cats;

profile of the human feeder; attitudes of the humans towards the cats; and the importance of the cats to the humans. Fifty-five different variables were considered and apriori contrasts were analyzed using the log-likelihood ratio test which is Chi-square distributed. Statistics which are significant at the 5% level of significance are followed by an asterisk (*) and those at the 1% level by two asterisks (**). Sample size is denoted by "N=".

Results

Resources provided by the human population

Of the 177 respondents, 42 said they fed cats and five (2.82%) reported they did so daily. Collectively the five daily feeders reported supplying approximately 1.471 kilograms of cat food plus table scraps per day. The 177 respondents represented only 6.9% of the number of households in the study area, extrapolation to the entire population suggests that there are approximately 72 daily cat feeders within the study area and that they provide a total of 21.30 kilograms of food or 1.145 kilograms food per hectare per day. Fitzgerald (1980) found that cats can be maintained on as little as 150-170 grams of food per day. Pet food companies recommend one small can of cat food, 184 grams, per day for pet cats. Based on these values, there is enough food within the study area to maintain at least 6.22 to 7.63 cats per hectare from the food supplied by daily feeders alone, Tables 2 & 3.

Thirty-seven (20.9%) households reported that they were occasional feeders and 12 of these said they fed stray cats at least once a week. If we assume that this percentage holds true for the entire 2563 households in the study area there are 535 occasional feeders in the study area of whom 174 are expected to feed at least once a week (usually a small can or table scraps). Stated another way, 9.33 feeders per hectare feed at least once a week. Thus if they feed on different days they are providing for at least 1.33-1.63 cats per hectare (Tables 2 & 3).

The study area enclosed 29 block faces, if the 72 estimated daily feeders were uniformly distributed throughout one could expect to find a mean of 2.5 daily feeders per block face. However, among respondents more daily feeders appeared to live in sector B than sector A. Four of the five daily feeders were from sector B and one from sector A. This small sample size made it impossible to test the null-hypothesis that daily feeders were distributed without regard to sector. An analysis of all feeders versus non-feeders with regard to sector showed no significant difference, suggesting feeders were no more likely to live in a particular sector than non-feeders were. In addition the author has personal knowledge of ten additional daily feeders who were not part of the survey sample but live in the study area. Of these ten, four lived in sector A and six in sector B. Thus food handouts are as likely to occur in one sector as in the other.

Shelter, medical help and adoption were also considered to be resources which could be provided by humans (Table 3). Nine of the occassional and four of the daily feeders stated that they provided shelter for stray cats, 7.34% of the sample. If this figure holds true for the entire population, the cats have 188.2 sources of shelter within the study area, or 6.49 per block face. Types of shelter provided varied. Three of the five daily feeders stated they provided handmade shelters, but shelter could be provided by just putting a box out or admitting the cat to a basement, lobby or one's own home. Of the ten daily feeders personally known by the author, eight provided shelter to the cats, and three had constructed elaborate handmade structures. These shelters were all built to stand above ground, to have roofs and walls and were lined with carpeting or soft fabric.

Twenty-one (11.9%) of the respondents claimed they had at some time provided medical help to stray cats, and 28 (15.8%) said they had adopted a stray from the street. Assuming those that had previously helped would do so again, there are 304 sources of medical help and 405 sources of adoption within the study area. Stated by block face there are potentially an average of 10.48 medical and 13.98 adoptive sources per block face (Table 4).

Profile of the feeder

A distinction should be made between an occasional feeder and a daily feeder. An occasional feeder is a person who is not committed to a daily routine of feeding cats; this may be a person who feeds as infrequently as a few times a year or one who feeds more then once a week. A daily feeder makes a considerable commitment in time, money and awareness. Only five people in our sample admitted to being daily feeders and this was too small a sample to make statistical inferences, however, any trends noted in this group could be compared to the behavior of the other ten known daily feeders. In addition, the whole sample of respondents could be tested for differences between feeders versus non-feeders (Table 5). Thus the approach to the analysis of these data was to look for trends among the five daily feeders, confirm or reject these by examining the other known daily feeders and then see if these trends also hold true for all feeders. Two such trends seemed apparent.

The first trend suggested that daily feeders were more likely to live in sector B than sector A. As stated above, four of the daily feeders were from sector B and one was from sector A. If this difference is real then a different sample of known feeders would probably exhibit the same or a similar difference. However, when the group of 10 additional daily feeders were separated by sector the sector difference seemed to disappear, six were from sector B and four from sector A. No disparity was noted for occasional feeders (21 in sector A and 16 in B), who appeared to be equally divided between sectors. Thus feeders appear to be as likely to live in one sector as the other.

Another result that seemed to indicate a trend among daily feeders was that four of the daily feeders were female and one was male. In this case, review of the group of known feeders did seem to support the hypothesis that females were more likely to be daily feeders. Eight of the other ten known daily feeders were female. Ocasional feeders did not show the same disparity, 17 were male and 20 female.

Defining the characteristics of a daily feeder seems more difficult than generally thought. Women appear to be more likely to be daily feeders than men, but this result is not conclusive. Further there is a significant relationship between providing other services, such as shelter, and feeding cats G=53.83** (1 d.f.), Table 5. Thus one might conclude that women are most likely to provide cats with other services they receive. However, there seems an exception for when asked if they had ever provided medical help to a sick stray cat men answered yes significantly more so than women, G=3.99* (1 d.f.).

Although there was no clear difference in feeding frequency by sector, the probability of providing shelter for cats was significantly greater among homeowners (sector B), than tenants (sector A), G=6.27* (1 d.f.).

A person's decision to feed cats seems to be independent of the sector she lives in and the attitudes of her neighbors. Sector B (brownstone) residents felt significantly less favorably about their neighbors feeding stray cats than those of sector A, G=7.70* (2 d.f.), but the frequency of feeding was not significantly different in the two sectors, Table 5.

Having previously owned a pet was significantly related to being a cat feeder, G=5.17* (1 d.f.), although currently being a cat or dog owner did not significantly predispose a person to feeding. Feeders of other urban wildlife such as birds, G=11.36** (1 d.f.), squirrels, G=6.01* (1 d.f.), and dogs, G=25.69** (1 d.f.), were also more likely to feed cats than non-feeders.

Race was not fouund to a determining factor in characterizing a feeder (Table 5) except in attitudes toward feeding (Table 6).

Many characteristics of the daily cat feeder were revealed by this study. The daily feeder is more likely to be a female and to have had a pet at some time in her life. She is more likely to be a feeder of other free-ranging urban animals such as squirrels, birds or dogs than the general public and will feed regardless of where she lives or the attitudes of her neighbors. Feeders are also more likely to provide other additional services such as shelter, in particular homeowning feeders are the most likely to provide shelter, Table 5. Occasional feeders are as likely to be male as female, and males are more likely to provide medical aid to a sick stray cat.

<u>Attitude of People toward the cat population</u>

It is valuable in describing the resources and environment of the urban cat also to describe human attitudes toward the street cat (Table 6), for this gives us a broader understanding of the components that go into making a particular environment conducive to their existence. Respondents were asked what they felt was true of stray cats and were allowed to select from a list of answers the responses with which they agreed. Thirty-seven percent of the sample expressed favorable responses, 35.90% ambivalent and 12.18% neutral opinions. Only 14.5% of the sample had unfavorable replies. When asked how they would feel if their neighbor fed stray cats, 39% replied they would be happy about it, 50% didn't care and 11% replied they would not like it. Of the attitudinal questions asked, at most only 14.5% of the sample had unfavorable responses indicating a fairly broad tolerance towards the presence and care of street cats. The question of how they would feel if their neighbor fed stray cats produced significantly different responses between persons who classify themselves "white" and all other races, people in sectors A and B, and tenants versus homeowners. Non-white people living in sector A (multiple dwellings), and people who were tenants expressed significantly more tolerant views towards cats being fed than their counterparts (Table 6). In view of these results one might expect to find more feeders in sector A then sector B. This, however is not the case; feeders will feed regardless of the attitude of their neighbors.

The questionnaire did not gather information about which floor the respondent lived on. In a six-story multiple dwelling, the third floor is the median floor. The brownstone houses in sector A were four and five story structures, however, in these structures it is customary for the bedrooms to be located above the parlour floor, usually on the third floor. Thus noise from cats would have been equally disturbing in both sectors.

Understanding the attitudes of the people in a neighborhood may give information about their tolerance towards stray cats but it is not necessarily indicative of how they will behave themselves. The interrelationship of an attitude and a behavior is a very difficult thing to describe. Attitudes are only one component of a behavior and at that are very situation specific, i.e. although one may express a certain attitude under one set of circumstances, given another situation, one may respond differently. Thus it is no surprise to find that among cat feeders only 40% responded favorably when given a list of choices of what they felt was true of cats. In fact there was no significant relationship between the cat feeders attitude toward stray cats and whether or not they fed cats, yet cat feeders did respond more favorably then the population as a whole. Clearly, there is more to being a feeder then one's professed attitudes.

Importance of the cat in the life of the feeder

Evaluating the importance of the street cat to the feeder is important because it gives us some idea about the reliability of this food source. Three out of five daily feeders name the individual cats, and two of the five continue to feed the cats although they feel it is too expensive for them to do so. Two out of the five will not leave the cats unattended but will find surrogate feeders when they have to be away and one daily feeder considers the cats in making social plans. For the daily feeder the cats have identities and the cat's needs are considered even when in conflict with the feeder's income or schedule.

If the feeders only reasons for feeding are purely altruistic and the feeder does not benefit in any way, food supplements might only be provided sporadically. In fact, one might speculate that occassional feeders fall into this category, but for daily feeders it appears, from these results, that there must be some emotional reward for their diligence.

Discussion

The distribution of cats within the study area is not uniform. Significantly more cats are seen per hour in sector A (multiple dwellings), than in sector B (brownstones) (Table 7). Contingency analysis of human feeding, however, does not reveal any differences in the distribution of human feeders. Clearly the supplementary food provided by humans is not the determining factor. Although cat feeders do produce sites for concentrations of cats, the cat's sectorwise distribution pattern had to be related to some other factor than the supplementary food offered by humans. One such factor might be the greater tolerance sector A residence have toward the maintenance of stray cats.

The estimates of food and other resources offered by humans is a minimum estimate. It must be remembered that the sample of respondents was drawn from people in the study area with listed telephone numbers. Since the daily feeder is probably more likely to be a female and females often have unlisted phone numbers, the results probably significantly underestimate the true values. Of the ten feeders personally known to the author not one appeared in the sample, and of the three for which the author had telephone numbers, all were unlisted.

Nevertheless, the quantity of food offered by human feeders is large. By these estimates the feeders are supplying enough food to support at least 7.55 to 9.26 cats per hectare, Table 3, and even if this were the only food available to the cats, such a density is high when compared to values gathered for cats living in other environments. Hubbs (1951) found 1 cat for every 8 hectares in the Sacramento Valley, California, while other researchers report even lower densities (Liberg, 1980; Warner et al., 1985).

The dispersion pattern of the cats which are maintained by human feeders is usually localized near the feeders' residences. This is not only because the food is there but because the feeder is also more likely to provide water, shelter and medical help. The cats which become part of a feeder's colony can not really be considered completely feral but, in fact, they are treated much more like pets. Daily feeders assume many of the same responsibilities and relationships to their street cats as a person might to a pet cat. For whatever reason, the feeder does not take the cat or cats into her home, and there may be many. The net effect is that these cats appear to be regarded as pets. Pets have a positive influence on human physiology. Stroking an animal has been shown to reduce blood pressure (Katcher, 1981). Pet visitation programs in hospitals and homes for the aged have been shown to enhance the "emotional climate" and to have a positive recreational value (Beck and Katcher, 1984). No doubt cat feeders are motivated in part by concern for the animals, however, daily feeders are doing more then saving a starving animal. The cats they maintain are well fed (Childs, 1986) and well sheltered. Cats have historically been valued for many attributes, from gods to protectors of the grain. Perhaps an additional value should be accorded to stray cats. If 2.82% of the population throughout the entire city are daily cat feeders then stray cats are providing 205,860 people in our city with the benefits and value of "pet" ownership, an attribute of substantial value.

CHAPTER 3

ABUNDANCE AMIDST ABUNDANCE

The urban environment is a charitable environment to the free-ranging cat; resources are plentiful. Urban cat population size, as that of other species, reflects the conditions prevailing within the cat's habitat, but population size may also indicate other factors as well. Population size may change with time, it may correspond to physiological or environmental periodicity or may reflect the health of the population. Interpopulation differences may reflect the different carrying capacities of the subhabitats. In general, population estimates are a necessary part of any ecological study and aid in interpreting ecological information. I studied home range, activity and supplementary feeding of the urban cat. However, to adequately understand changes in these behaviors and the effects of feeding it was necessary to know whether or not the populations size was stable and how population size varied in different parts of the habitat. Therefore, estimates of the cat population were undertaken. The purpose of these estimates were to compare the effects of season, subhabitat (sector) and supplementary feeding on cat population size.

METHODS

The estimation method used is a modified version of the triple-catch mark-recapture method outlined in Tanner (1978) and developed by Jolly (1965) and Seber (1965) separately. This is a modification of the Lincoln-Petersen Index based on trapping and marking a subset of the population. These individuals are released back into the population and allowed to mix freely. Retrapping, if done randomly, recovers only part of the population from which one can establish a ratio of the number of marked recaptured to total number captured. This ratio is assumed to reflect the proportion of marked individuals to the population as a whole and so permits a population estimate. In the triple-catch method, two recapturing events are employed and each individual is marked as first time captured or previously captured. The triple-catch method was used since it does not require a closed population, and its two basic assumptions, being able to recognize previously marked individuals and that capture is random with respect to marked and unmarked individuals, were met. The population model is stochastic and the calculations do not depend upon the capture being made at regular intervals.

Cats for marking were captured alive using Havahart traps, Fig. 3, (Haspel and Whitman, 1981). Cats were trapped and marked for thirty days prior to each of the three sampling seasons of this study. Marking was accomplished through the use of individualized color coded collars fashioned out of hospital identification bracelets, see Methods Chapters 4 and 5.

Recapture did not involve retrapping, instead the study area was patrolled nightly and all cat sightings recorded. Sighting a collared cat was considered a recapture. Sighting data as a recapture technique for cats was suggested by Liberg (1982). Data were pooled for three nights of sightings. The reason for this procedure was that the hours from 2200 to 0700 hours, the cat's most active period (see pilot, Appendix B), were considered the sampling period during this study, however, only three consecutive hours per night were examined. Thus it took three nights to complete one repetition; patrols were conducted separately in each sector. Ten such repetitions were completed each season but only the first two are used for this analysis (two recaptures were necessary). On any night, a specific cat might be seen more than once, thus each recapture patrol produced values for total marked cats recaptured, number of unique marked cats, number of total unmarked cats and number of total cats (marked plus unmarked). To derive an estimate of the number of unique unmarked cats seen during each patrol it was assumed that the ratio of unique marked cats to total marked cats would be the same for unmarked cats as well; this method was suggested by Dr. Robert Calhoon.

The population was observed during Fall 1981, Spring 1982 and Fall 1982; population estimates were made separately for each season. Fall 1981 and Spring 1982 were seasons in which baseline estimates were gathered. Fall 1982 was the experimental season in which supplementary food was provided for one portion of the population. The study area encompassed two distinct areas. Sector A was composed predominantly of multiple dwellings and had significantly poorer garbage containment than sector B, an area composed mostly of privately owned brownstone rowhouses, Table 1. Three feeding stations were established in Sector A and each was provided nightly with food, Fig.1. Enough food was provided to maintain a minimum of 12 cats and possibly as many as 30; see methods section of Chapter 4 for more details. Population sizes for sectors A and B were calculated separately. The purpose of this portion of the study was to determine the effects of food supplementation on the cat population.

Population estimates of the three seasons were compared. Comparison of the two unperturbed seasons, i.e. Fall 1981 and Spring 1982, permitted evaluation of the population's stability; while comparison between the two falls permitted an evaluation of the effect of food supplementation and comparison between the two sectors permitted an evaluation with regard to subhabitats. Log-likelihood ratio tests were used for all comparisons.

Results

The results of our calculations are presented in Table 7, population sizes are reported with 95% confidence intervals. Mean population size for sector A was estimated to be 80.30 ± 13.54 and for sector B, 34.06 ± 3.30. Comparison of the mean population size of sectors A and B revealed sector A to have a significantly larger population than Sector B, G=37.38** (1 df). Sector A was 16.44 hectares and so there was an average density of 4.88 ± 0.824 cats per hectare (1.98 ± 0.33 cats per acre). Sector B was 16.75 hectares and supported an average of 2.03 ± 0.197 cats per hectare (0.82 ± 0.08 cats per acre). Seasonal differences were not found (95% confidence intervals over lapped). Comparison of population size by season was not necessary since no significant differences in population size by season were found.

A precise estimate of the number of pets and maintained strays deliberately decollared is not known, however, 73.6% of all collared cats were recaptured by the end of Fall 1982, a rate which compares favorably with other studies for loss of tagged individuals (Mares, 1981). In addition, the triple-catch mark-recapture method is the preferred method to make population estimates when removal of individuals is expected (Tanner, 1978).

DISCUSSION

The urban environment is a resource-rich habitat. The results suggest that the cat population in the study area is stable and that the environment has a considerable carrying capacity. Differences in population size of the two sectors reflect differences in resource availability in these two areas but even the relatively resource poor area, sector B, supports a population which is as large as other known urban cat populations. Reports of urban cat densities by Dards (1981) in Portsmouth Dockyard, England, indicated two cats per hectare while that of Oppenheimer (1980) in Baltimore indicated a range of 1.51 to 7.43 cats per hectare, depending on which neighborhood she examined. Rural estimates were much lower; Van Aarde (1978) found 0.35 cats per hectare for cats on Marion Island, while Hubbs (1951) found 0.12 cats per hectare in the rural Sacramento Valley, Warner (1985) in rural Illinois found 0.063 cats per hectare and Liberg (1980) found 0.025 to 0.033 cats per hectare.

Garbage availability in sector B, the brownstone sector, is relatively low when compared to the multiple dwelling sector, Table 8. Refuse cans are always tightly lidded and the streets are clean. Harborage is also very limited, the buildings are well maintained. Although opportunistic resources are limited, cat density figures are average; food and shelter are coming from another source. The source is the human population. Cats in sector B must be maintained either as free-ranging pets or maintained strays.

The author conducted a telephone survey of the human residents within the study area in conjunction with this project (see Chapter 2). Two hundred and seventy residents were contacted and 177 agreed to participate. Five residents, 2.82%, admitted to feeding cats daily, four were from sector B, the brownstone sector. Sector B residents, homeowners mostly, were significantly more likely to provide shelter to cats than those of Sector A. On the average the five daily feeders provided the cats with 1.471 kilograms of food daily and four of the five said they also provided shelter. It appears that sector B supports a smaller population than sector A because it is more limited in its conventional urban resources, but it can still support an average population because of the human contributions which are so highly concentrated in the urban environment. Dards (1981) and Tabor (1981) both reported that supplementary feeding by humans was the primary factor accounting for the high population sizes of the cat population in urban England. The carrying capacity of an urban environment is determined by more than the conventional sources of foraging and hunting; human intervention, particularly in well-maintained areas, is a controlling factor.

The absence of population increase in Fall 1982 suggests that food alone is not the limiting factor in the multiple dwelling area, sector A. However, food appears to affect the population's distribution. Observations of cats in all three feeding stations increased over the previous fall until the superintendent at Station 1 boarded up all the broken windows and doors of his building. From then on, cat sightings at Station 1 dropped to its previous rate while those at the other stations remained high, (Fig.2). Although food continued to be available, cat utilization of the station did not remain high in the absence of shelter. Although food has an obvious effect on carrying capacity of an environment, in an urban environment increasing food alone without a corresponding increase in shelter may not be enough to bring about a population change.

The results of these analyses indicate that there is a large cat population in this study area, yet despite these high values the results probably still significantly underestimate the true population size. Mares (1981) compared three commonly used mark-recapture techniques and found he did not get relatively accurate and precise estimates of a known population of Eastern Chipmunks, <u>Tamias striatus</u>, until at least 75% of the animals had been recaptured. The estimates were either significantly too small or confidence intervals were too large. To determine population estimates in accordance with the Triple-catch Mark-recapture technique, values for two sampling repetitions were used but by the second recapture period only 66.6%, 35.8% and 70.1% respectively of the estimated populations had been recaptured in each of the three seasons. These low percentages of recapture probably account for my large confidence intervals. Although the large confidence intervals make subtle differences in population change hard to detect, and so may have masked population increases in Fall 1982, they are necessary to insure "acceptable concordance between the estimate and the actual population size",(Mares,1981).

CHAPTER 4

HOME RANGE - THE PROSPEROUS SEX

Feral populations are derived from populations of domesticated animals which have returned to a free-ranging existence. In the urban environment, the feral mammal most commonly encountered are dogs, *Canis familaris*, and cats, *Felis catus*. An ecological study of such species permits access to many facets of information simultaneously; for example, studies of free-ranging urban cats can shed light on broad ecological parameters that may affect all species. Cats are capable of successfully living and reproducing in the urban environment independently of humans but because of their domestication even feral individuals often interact with humans and so a study of urban cats opens a window into the interdependence of these two species.

I explored activity patterns, home range, and resource utilization of the urban cat with particular emphasis on the interactions of the human and cat populations. The results reported in this chapter pertain to home range. Home range was studied with regard to garbage availability, supplementary feeding by humans, season, sex, neighborhood (sector) and shelter availability. The purpose was to quantify the effect of each on the cat's home range.

Methods

Free-ranging urban cats were investigated. Cats were considered free-ranging if they were seen on the streets unescorted by a human; only adult cats were considered in home range estimates.

A 33.19 hectare study area was established in the Prospect Heights section of Brooklyn, New York, Fig.1.; it was divided into two sectors. These two sectors, A and B, measuring 16.44 and 16.75 hectares respectively, adjoined one another and permitted cats to move freely between them. For a description of the sectors see Methods, Chapters 2 and 3, and Table 1.

The cat population was studied for three seasons: Fall 1981 (9 September - 25 November), Spring 1982 (1 April - 18 June) and Fall 1982 (9 September - 7 December). Fall 1981 and Spring 1982 were considered seasons in which baseline parameters were measured. Comparison of home range between these two seasons also permitted an analysis of differences due to season. Although spring and fall have approximately the same mean temperature, spring is a season of lengthening days and shortening nights and fall is roughly the reverse. In addition spring is one of the cat's peak estrous periods while fall is a time of reduced reproductive activity. Fall 1982 was the experimental season and results from this season were compared to those of Fall 1981. The experimental perturbation was one in which available food, in sector A, was increased through supplemental feeding. The purpose of this manipulation was to assess the effects of increased food on the cat's home range (see below for more specific information).

The cats studied were free-ranging cats captured within the study area. No determination was made as to whether they were free-ranging pets, although a letter was distributed throughout the study area prior to trapping to alert cat owners that they might keep their pets at home. Cats were live trapped nightly from 0500-0700 hours, the peak of their active period, for a period of 30 nights prior to each sampling season. Thus Fall 1981 was trapped from 1 August to 8 September, Spring 1982 from 1 March to 31 March and Fall 1982 from 1 August to 4 September. Nightly three modified Havahart traps (Haspel and Whitman, 1981), Fig.3, were baited with cat food and placed strategically along one block face of each block enclosed within the study area. A block was continuously trapped until no new cats were caught during a one night trapping period. Only three traps were used at a time since that was the maximum number that the author and her assistant could supervise. No trap was left unattended and no cat was permitted to remain in a trap unprotected. The traps were designed with lights that lit when the door shut and so signaled the author. A physical description of the cat was recorded while the cat was still within the trap. The pelage pattern and color, size and any scars or other distinguishing marks were recorded and photographs of each cat taken from both sides and frontal views. The cats were then transferred to a cloth sack for examination of their genitalia and attachment of a color coded collar. Castrated males were identified by palpation of the scrotum; the reproductive status of females could not be determined. Males which were apparently intact and all females were included in home range estimates. It was understood that any difference in home range size due to gender would be more difficult to detect because of confounding by female reproductive status. Each cat was fitted with a unique collar, no patterns were repeated. Color coded collars were fashioned from hospital identification bracelets. These were used because they were light weight, had a water tight compartment, could easily be attached to the cat and adjusted to any neck size, and had a strong, long bonding adhesive. The patterns on the collars were applied by using color adhesive tapes in varying shades of contrasting color and geometric patterns. The patterns assigned to each cat contrasted with its fur and had an identification number. This number and a return address were written on a paper which fit into the water-tight compartment on the collar. It was the hope that lost collars might be recovered. The cats were readily recognized by their collars from at least 25 meters.

In the urban environment there is very little continuous free space, buildings occupy most of the land, Fig.1. The amount of space available to a free-ranging medium sized mammal, such as a cat, is limited. The buildings are often tightly secured and other than the ones they can occupy the cats only have use of the backyards, the alleyways that connect the back and front yards and the sidewalks. This is the physical nature of the habitat of the urban cat and makes the study of their land use patterns difficult; it is for these reasons that the traditional methods of trapping grids, continuous observation and telemetry were not used. The first two methods were disregarded since the physical structure of the ecosystem made them impossible. In addition human tampering with traps or harassing of trapped cats had to be avoided. Radio telemetry was tried and found unsatisfactory; the signal was lost to electronic "noise" in less then one-half block, a distance from which a cat can clearly be seen. From those areas into which one could not see, i.e. backyards, the signal was not distinguishable, in addition, there was so much ricocheting of the signal off the metal objects that reliable triangulation was not possible. As sidewalks are continuous paths through the urban environment it was decided to use them as transects for observation. The sidewalks were both accessible and readily used by the cats.

To record the locations of the cats, sampling was conducted in a systematic way. A transect along the sidewalk of each sector was established. These transects allowed for sightings to be made from every block face within the sector without going over any block twice, Fig.1. At the start of each sampling hour the author and her assistant would start walking from the designated starting point always looking forward and recording every cat seen from the center of the road to the edge of the building line, every alleyway passed was checked for cats. While the author collected the data on cats, the assistant recorded availability of garbage. Samples of data sheets used are included in Appendix C. Cats were recorded for individual identity, location (by nearest house address), activity, and time of sighting. Prior to each hourly walk the ambient temperature and relative humidity were taken. The completion of each sector transect took approximately 45-50 minutes, allowing enough time to return to the starting point for the next hour. Three such hourly walks were conducted each night.

The sampling period each season consisted of 60 consecutive nights of sampling. A pilot study (Appendix B) had revealed that cats are most active from 2200 hours to sunrise. Thus, it was decided to sample during these hours.

This nine-hour active period was divided into three 3-hour time blocks; each night one of the three time blocks was used as the sampling period. Time block one consisted of the hours from 2200-0100 hours, time block two from 0100-0400 hours and time block three from 0400-0700 hours. It took three nights to complete the nine hours that comprised the cat's active period. The combinations of time block and sector were randomly selected by drawing from a hat without replacement. It took six nights to complete all three time blocks in both sectors. Completion of all time blocks in both sectors was considered a repetition and 10 such repetions were done adding up to the 60 nights of sampling. Sampling proceeded regardless of weather conditions.

Three protocols were used to avoid the problem of time contingency of sightings. First, the transect was designed to minimize patrolling opposite sides of the same street in succession, Fig. 1. The second protocol involved sighting an animal more than once on the same patrol. The sighting was recorded at the address where the animal was first seen. A second sighting for that animal was not recorded unless the animal had not been seen for a minimum of 5 minutes and then only if there was no indication that the sighting was in any way related to our movements. The third protocol was derived from our sampling design. The cats active period was viewed over three nights and separately in each sector, requiring six randomly selected days to complete a repetition.

To evaluate the effect of food supplementation on the cat's home range, particularly the supplementary food offered by humans, we became nightly feeders during Fall 1982. Within one sector only, sector A, three feeding stations were established. These stations were supplied with food nightly. Feeding was begun prior to the onset of trapping, 28 July 1982. It was felt that the effects of feeding would not be recognizable if the feeding stations were not familiar to the cats prior to the onset of sampling. All three stations were supplied with food nightly from 28 July to 7 December, the close of the season. Each received the same mixture and quantity of food. Six small cans of Kal Kan cat food, 184 grams each, were mixed with four cups dry food (Purina Cat Chow, 340.2 grams). This mixture was divided into nine portions, each placed on a sheet of aluminum foil. Three such portions were placed at each feeding station. Enough food was supplied to fully support at least 12 and possibly as many as 30 cats according to the food requirements suggested by Fitzgerald (1980) and the feeding habits of cats described by Collier et al. (1978).

The time of feeding varied nightly, it corresponded to our sampling schedule which was randomly selected. If we were sampling during time blocks one or two we fed them before we left the study area. If we were sampling during time block three we fed them prior to the nightly patrol.

There were four criteria for selecting the sites of the feeding stations. The site had to be readily available to cats yet inconspicuous to humans and inaccessible to dogs. The site had to be somewhere on our transect so we could monitor its effects. The site had to be entirely within the study area, not on its boundary, so the movement of the cats with regard to the site would be within the study area. The site should have a biologically interesting aspect that warranted investigation.

Station 1 (Fig.1) was located on a residental block and was of biological interest because cats had rarely been seen on this block face although just around either corner there were large cat colonies. It was our purpose to determine whether or not a cat colony could be established there by supplying food. Station 1 was located in an alleyway that supplied the backs of buildings on either side. This alleyway had iron gates, over two meters high, closing it off to through traffic or dogs but the gates could be opened or closed for entry by humans and the cats could easily pass between the bars. Garbage cans were stored behind the gates and so placing the food out of view behind the cans made it inconspicuous to passersby.

Station 2 was around the corner from station 1. This site was selected because of the unusual sex ratio found among cats on this block during the pilot study. Cats living in colonies are usually reported as mostly female yet on this block three male and no female resident cats were found. The purpose was to determine whether or not supplementary feeding would affect sex ratio. Station 2 was located in front of a six story apartment building. This building had 75 centimeter high brick walls extending around both sides of the entrance which enclosed small dirt plots originally designed for a garden, now totally neglected. Above the wall was an iron gate approximately 19 centimeters high that had been built probably to discourage children from climbing over the wall and damaging the garden. Food was placed behind this wall on the ground; cats could easily scale the wall and pass through the bars, dogs could not. Human passersby could not see the food and in addition the neglected garden had refuse strewn about so our additions were not noticeable.

Station 3 was located on a commerical street and was of biological interest for reasons similar to Station 1. Few cats were found on this street. It was assumed this was due to heavy traffic. The site of Station 3 was under a garbage bin in front of a small supermarket. The bin was elevated about 15 centimeters from the ground on wheels and was moved twice a week when emptied and then replaced in its spot. The back of the bin rested against the store and the other three sides were wired with heavy duty mesh to prevent dogs from pulling out the food. We left only a small space between the building line and the rear wheels as a passageway for cats. We monitored the condition of the mesh nightly and repaired it as needed. Humans did not notice the food since uncontained refuse was often scattered around the bin.

The use of a transect for sighting cats resulted in a collection of data points all of which were on the perimeter of blocks. A method for estimating home range was needed that evaluated and ranked linear distances. The Probability Utilization Distribution (PUD) of Ford and Krummme (1979) did just that and so was selected as the method for estimating home range size. PUD is a frequency distribution of all relocation distances between each pair of sightings and provides the best formula for describing these distances by using the least squares method. Ford and Krumme (1979) have developed the "MAP" index as well as a means of indexing the distribution with home range size. "MAP" stands for minimum area at a specific probability. This index permits one to estimate home range size for any probability of sighting a cat and can be translated into a visual representation of the home range. PUD is independent of the number of sightings because it lumps the sightings from many individuals and repartitions the total sightings into appropriate size units for generating a PUD; an average or a mean PUD is then generated from the separate PUDs. Since PUD generates a mean value the results must be thought of as representing the home range of a representative member of the group and not an individual home range.

Mean home ranges were estimated using the PUD method for the independent variables: sex (male, female), sector (A,B) and season-food supplementation (Fall 1981, Spring 1982 and Fall 1982). Implementation of this procedure was done as follows.

A copy of a program to estimate PUD was obtained from Dr. Glenn R. Ford. A surveyor's map of the study area was obtained from the Sanborn Map Company. Every address within the study area was assigned a coordinate by placing a quarter inch square transparent grid over the surveyor's map. This was considered a master list of coordinates. The master list was loaded into the computer and a program, designed by Dr. Robert Calhoon, read addresses of each cat sighting and assigned them proper coordinates from the master list. These coordinates were used to generate relocation distances between every two sightings. Relocation distances were scaled to conform to the PUD program's requirement of a 7x7 grid. Ninety-five percent probability PUD estimates were generated and those results were transformed to square root. This corrected for departures from the assumptions of the analysis of variance (additivity and homogeneous variance). The sample sizes were unequal, but a one-way analysis of variance with orthogonal contrasts permitted tests of the three independent variables (season-food supplementation, sex and sector). Within the season and sector of supplemental feeding, home ranges of cats using the feeding stations were compared to the remaining cats by a separate contrast.

An F test was used to compare the observed variances of male and female range sizes. This F test was conducted by squaring the standard deviations generated for each sex in our PUD analysis and using these variances as the numerator and denominator. Gender differences in home range usage were depicted by using three dimensional representations and contour maps of the "MAP" indicies.

The convex polygon method was not used to estimate home range because it was felt it would describe an area that was spurious. Convex polygon estimates are derived by connecting all the outermost points of a collection of sightings; such estimates are not stable unless a vast number of sightings per animal are used (Ford and Myers, 1981). The Bivariate Normal method was considered but also rejected since the assumptions of normality and independence of sighting could not be confirmed and were unlikely. PUD does not have any underlying assumptions which can be violated, as the Bivariate Normal does, and is not modified by the number of sightings, as the Convex Polygon.

The effects of food supplementation were evaluated by two approaches. The first was the analysis of variance (described above) in which seasonal differences in home range size were compared, specifically Fall 1981 and Fall 1982, the season of supplementary feeding. Since this study concerned itself with free-ranging cats, it could not be assumed that the cats present in the first Fall would be present in the second Fall. Thus, mean home range sizes were compared, not those of individual cats. The second approach was specific to changes in land use patterns. Frequency of cat sightings at addresses corresponding to feeding stations were compared for Fall 1981 and Fall 1982 (experimental season). These data are frequency counts and as such are not normally distributed therefore the log-likelyhood test for goodness of fit, the G test, was used instead of ANOVA. Differences in number of unique cats utilizing each station were also analyzed using the G test. Station 2 data was analyzed for differences in cat frequency with regard to sex.

Results

Gender was found to have a significant effect on home range size. Analysis of variance, Tables 9 & 10, showed that male home range size was greater than that of female's, $F=4.98^*$ (D.F.1,83). This difference in home range size was even more striking when the mean minimum area in which a cat could be found 50% of the time was analyzed, F=7.15** (D.F.1,83), Table 10. An F test of difference in variance in male and female range size was also found to be statistically significant. Females not only had significantly smaller home ranges but also showed significantly less variation in home range size, Table 11. The mean minimum area in which a female could be found with 95% probality was 1.57 $\leq$ 1.765 $\leq$ 1.98 hectares (3.89 $\leq$ 4.36 $\leq$ 4.89 acres), n=47. The mean minimum area in which a male could be found was 2.38 $\leq$ 2.62 $\leq$ 2.87 hectares (5.89 $\leq$ 6.48 $\leq$ 7.09 acres), n=48. Males had larger range sizes, used the periphery of their range more and showed significantly greater variability in home range size. Home range estimates were based on a total of 2082 observations. Figures 4 & 5 are graphic representations of these ranges. Figure 4 is a contour map which permits an aerial-like view of the range and describes the probability with which the cat can be found at any point in the range. In this presentation the probability of occurrence is established by each contour line. In Figure 5, the three-demensional representation, the height of the columns represents the comparative usage of space within the area. The differences in male and female home range size and use are illustrated by these diagrams. No significant difference was found in home range size by season or sector, Table 9.

Feeding the cats increased their useage of the feeding sites but did not change the average home range size (see Table 9 for home range size due to season). However, within the season and sector of supplemental feeding, the cats seen at the feeding station had significantly larger home ranges than the remaining cats, $F = 6.45^{*}$ (1,32 df). Log-likelihood ratio test results indicated a significant increase in cat sightings at the sites of the cat feeding stations in Fall 1982, $G=110^{**}$(D.F.1), Table 12. In addition, numbers of unique cats seen at these locations significantly increased, $G=17.7^{**}$(D.F.1), Table 12. The sex ratio for cats using the feeding stations was not significantly different from 1:1.

Station 2 had 12 cats using it during the season of which four were there for the duration, Fig. 2. This station was the most successful in attracting and maintaining cat use. Station 1 and 3, both of which were established in areas rarely used by cats, also attracted cats but not as strongly. At Stations 1 and 3 the number of different cats and the number of total sightings although similar to each other were substantially less than those seen at Station 2, Fig.2. Although Stations 1 and 3 seem similar with regard to numbers of sightings, when station activity is examined on a monthly basis a difference in station use becomes apparent. Station 3 showed an increasing number of cats using the station from September through November. December was only sampled until 7 December and so its values are low. Station

1, on the other hand, showed a declining usage over the same period of time.

Discussion

Cat home range size in the two areas studied in Brooklyn, New York, was found to be stable and to vary only by gender. Male home range was significantly larger than female. Males utilized the perimeter of their home range more than females and showed greater variability in home range size than females. In addition, the home range size of the urban cat was found to be small when compared to that of cats in rural areas. Macdonald and Apps (1978) found that semi-dependent male farm cats ranged over 60 hectares while females ranged between 2 and 7 hectares. Liberg (1980) studied rural cats in Sweden and found males had a range 2 to 4 kilometers across while females had ranges of 30-40 hectares. Warner (1985) found home ranges of male cats in rural Illinois of 228 $\pm$ 100 hectares and females 112 $\pm$ 21 hectares, Brothers et al. (1985) found a male cat's range on Macquire Island to be 41 hectares, while Apps (1986) on Dassen Island, South Africa, found the male cats' home range to be 44 hectares and the females' 19 hectares. The males in this study area had a mean home range of 2.62 hectares and the females 1.77 hectares. Other urban researchers report similar results to those reported here. Dards (1978) studied cats in an urban dockside of Portsmouth, England. She too reported small home range sizes. The males' home range size was 8.4 hectares and females' 0.84 hectares. Tabor (1981) studied cats in London and in Barking, England. He reported females had a range size of 0.18 and 0.04 hectares respectively and that the male's home range was 10 times larger. The results reported here are similar to Dard's and Tabor's with regard to average home range size. However, their work shows a 10 fold difference between male and female home ranges. It must be noted they did not tag individual cats but identified them by pelage pattern and used the convex polygon method of home range estimation, a technique which tends to overestimate home range size (Ford and Myers, 1981). The results of this study indicate a 1.5:1 difference between male and female home range size and is the only urban study, known to the author, in which tagged cats are used. Home range size of other urban species have also been reported to be smaller than those of their rural counter-parts (Beck, 1973). Thus urban cats were found to have smaller home ranges than rural cats. Availability of large quantities of food in the form of garbage is often suggested as the cause for smaller urban ranges. Food as a limiting factor in home range size is discussed by many authors (Miller & Getz, 1977; Mares et al. 1976, 1982). Mares et al. (1982) in a series of studies of Eastern Chipmunk, *Tamias striatus*, found that an increase in food led to a contraction of home range even when population size was diminished. However, Van Orsdol et al. (1985) found that only during periods of food scarcity was the home range size of the African lion correlated to food abundance. Food was not found to be a limiting factor in my study. Neither differences in home range size by sector (sector A had signficantly more food in the form of garbage than sector B) nor differences in home range size by season (Fall 1982 was the season of supplemental feeding) were significant. What one must assume is that for rural cats food availability might well be a factor governing home range size but for urban cats food is abundant and is not a limiting variable. The lack of contraction of home range size during Fall 1982, the season we fed, suggests the possibility that cats have a minimum home range size below which it will not shrink. However one can not rule out the possibility that other factors are preventing its further reduction. Availability of shelter can not be the other factor since sector B had significantly less shelter than sector A and yet home range size was not significantly different in the two sectors. In addition, the activity findings suggest that cats in resource rich environments may reduce their activity periods. Thus time spent foraging may be reduced and not the area searched. Beck and Marden (1977) found a similar result for human "Street Dwellers" in New York City. The lack of influence of food on home range size in urban animals may be seen in the work of Rubin and Beck (1982). They found that home range size of free-ranging pet dogs, which were fed by their masters, varied with the amount of autonomy of the animal.

The design of my experiment permitted me to examine whether or not additional food supplementation by myself or a human benefactor would affect cat home range size, it did not address the effect of food supplementation already present within the study area. A food-reduction experiment would be necessary to assess this component but such a design would be difficult to execute and sustain in this environment. The telephone survey revealed an estimated 25.86 $\pm$ 0.57 kilograms of food supplied daily to free-ranging urban cats by human residents in the study area. This amount of food is enough to support a density of 7.55 to 9.26 cats per hectare. Childs (1986) found that 16% of the human residents in Baltimore fed free-ranging cats. My results do not contradict the explanation that the abundance of food in the urban habitat accounts for the difference in home range size between urban and rural cats.

The results of this study suggest that females may be regarded as the prosperous sex, from the point of view of resource availability. Females were more site oriented, wandering only infrequently from the center of activity of their ranges. As reported in chapter 5, females tend to spend fewer hours active than males, reducing their activity in the middle of the night. In all, females wander shorter distances and spend less time moving about. Females are solely responsible for the care and rearing of the offspring. It would be to their selective advantage to establish a home base that was situated in an area of high resource availability and to wander little from it. This would optimize their energy for their maternal tasks and secure an environment that would enhance reproductive success. Males, in this species, have no such requirement. With females occupying the most desirable locations, males, of necessity, may have evolved a more fluid and larger home range size in which males have larger home ranges and use the periphery of their range more. One factor controlling home range size in urban cats may be the different roles played by the sexes in reproduction. The work of Leyhausen (1979) lends support to this theory. He found that female cats were more territorial than males and that territorial behavior was enhanced during pregnancy and kitten rearing. In addition, he found, land usage among cats is on a "first come" basis not according to a dominance heirarchy. That the difference in home range size was not specifically due to males searching out estrous females can be seen in the lack of significant change in range sizes by season. January to

March and May through June are peak estrous periods. However there was no significant difference in range size between fall and spring. In addition, the larger home range of males may be selected for concurrently; it potentially enhances their reproductive success to encompass the range of many females. Ghiglieri (1985) described the home range and social patterns of chimpanzees in the Kibale Forest Reserve of Uganda and reported a similar pattern. Females had smaller ranges than males and wandered significantly less. The females had pocketed ranges within the ranges of the males. This behavior, the author believed, enhances the reproductive success of the female. Bowers and Smith (1979) found that when Peromyscus maniculatus lived in a xeric environment where water was heterogenously distributed the females had significantly smaller home ranges and occupied the most desirable areas while males wandered more broadly. Thus in urban cats where food does not appear to be a factor in regulating home range size resource utilization may be a factor in gender differences in home range size.

Land use patterns were changed by food availability even if range size was not. The mean range size in sector A Fall 1982 was not different from controls. The cats which used the feeding stations had larger ranges than those which did not. I conclude that this was nothing more than a redistribution of cats within the sector. Frequency of cat sightings and numbers of cats using the areas of the feeding stations increased significantly in the season in which cats were fed, Table 12. However, they did not increase uniformly at all the stations. Station 1 utilization dwindled after a short lived increase although food continued to be available during the course of the season, Fig.2. These findings appear to indicate that establishing an area as a site of cat activity is dependent on more than food availability and, in fact, the history of Station 1 seems to suggest that shelter may be the limiting factor with regard to determining whether a specific area will be utilized by a cat. Station 1 was situated between two buildings in their common backyards. In late September the landlord installed a new boiler in one of these buildings. In order to protect it from vandalism and to reduce its work, the superintendent, who maintained both buildings, boarded up all the basement windows and locked all doors into the building, taking the opportunity to do the same in both buildings. These actions corresponded to the onset of reduced cat sightings at Station 1, implying that in a food rich environment availability of shelter may be a critical factor delineating cat dispersion patterns. Usage at the other two stations implies the same. Station 2 was situated next door to and across the street from two separate abandoned buildings. Station 2 was the station of greatest cat usage. Cats were often seen inside the buildings. In the adjoining building one tagged female successfully reared her litter. Station 3, although on a commercial block, was in front of a building that had residental rental units above the supermarket. The entrance to the building was immediately next to the station. The building itself was poorly maintained. The front door was continuously open and there were a number of unoccupied apartments. Tagged cats were seen in the lobby and even sitting on the fire escape, tenants did not appear to object. From these findings it appears that both food and shelter must coexist for the cat to establish an area as a home site and that food alone is not adequate.

Summary:

Males have significantly larger home ranges than females, are less site oriented (use the perimeter of their range more), and have greater variability in their ranging behavior. The gender difference in home range size is interpreted to reflect the species solution to resource utilization. Seeking fertile females is ruled out as an explanation for gender differences in home range size. Home range size was found not to be dependent on availability of: garbage, food supplements from humans, availability of abandoned buildings, or season. It appears to be a stable characteristic of the cat population differing only among cats by gender. These results are interpreted to reflect the resource rich environment that urban cats live in and may reflect the existence of a minimum range size, although modification of other factors (i.e. human harassment or water availability) may reduce home range size even further. Dispersion patterns of urban cats are affected by a combination of food and shelter availability. Although cats will shift their distribution to encompass food sources they will not typically establish a center of activity in the absence of shelter.

CHAPTER 5

PROSPERITY'S EFFECT ON CAT ACTIVITY

Animals living in an urban environment must integrate into their activity schedules the temporal patterns of people. Such populations have the same problems procuring their necessities as animals in rural areas but they have the added factor of human intervention and harassment. This activity study of an urban species offers information about behavioral and ecological adjustments an animal makes to its environment. Variations in the cats' activity patterns with regard to hour of the day, season, gender, garbage availability, food supplements by humans, shelter availability and ambient temperature were examined.

Methods

To explore the activity patterns of urban cats I compared three seasons: Fall 1981, Spring 1982 and Fall 1982. Fall 1981 and Spring 1982 were seasons in which baseline data were collected and compared. Fall 1982 was the experimental season and results from this season were compared with Fall 1981. For more explicit information about trapping and sampling methods see Chapter 4, Methods.

Cat activity was measured as frequency of cat sightings per hour. All cats seen, while the observer was looking forward, from the center of the street to the edge of the building line were recorded. Changes in the number cat sightings per hour (visibility) were used as an index of cat activity; only quantitative aspects of activity were measured in this way. The comparative visibility of populations as ecological indices of activity and population size have been used by other investigators (Beck, 1973; Burnham, 1980; Smith, 1985).

Two types of measurements were kept: total number of cats and percent of collared cats seen per hour. Total cats is the number of cats encountered without regard to identity and reflects overall street activity, while collared cats reflects the percent of the population active at any time. Sightings were recorded by cat identification, location (nearest house address), time and date. Cats were identified as individuals by the color coded collars they wore. The color coded collars were modified hospital identification bracelets uniquely colored and patterned for each cat. The collars were attached to the cats in 30 day trapping seasons that preceded each sampling season. The numbers of cats collared each season are listed in Table 13. Cats were trapped in modified Havahart traps (Haspel and Whitman, 1981), their appearance noted and photographed, sex identified, weight recorded, collars fitted and then the cats were released. By collaring cats we were able to recognize both known and unknown populations.

Sampling was conducted between 2200 and 0700 hours. These nine hours were divided into 3 three-hour time blocks. Block 1 encompassed the hours from 2200-0100 hours, Block 2 from 0100-0400 hours and Block 3 from 0400-0700 hours. These hours were selected because they were found to be the period of the greatest cat activity during the pilot study.

The study area was located in the Prospect Heights section of Brooklyn, New York (Fig.1). For details about the study area see Chapter 4 (Methods) as well as Table 1.

To count the number of cats visible per hour a pathway was established through each sector, in effect a transect. In addition to cat sightings, garbage availability was measured per night by recording the number of open and closed garbage cans, number of open and closed trash bags and amounts of uncontained garbage, Table 8. The transect was such that every block face of each block within the sector was traversed without repeating any block face twice, Fig. 1. The author and her assistant would begin, on the hour, at the designated starting place and walk the transect each hour. The numbers of people and dogs, temperature and relative humidity were recorded. This entire procedure was repeated for all three hours of each time block. Every night only one time block (3 hours) was sampled. Thus it took six nights to complete all three time blocks in both sectors, this constituted one repetition. The sector and time block to be sampled was selected at random without replacement; ten repetitions were completed each season requiring 60 nights of sampling per season. Fall 1981 was sampled from 9 September to 27 November, Spring 1982 from 1 April to 16 June and Fall 1982 from 9 September to 7 December.

The effect of supplementary feeding by humans on the cats' activity was studied in Fall 1982. Three specific feeding stations were established in sector A only. Cats were fed each night from 28 July to 7 December. A mixture consisting of six cans (184 g each) of wet cat food and 4 cups dry food (340.2g) was divided into nine aluminum foil packets. Three such packets were placed at each feeding station. This amount of food was ample to fully support at least 12 cats or supplement the diets of many more than that (see Chapter 4). The food was placed in the same spots each night but the hour of feeding was related to our sampling schedule and so was random with regard to the cats. Each station was selected because of biologically interesting problems at that site, because feeding could be accomplished there inconspicuously and dogs could be restricted, Fig. 1. See Chapter 4 Methods for more details about feeding stations.

Station 1 was at 227-229 Underhill Ave behind a two and one-half meter high fence in a rear, but common, alleyway between two apartment buildings.

Station 2 was at 345-365 Lincoln Place behind a garden wall surrounding an apartment building.

Station 3 was at 840 Washington Avenue beneath a garbage bin in front of a supermarket. The bottom of the bin was protected from dogs by wire mesh which was examined nightly.

STATISTICAL METHODS:

The data collected consisted of frequency counts of both total cats and collared cats seen per hour. Numbers of collared cats seen were converted to percent of all known collared cats to provide the relative amount of the population active at any time. All percentages were transformed to square root and than to arcsine while total cats were transformed to square root; two three-way, fixed model analyses of variance were done, one on total cats and one on percent collared cats, (Table 14). F-max tests for homogeneity of variance were conducted and no debilitating deviations were found. Student-Newman-Keul (Sokol and Rohlf, 1969) tests were used on all contrasts of season, sector and sex effects.

RESULTS

Cats display different activity patterns in different neighborhoods and these patterns vary with regard to season, sex and the presence of supplementary food, Table 14. Season, sector and week of the season were all found to have significant effects on cat activity when both total cat and collared cat populations were examined.

One must keep in mind when examining these results that differences in total cat activity reflect the number of cats seen without regard to identity and so may include multiple sightings of the same cat. This value accurately reflects the movement of the cats on the street not necessarily an increase in number of individuals. Collared cats explicitly reflect the number of different cats and is a better indicator of changes in activity levels of the populations as a whole.

If we examine the results for collared cats first, we see that season affected collared cats but the response to season was different in each sector, Fig.6. Sector A cats showed a decrease in activity in spring although there was no siginificant difference in activity between the two falls (feeding versus not feeding). Sector B cats did not show a decrease in spring activity but did significantly increase their activity in Fall 1982.

When we examine the same animals divided into males and females, Fig.7, we see that females significantly decreased their activity in spring but showed no change in activity levels between the seasons of feeding and not feeding, i.e. Fall 1981, Fall 1982. Males, however, had approximately the same percentage active for both spring and fall but significantly increase their activity in Fall 1982, the season supplementary food was offered. The decrease in activity seen in sector A in Spring 1982 is interpreted as a decrease in activity of females during the season of reproduction, while the increases seen in Fall 1982 are attributed to the male's response to feeding. These ideas are examined more closely (Fig.8, shows values for cat visibility) by displaying season, sex and sector simultaneously. Females in sector A decreased activity in spring while male activity remained constant, however, feeding reduced female activity in Fall 1982 and masked the increase shown by males. Thus the stable activity level noted for sector A cats, Fig.6, between the two autumns is misleading. Sector A males and females are behaving differently with regard to feeding. Males appear to be responding to food by increasing activity; females are responding by decreasing activity (Figure 7). Figure 8 also elaborates on sector B. Sector B females do not respond to spring as sector A females. In sector B female activity does not decrease in spring. Female and male activity are very similar in sector B and, if anything, activity increases slightly in spring. In Fall 1982, the season of food supplementation, both sexes responded by increasing activity however the male response was much more dramatic. Four times as many males were seen when compared to the previous fall while females showed less than a two fold increase. Thus males consistently show the same pattern throughout this analysis. Male activity levels are the same in spring and fall, but an increase in the availability of food increases male activity regardless of sector. Female activity, with regard to season and food availability, varies with the sector she lives in. In sector A females decrease activity in spring and respond to supplementary food by decreasing their otherwise higher fall activity levels. Sector B females do not decrease their activity in spring and, opposite to their sector A counterparts, they increase their activity when supplementary food is available. Although sex had a significant effect on behavior this fact is not revealed in the analysis of variance. This is a confounding of the analysis. Females behaved in opposite ways in the two sectors as well as between seasons thus obscuring any significant result. This situation is confirmed by the significant interactions of sex by sector and sex by season.

These results were specific to collared cats; when total cats were examined no seasonal differences between spring and fall were found for either sector, Fig. 9. The seasonal difference that did exist was attributable to feeding versus non-feeding. Sector differences in total cat activity indicated that cats were significantly more visible in sector A than B and that feeding cats increased total cat visibility in both sectors keeping these differences the same. Mean visibility in A was 19.5 cats per hour versus 5.52 in B.

Feeding the cats in sector A makes them more visible, increases total cats, but does not enlarge the percentage of the population that is seen. These results are somewhat confounded when one regards an area in which food had not been previously available. The feeding stations were located in places that had not formerly been sites of available food and, at each station, frequency of sightings and numbers of different cats seen increased significantly in Fall 1982, G=110**(1 df) and G=17.465* (1 df), Table 12. Thus, although the number of active cats in sector A remained the same when food sources increased the frequency of sightings of cats, particularly with regard to feeding sites, increased.

Activity decreased week by week in each fall and increased in the spring. Figure 10 represents a composite of the two falls and one spring and depicts sector differences in activity. This figure represents data for total cats and indicates that cats in sector A are seen on the street less frequently as the season progresses but cats of sector B do not reduce their activity. Sector B cats appear to maintain a constant presence. This overall view has to be further refined by examination of the behavior of the known, collared cats. Figure 11 illustrates the same period of time for collared cats. According to this graph collared cats in both sectors appear to leave the street as the season progresses. In light of this, we must interpret Fig. 10 to mean that activity levels in sector B are maintained by transient cats, once the collared cats "go in" for winter and that this replacement does not occur in sector A. Males and females behave similarly with regard to seasonal progression; activity decreases in fall and increases in spring, Fig. 12.

Nightly activity patterns are similar in both sectors for total cats. Activity increases from 2200 hours all through the night to its peak around sunrise, Fig. 13. However, when we look at collared cats some information is added. Two patterns of hourly activity seem to emerge. The first is similar to that described above, a progressive increase through the night to peak activity at sunrise. The other pattern appears to be an initial increase in activity followed by a decline in activity in the middle of the night and a subsequent rise at sunrise. This decrease in activity in the middle of the night is exhibited by sector B cats, female cats and Fall 1982 cats, Figs. 14, 15 and 16.

The overall view of cat activity generated by this study depicts the cat as increasing its nightly activity from 2200 hours to reach a peak around sunrise but females, sector B cats and cats of Fall 1982 curtail activity during the middle of the night. Seasonally the cats decrease their activity as the fall progresses and increase it again in spring, although mean activity for the two seasons is the same. Visibility of cats is greater in the multiple dwelling area, sector A, than in the brownstone area, sector B, and seems to reflect differences in population size. Feeding cats increases their activity at the site of feeding. Males display the same activity level in both fall and spring but increase their activity when supplementary food is available. These responses occur regardless of the sector in which the male lives, while females show both seasonal and sector differences in activity. Sector A females decrease their activity in spring and do not increase it again to the level of the previous fall if supplementary food is available. Sector B females are more similar to the males, showing no difference in activity levels between fall and spring and increasing their activity with supplementary feeding.

DISCUSSION

Deciphering the activity patterns of the urban cat is a complex task. Both sectors have significant but different effects on the cats' behavior. More clarification of the different characteristics of each area is needed to sort out the cats' responses. Sector A, the multiple dwelling area, is composed of large apartment buildings with garbage routinely available in unlidded cans and plastic garbage bags. The buildings themselves are fair to poorly maintained, many having broken basement windows, vacant apartments and open lobby doors. The block on which the feeding stations were located had three abandoned buildings each six stories high and only partially boarded up.

Sector B, by contrast, is composed mostly of brownstone rowhouses which recently have become fashionable. Garbage is also placed in front of the buildings but invariablely in lidded cans. The houses are mostly neat and the few which are abandoned are tightly boarded up, Table 1.

A free-ranging cat living in sector A is often a feral individual or at best a quasi pet (a cat receiving regular food supplements from a human benefactor). A cat living in this area can be depicted as a "working" cat living in a resource rich or prosperous neighborhood. Sector B cats are often free-ranging pets or quasi pets which do not "work" for a living and can be thought of as "prosperous" cats living in a resource poor environment. With this understanding the apparent differences in behavior patterns are easier to understand. One immediate conclusion one can draw from the sector differences in cat behavior is that cat activity is highly responsive to environmental factors and in part probably accounts for their success as an urban species.

Total cat activity in each sector is stable from fall to spring. However cat activity increased significantly with feeding, in Fall 1982, Fig. 9. At first glance this seems inconsistent since feeding stations were only established in sector A. As is often the case in field experiments, an unexpected change occurred. During the summer, three additional cat feeders moved into sector B establishing a parallel situation in sector B to the three feeding stations established in sector A. Sector B now became a duplicate of our experiment instead of a control and the results reported here must be seen in light of this fact. Thus, changes between the two falls reflect differences between a season with food supplementation and one without.

Sector differences in activity are apparent, Fig. 6. The percent of active collared cats declines significantly in spring in sector A but not so in sector B. Sector A cats are mostly feral and as such are reproductively intact. A reduction in activity in spring could well reflect the period of kitten birth and care and reduced female activity. January through March and May and June are the cats' peak estrous periods which results in spring and summer litters (Scott, 1976). Evaluation of seasonal activity by sex strengthens this hypothesis (Figs. 7 and 8). Female activity is reduced in spring while male activity is stable; this accounts for the overall drop in percent collared cats seen in sector A. Male activity is not significantly different between fall and spring. Sector B females do not decrease their activity levels in spring which is consistent with their free-ranging pet status. Most pet owners will not permit females to range freely unless the cats have been neutered; Figs. 7 and 8 confirm that activity levels are the same for males and females in sector B. It appears that sex differences in activity abated in sector B but whether this is due to only females being neutered or both sexes being neutered can not be evaluated. Investigators have noted masculinized behavior in neutered females and female behavior in neutered males with regard to home range, territorial defense, and movements in free-ranging cat populations (Leyhausen, 1979; Rees,1981).

Feeding the cats increased the activity observed but this does not necessarily mean that the percent of cats which are active has increased, although it may mean such. To clarify one must examine the activity of the collared cats, Figs. 6, 7 and 8. By comparing Figs. 7 and 8 we see that feeding cats brings about effects dependent upon the sex and area in which the cat lives. Male cats respond to increased food availability by increasing their percent active regardless of the area in which they live. Intact females, sector A females, do not respond with increased activity to food supplementation. Their percent active is substantially below that of the previous fall; again the answer appears to be related to their being sexually intact. Females are already situated at sites of high resource availability (see Chapter 4) thus increased food availability permits them to reduce their foraging time. This reduction in activity allows them to conserve energy, a consequence which may further enhance their reproductive success. Ghiglieri (1985) reported female chimpanzees wander significantly less than males. He suggested that this helps them conserve energy for caring for the young.

Feeding cats affects their dispersion pattern, (see Chapter 4), thus it is not surprising to find increased activity at the feeding station without bringing about a sectorwise change in the percent of cats active. Both Dards (1981) and Tabor (1981) found high cat activity at sites of auxiliary feeding in urban England.

To test this hypothesis the cat sighting data was divided by sector and sex. In sector A, broken basement windows and available garbage are often placed on the sidewalk side of the buildings; in sector B garbage cans are lidded and windows are unbroken. Resources are provided by humans in sector B and often placed in the backyards out of the neighbors' sight. In fact, the survey indicated that sector B residents were more likely to provide shelter to stray cats than sector A residents. Since the transect in the study followed the path of the sidewalks, and the sidewalks are regions of high resources availability in sector A but not B, one should expect to see a higher percentage of female cats in sector A than B. Males should exhibit equal visibility in both sectors. Figure 17 confirms these expectations. Male visibility is equal in both sectors while the likelihood of seeing a female is nearly two times as high in sector A as B.

Differences in resource availability in the two sectors are dramatized by the difference in male responses to feeding. The population's visibility increases by only 2.5% in sector A and by 13.3% in sector B. Sector A is a resource rich environment, increasing food availability only moderately changes activity levels; sector B cats, particularly the males, live in a resource poor environment and respond accordingly to an increase in resource availability.

Weekly activity changes in total cat activity in sector B indicates that cats do not reduce their activity as the fall progresses, Fig. 10. At least at a quick glance this seems reasonable since sector B cats are mostly pets and their sheltered status may make them somewhat immune to changing weather conditions. Examining the responses of collared cats however clarifies the situation, Fig. 11.

Sector B cats reduce their activity on the streets as the season progresses just as sector A cats, yet total cat activity in sector B stays constant throughout the season. As the fall season progresses and the weather deteriorates pet cats are less likely to be let out. The resources and space that they utilize is now available to other cats and transients replace them, filling the area to its carrying capacity. Sector A cats never relinguish their territories. They may use them less often but they have not vacated them and so the amount of individual movement on the street and percent of the population active both go down as the season progresses. Males and females behave similarly with regard to seasonal progression: activity decreases in fall and increases in spring, Fig. 12.

Many mammals show peak activity periods at both sunrise and sunset (Brown, 1962); urban cats do not. Activity does not significantly increase until 2200 hours in either sector which corresponds to a reduction in human activity. This response is interpreted to reflect human avoidance and has been observed in other urban species and non-urban environments too (Kunz & Todd, 1978; Egughi and Nakazono, 1980; Van Dyke et al., 1986).

Nightly activity increases from 2200 houurs to a peak at sunrise. However, cats with dependable food resources such as Fall 1982 cats, pet cats of sector B and site oriented females show a modification to this general pattern. These food endowed animals reduce their activity in the middle of the night suggesting that there is a reduced need for foraging time.

Summary

The results suggest that cat activity is highly responsive to environmental and biological factors. Feral females, in a resource rich environment, sector A, respond to food supplementation by reducing activity. This reduction in activity as well as the middle of the night decrease in activity suggests a reduced need for foraging time. Sector A males increase their activity during food supplementation but not nearly as dramatically as Sector B males which reflects the latter's ecologically disadvantaged position. As the cold weather sets in, sector A cats reduce their activity but do not vacate their territories and so fewer cats are seen at these times. Spring, in such an environment, is a season of lowered cat visibility since the females are busy rearing the young. Pet cats living in a resource poor enviroment, Sector B, respond both with individually increased activity and an increase in the proportion of the population active when the environment is enhanced by food supplementation. Their pet status is reflected in the continued level of female activity in the spring and in the stable level of cat activity throughout the fall, both reflecting man's intervention.

CHAPTER 6

THE FULL STORY

The urban environment is seldom considered a legitimate habitat for ecological inquiry. Because of its man-made structures it is regarded as artificial and not the product of nature; the result is that the organisms that live there are rarely studied. Cities have existed for thousands of years and, as Egyptian ruins indicate, cats have lived in cities since ancient times. What can be artificial about an environment that has existed for so long and what can be artificial about the ecology of an organism that has successfully lived within such an environment for so long? The study of the urban cat is not a study of a temporarily misplaced creature. It is the study of a species within a unique ecosystem. An understanding of this ecosystem as well as how the cat has adapted to it reveals a story of the cat's adaptable behavioral repertoire, an environment with a superabundance of resources and the complexity of integration of the human and the cat as well as their mutual interdependence. This chapter presents an intergrated understanding of the ecology of the free-ranging urban cat. Prospect Heights in Brooklyn has served as the model but it is not unlike many other residental parts of the city or any other city for that matter. Although inferences from this study can only be made to other environments similar to it, this area is a typical inner city area.

Physically there is relatively little open space in the urban environment and there is spotty distribution of available inner space (shelter). Shelter takes many forms. It may be purposely provided by human benefactors in the form of a handmade solid structure with a roof and floor, a box, or merely by being admitted to an apartment or basement, either deliberately or by leaving a window open as an invitation to take up residence. At the other extreme is the opportunistic finding of harborage in abandoned buildings. Concurrent with these circumstances are the attitudes of the community with regard to sustaining stray animals.

This study indicates that an area of multiple dwellings can support a much larger cat population than an area of private homes. In part this is due to the large amount of harborage provided by abandoned buildings and to direct intervention by humans in the multiple dwelling area but it must also be attributed to the more tolerant attitudes of the residents towards the maintenance of stray cats. One superintendent told me he purposely left basement windows broken to encourage cats to take up residence and to combat mice and rats. Results of the survey indicated that renters living in multiple dwellings had significantly more tolerant views towards the feeding of stray cats than did home owners. These results correspond to those of Oppenheimer (1980) in which she compared cat population sizes in areas of private homes to areas of multiple dwellings in Baltimore. She found a positive correlation between cat population size and the number of renters although there was no significant relationship between human and cat population sizes. She interpreted these results to reflect the poorer attitude of renters than of home owners towards garbage containment. Although this study also found a significant difference in garbage availability in the two areas, the availability of shelter and the human attitude must also be factored into our understanding of urban cat ecology. As the observations from feeding station 1 suggest, shelter, rather than food, may be the critical factor determining population distribution.

Neighborhoods composed primarily of private homes provide shelter for cats in different ways. Although the occurrence of abandoned buildings or broken basement windows is much rarer, private home owners admitted to deliberately providing significantly more shelter for stray cats than renters (see Chapter 2). The quality of shelter provided is also different. Having ones own backyard provides the home owner with an ideal place to erect a shelter. Shelter is available to cats in both the multiple dwelling and private home areas. Differences in shelter availability, at least in part, are reflected in differences in cat population size in the two areas.

This study suggests that food is so abundant in the urban environment that it is probably in surplus. Although this study did not address itself to cat predation, the work of other researchers indicates that population sizes of urban species are high. Lancaster and Rees (1979) in their study of bird populations in Vancouver found a positive correlation between bird population size and the degree of urbanization. The work of Orgain and Schein (1953) found surplus rat populations in Baltimore. After a removal of 40% of the rat population in their study area the population size rebounded in only two weeks; they interpreted these results to indicate that many peripheral individuals who had been denied access to food now had it available to them.

Studies of stomach contents of cats and scat analyses confirm that predation is a minor source of food in the urban environment. Cat scat analysis by Jackson (1951) found only 6.9% rat and 0.6% mouse parts, with the highest percentage of material attributed to garbage. McMurry and Sperry (1941) studying stomach contents of cats in residental Oklahoma found 66% garbage, 10% rodents, 6.5% birds and 17.5% insects. Childs (1986) found that 45.8% of rats killed went uneaten, 33.3% were only partially eaten and only 20.8% were totally eaten. He also reported that it is common for cats and rats to eat simultaneously from the garbage in the alleyways of Baltimore without any conflict. Despite abundant prey, in an urban environment, cats are not hunting for food as they are in other environments (Errington, 1936; Coman and Brunner, 1972; George, 1974; Dilks, 1979; Davies & Prentice, 1980; Fitzgerald, 1980; Liberg, 1984; Warner, 1985; Brothers et al., 1985). In 1000 hours spent in the field, the author witnessed successful predation only once, and that was of a female catching a house mouse. She chewed on it briefly and then discarded it. Leyhausen (1979) as well as many investigators (George, 1974; Toner, 1956; Warner, 1985) have shown that cats continue to hunt even when fully satiated. Dards (1981), as well as Tabor (1981), both of whom study urban cat populations in England, found little evidence of predation as a primary food source.

Garbage is one of the primary sources of food in the urban environment. The results of this study indicate that there is more available garbage in the multiple dwelling than in the private home area. These results correspond to those of Oppenheimer (1980). However, it must be remembered that in an area of multiple dwellings the superintendent or landlord is largely responsible for garbage containment not the residents. One superintendent reported that he deliberately leaves the garbage cans uncovered and the basement windows broken to attract cats. Cats are favored in this area, in part, as they have been throughout history, for presumed pest control.

The amount of garbage available to cats varies with the neighborhood, however it appears there may be a minimum amount required per cat. Considering only receptacles in which garbage is accessible, Table 8, there is available to the cats an estimated 37.7 containers per day per hectare in the multiple dwelling area as compared to an estimated 14.29 containers per day per hectare in the private home area. Schein & Orgain (1953) found in Baltimore that one-third of the available garbage was edible by the rats and that there was 150 grams of garbage per day per rat. Although rats are omnivores and cats carnivores, cats are known to eat cooked vegetables and bread products. If we assume that one-third of the garbage available to the cats is edible and that they can reach only the top 15 centimeters of any receptacle and,in addition, that the average receptacle is the size of a medium garbage can 53.34 x 45.72 centimeters (21x18 inches), we can then calculate the volume of edible garbage available per cat per neighborhood. Based on these figures and the knowledge that the average cat population in the multiple dwelling area is 80.30 cats, it can be concluded that there are 5725 cubic centimeters of edible garbage per day per cat per hectare in sector A. The average cat population in the private home area was 34.06, based on a similar calculation, there are 5116 cubic centimeters of edible garbage available per day per cat per hectare in sector B. These two values are tantalizingly similar, suggesting that approximately 5420 cubic centimeters of edible garbage per day per cat is required regardless of the neighorhood in which the animal lives. Translated into more common terms, the volume of accessible, edible garbage in a little less then one-half the average garbage receptacle may be required by one free-ranging urban cat per day, or one average garbage receptacle can support 2.25 cats. One could test the hypothesis that the number of garbage receptacles in a neighborhood is an index to cat population size by comparing the observed population size to the estimated population size derived by multiplying 2.25 times the mean number of accessible garbage receptacles.

Many urban researchers have found garbage to be a primary food source. Childs (personal communication) studying cats in Baltimore found the local garbage depot to be similar to the African watering hole. Many species (rats, cats, dogs) eat simultaneously with little conflict. Beck (1973) observed urban dogs tipping over garbage cans and ripping open plastic bags. He also noted increased dog activity on the mornings prior to garbage collection. Dards (1981) and Tabor (1981) also described garbage as a primary food source for urban cats.

Food deliberatedly supplied by human benefactors is another source of food for urban cats. Urban cats can derive food from three sources: prey, garbage and human benefactors. The results of the survey indicate that food supplements are not found to be area specific. A daily cat feeder is as likely to live in the multiple dwelling area as the private home area. On the average it is estimated that 1.39 kilograms of food is provided daily per hectare and this can support between 7.55 to 9.26 cats (see Chapter 2). It is little wonder, given all these food sources, that urban cats do not depend on predation.

The areas studied have unequal distribution of resources. The multiple dwelling area has significantly more harborage and food than the private home area, although both areas can be considered to be resource rich when compared to more rural environments (Jones, 1977; Van Aarde, 1978; Brothers et.al, 1985). Food and shelter are superabundant yet the environment is not without its problems. Cat activity patterns indicate a shift in the commonly observed sunset peak in activity to after 2200 hours and is interpreted to represent human avoidance. Kunz & Todd (1978) believed that reduced cat observability in Athens, Greece corresponded to peak human activity. Harassment by children, traffic and dogs are continuous dangers yet, seen from a comparative ecological point of view, the urban environment can be considered a benign environment. With this description of the environment we can now examine the behavior of the cat in its environmental context.

Sex ratio was found to be 50-50 in all seasons. This was true of trapping results as well as cat sighting results. One of the reasons for placing feeding Station 2 at its specific location was to examine the effect of feeding on sex ratio. The results of the pilot study suggested that there was an unbalanced sex ratio, in favor of males, on that block. However it now appears that this was a false impression resulting from the small sample size. The sex ratio of cats utilizing the three feeding stations was not significantly different from 1:1.

No attempt was made to determine the ages of individual cats. All home range estimates were based on adult sightings. Very few juveniles or kittens were trapped.

Population density estimates calculated in this study are close to those derived from the pilot study. The density of cats was estimated separately for each sector, A and B. Sector A, the multiple dwelling area, was found to have 4.88 $\pm$ 0.184 cats per hectare and Sector B, the private home area, 2.03 $\pm$ 0.197 cats per hectare. These values were averages of the three seasonal estimates; no distinction was made between resident and transient cats. However sector A cats are believed to be mostly feral and so reflect a higher percentage of transient cats than sector B cats which are believed to be mostly free-ranging pets or quasi-pets and so reflect more resident cats. In the pilot study resident cats were defined as those seen for more than one season. Resident cats were estimated to have a density of 2.00 cats per hectare while all other cats were found to have a density of 3.93 cats per hectare. These value were attained for cats only identified by pelage pattern, never collared, and were generated out of observed cats only. Considering the shortcomings, it appears they give good corroboration to the current results.

Despite these high values for cat density one must wonder why they are not even higher considering the estimated food sources available. Based on the estimates of food supplied by the daily feeder alone the estimated density is 7.55-9.26 cats per hectare. Two different explanations may account for this discrepency. The number of cats that can be sustained by the feeders was estimated assuming 184 grams of food per day (as the pet food industry recommends) and 150 grams (Fitzgerald, 1980) respectively, if however, we use the value suggested by Scott (1976), 300g per day, we get 4.63 cats, a value more consistent with the density values reported. Another possibility is that not all the food provided is eaten by cats. Food, at the feeding stations as well as at the locations of known feeders, often remained after the cats had departed or had finished eating. Other urban species eating this food would account for our lower than expected values.

Oppenheimer (1980) in her work in Baltimore found a range of 1.51 to 7.43 cats per hectare, with higher densities in areas occupied by renters. Dards (1981) reported that the total population size in Portsmouth Dockyard, England, ranged over the three years of her study at around 300(252- 351) and that of the adults around 190(164-203). She stated that the average density was over two cats per hectare although she does not explain how she derived this value. She reported that her study area was 85 hectares, thus her average total cat density would be 3.52 cats with a range of 2.96 to 4.13. Her average density for adult cats would be 2.24 with a range of 1.93 to 2.39. Perhaps she was referring to adult cats only when she stated her average cat density. Nevertheless her total cat density values are not unlike those reported here.

Different subhabitats in the city support different cat population sizes, an observation also made by Oppenheimer (1980). The areas of poorly maintained multiple dwellings (sector A), with large quantities of accessible garbage and shelter will support more than twice as many cats as the cleaner private home areas (sector B). However, within either area the distribution of the cats will be such that colonies will localize near a feeder; daily feeders generally provide shelter and other services as well. Supplying food is not enough to establish an area as a center of activity for a cat. Shelter and food have to coexist to attract cats, particularly females. Discouraging daily cat feeding may be one effective way to reduce free-ranging cat population size although such an activity may have an impact on the mental and physical health of the human as well.

Home range size is stable in this resource rich environment. Although availability of food modified cat activity, it did not reduce home range size. The stability of the range size was seen in two ways. Firstly, the mean range size was the same in the two areas despite differences in resource availability and population size. Secondly, supplying additional food did not reduce it further. Other researchers in other environments have reported large home range size for cats (George, 1974; Macdonald and Apps, 1978; Liberg, 1980; Warner, 1985; Brothers et al., 1985). The larger estimates were attributed to food scarcity. Certainly one can expect contraction of home range size when food availability changes from scarce to abundant, however it may be unreasonable to expect further reduction when food is in surplus. Minimum home range size must be correlated with other variables. Home range size varied with gender. As in other studies, the male has been found to have a significantly larger home range size than the female but not the 10 fold difference reported by Dards (1978), Tabor (1981), Macdonald and Apps (1978), Liberg (1980). Difference in range size was less than 2:1 with females having a range size 67% of that of the males. Warner (1985) radio tracked four males and seven females in Illinois and also found a sex difference in cat home range size. The male ranged 228 ± 100 hectares and females 112 ± 21 hectares, approximately a two to one difference. Apps (1986) on Dassen Island, South Africa, with radio collared cats, found males ranged 44 hectares and females 19, a 2.31:1 ratio. Studies of large cats, Litvaitis et.al (1986) and Rabinowitz (1986), have found approximately a 3:1 ratio for Bobcat and Jaguar respectively. Although the ten-fold difference Dards (1978) and Tabor (1981) found was for urban cats, they used visual identification as a means of differentiating individuals, a method my pilot study demonstrated unreliable. Tabor did not explain which technique he used for calculating home range while Dards used the convex polygon method, a technique known to over estimate home range size (Ford and Myers, 1981).

Differences in reproductive responsibilities are believed to explain observed differences in home range size and use by the two sexes. Females wandered significantly less from their center of activity than males did and did so with less variability. Females were observed to locate themselves near both food and shelter and to wander little from that site. This behavior provides females with the most favorable locations for rearing their young with the least energy expenditure and thus enhances their reproductive success. As a result males are constrained to utilize less desirable areas and wander further. This arrangement may have an additional selective advantage for males, it brings them in contact with many different females. Dards (1978), Macdonald and Apps (1978), Liberg (1980), Tabor (1981) all reported similar observations on the land use patterns of the cat. Female home ranges are aggregated and females wander only slightly from these centers while males wander much more broadly encompassing many female groups and having somewhat overlapping home ranges. Differential land use patterns as a reproductive strategy has also been suggested for Chimpanzees (Ghiglieri 1985) and Peromyscus maniculatus (Bowers and Smith 1979).

Considerable similarity was found between the home range results reported in the pilot study and those reported here, considering the differences in methodologies employed. In the pilot, a distinction was made between maintained and feral cats. A maintained cat was one observed to receive daily food alottments from a human. All other cats were feral. In this study no such distinction was made. It was felt that many cats may be receiving varying degrees of supplementation and it was not possible to distinguish amounts with certainty. However, overall sector differences did suggest that the average cat of sector A could be considered feral and the average cat of sector B maintained. Home range estimates were based on these broad categories. No significant difference was found between sectors (perhaps because of the above described categorization). The mean home range of all cats, without regard to sex, was 2.19 hectares. In the pilot study maintained cats were found to have a home range of 0.43 $\pm$ 0.14 hectares and all other cats 2.4 $\pm$ 0.56 hectares. Comparing the results for all other cats of the pilot (2.4 hectares) with the overall estimate for the full scale study (2.2 hectares) reveals considerable similarilty. In the pilot study the bivariate normal method for calculating home range was used because the data were such that other methods were not usable, however, the underlying assumptions of bivariate normality were not confirmed. This method was not used in the present study to avoid spurious results. Nevertheless the two independent methods seem to produce very similar results and enhance the confidence with which these values are reported.

The neighborhood in which a cat lives affects its activity patterns. Despite lack of difference in home range by sector, sector did affect cat activity, in particular female activity. Differences in female activity are interpreted to reflect differences between pet and feral status and as such neutered and reproductively intact females. Free-ranging females in the private home area appear to behave more like males in that they do not reduce their activity levels in spring and respond to supplemental feeding by increasing activity. Reduced spring activity of females in the multiple dwelling area is believed to reflect the period of kitten birth and care. Reduced female activity in the multiple dwelling area during the season of supplemental feeding is believed to reflect further reduction in foraging times as the already resource-rich, well-situated females are exposed to food supplementation. In general, food supplementation appears to increase the percent of the population that is active, particularly the number of males in the private home area, however it reduces the number of active hours on a nightly basis. When food is readily available, as in the multiple dwelling area, among females and during the season of supplemental feeding, cats appear to reduce foraging time and curtail their activity schedules to peak between 2200 and 0100 hours and again at sunrise.

Seasonal activity patterns in the two subhabitats (sectors A and B) also appear to be different. In the private home area, sector B, activity levels remain constant as fall progresses. This change is interpreted to represent transient cats occupying the territories that become vacant when the pet cats are withdrawn in the bad weather. In the multiple dwelling area, sector A, activity levels decrease during fall but territories are not vacant. Other researchers have noted similar seasonal reductions in cat activity in fall and increases in spring (Brothers et al., 1985).

Despite periods of reduced activity, cats can be seen on the streets of Brooklyn in all seasons and in all kinds of weather except during severe rain storms. Heavy rain seems to hinder their activity. However, immediately after a rain shower cats appear on the streets in numbers higher than normal. Beck (1973) while studying urban dogs in Baltimore found they too were active in all kinds of weather including snow; only severe cold lessened their activity.

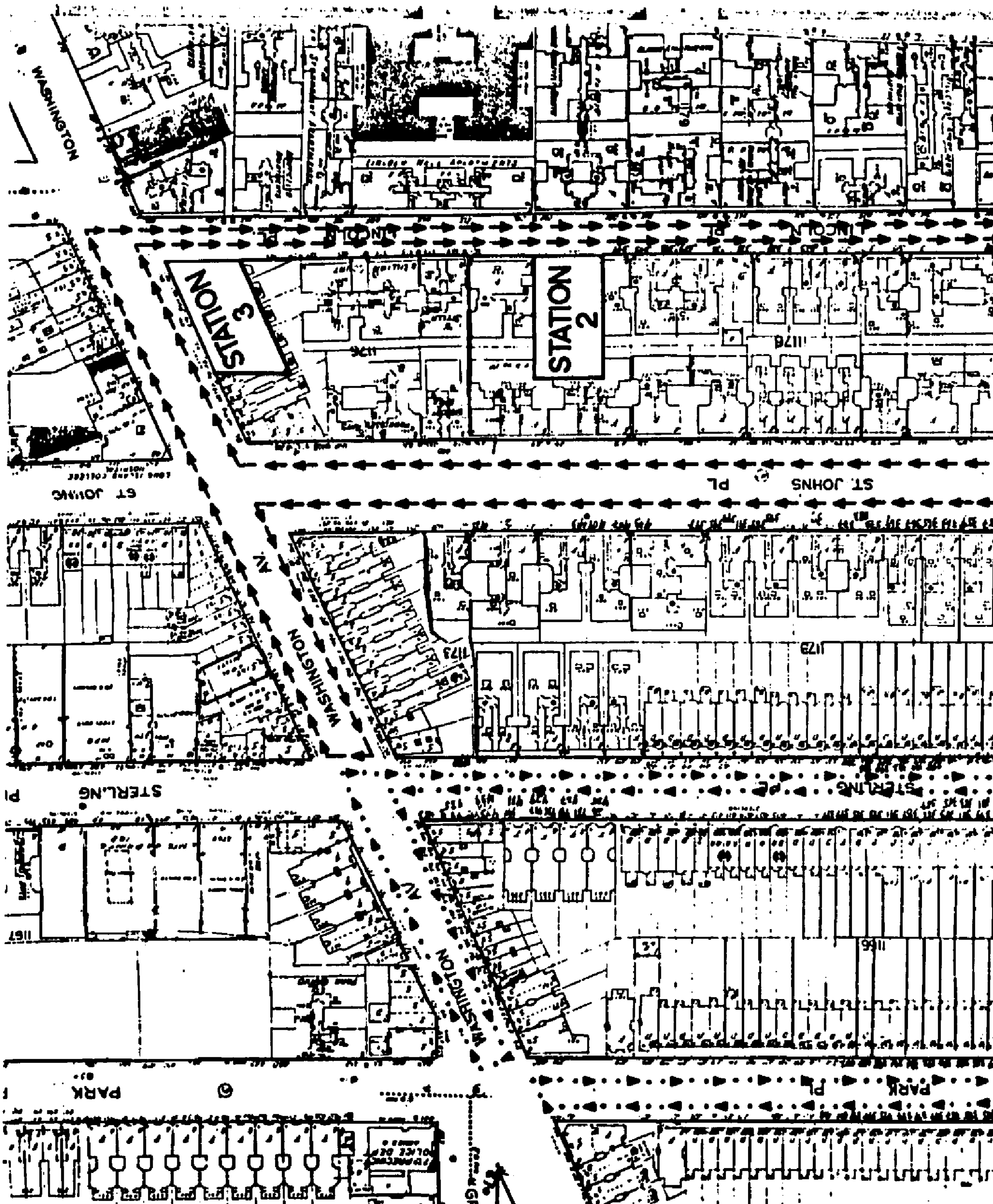
The purpose of this project was to examine the ecology of free-ranging domestic cats in an urban environment. The specific goals were to explore home range and activity patterns and to evaluate the availability of resources within this environment. The interactions of environment, cats and people were also examined. Knowledge acquired through this study falls into many categories. Information was gained: 1) that is useful for contrasting cat activity in different environments, 2) which elucidates the interdependence of the human and cat populations, 3) that describes the specific responses of cats to two different urban subhabitats,

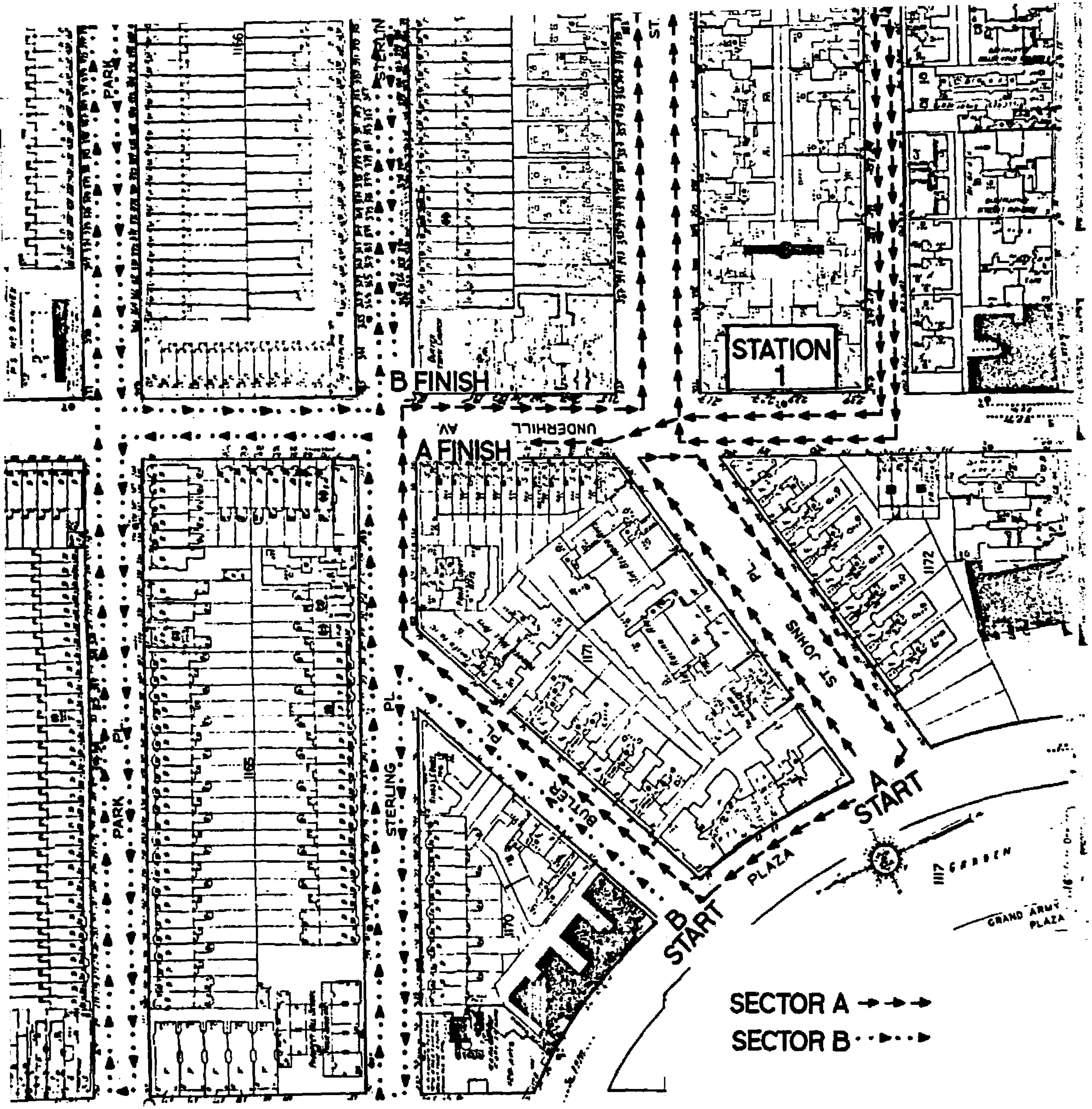
4) which delineates the structure of the urban environment and the availability of food and other resources within it, 5) as to the effects of season and hour on cat behavior, 6) regarding the effects of food supplementation on cat behavior and 7) on gender differences in cat behavior.

Figure 1. Surveyor's map of the study area in the Prospect Heights section of Brooklyn, New York. The transect pathways, indicated by the arrows, also delineate the boundaries of each subhabitat (sector). Food supplementation was placed at feeding stations (Stat.) during Fall 1982 only.

FIGURE 1

STUDY AREA IN BROOKLYN, NEW YORK, WITH SECTORS, PATH OF TRANSECTS AND FEEDING STATIONS





STATION 1
B FINISH
A FINISH
UNDERHILL AV.
PARK PL.
STERLING PL.
ST. JOHNS PL.
BUTLER PL.
PLAZA ST.
A START
B START
GRAND ARMY PLAZA
SECTOR A
SECTOR B

Figure 2

FREQUENCY OF CAT SIGHTINGS AT THREE FEEDING STATIONS IN BROOKLYN, NEW YORK, DURING FALL 1982

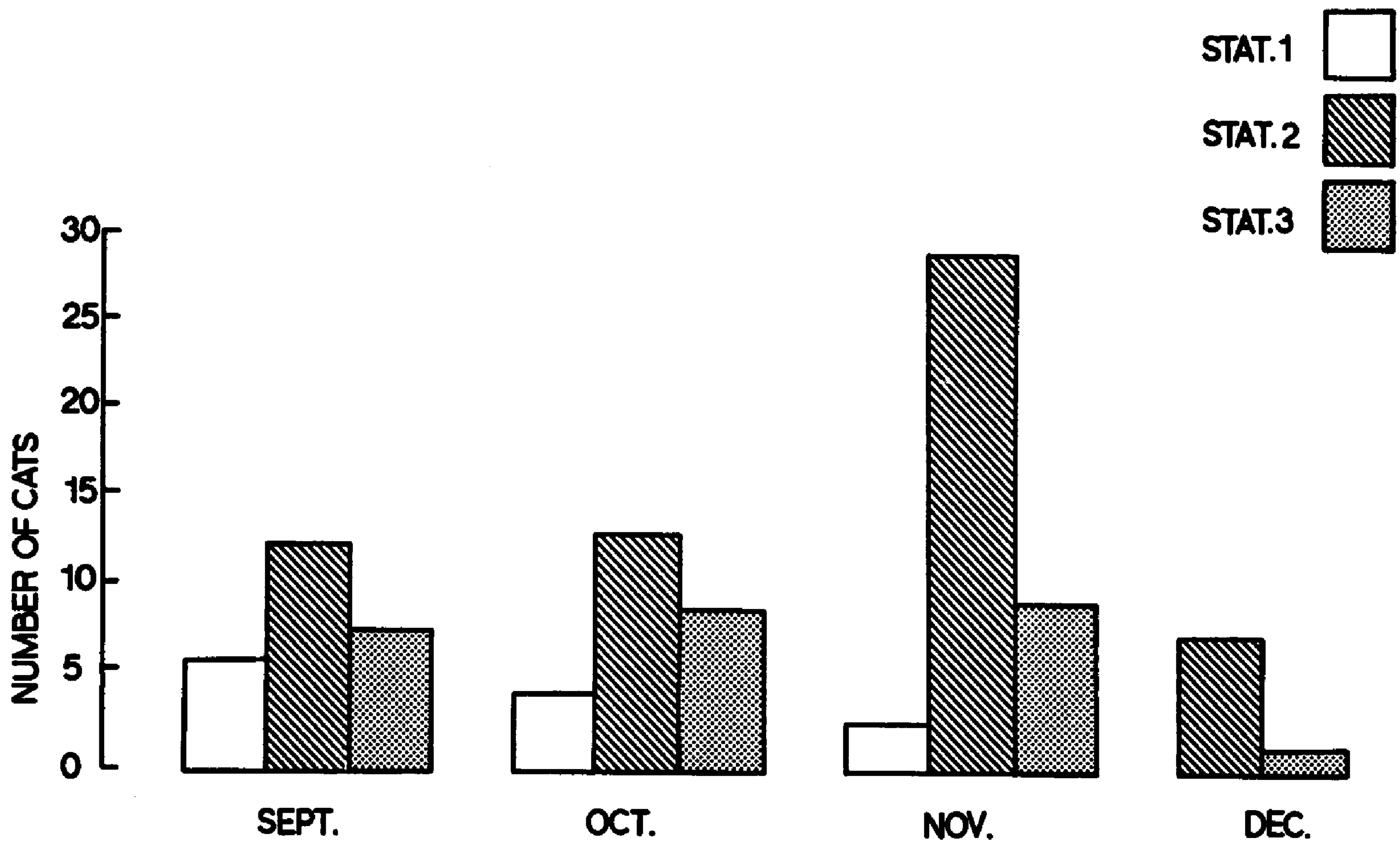


Figure 3. Design improvements made in Havahart traps to facilitate the capture of cats. The bait tray was in the center of the trap originally (A). This location permitted the cat's hindquarters to extend beyond the trap when it ate from the tray. The tray was moved to one end of the trap so that the cat had to enter the trap entirely to reach the bait (B). In addition, the centrally positioned pivot bar (C) was placed off-center to make the tray more unstable (D)

Figure 3

HAVAHART TRAPS USED TO TRAP CATS WITH (B & D) AND WITHOUT (A & C) MODIFICATIONS

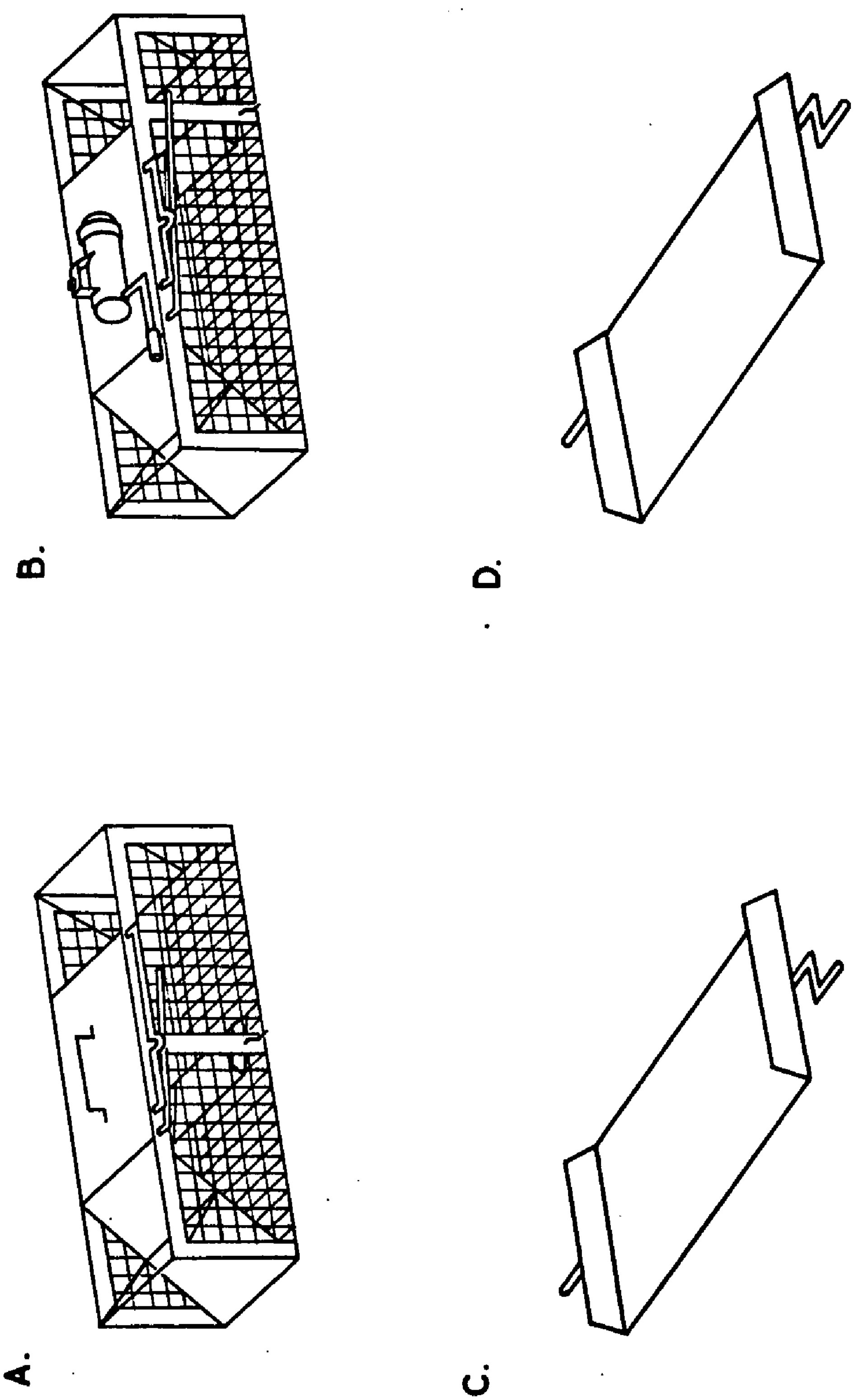


Figure 4. Each contour line represents the likelihood of cat sightings this far or farther from the center of their range. The closer the lines are the more concentrated is the land usage.

Figure 4

A CONTOUR MAP DEPICTING THE HOME RANGE USAGE OF MALE AND FEMALE CATS IN BROOKLYN, NEW YORK

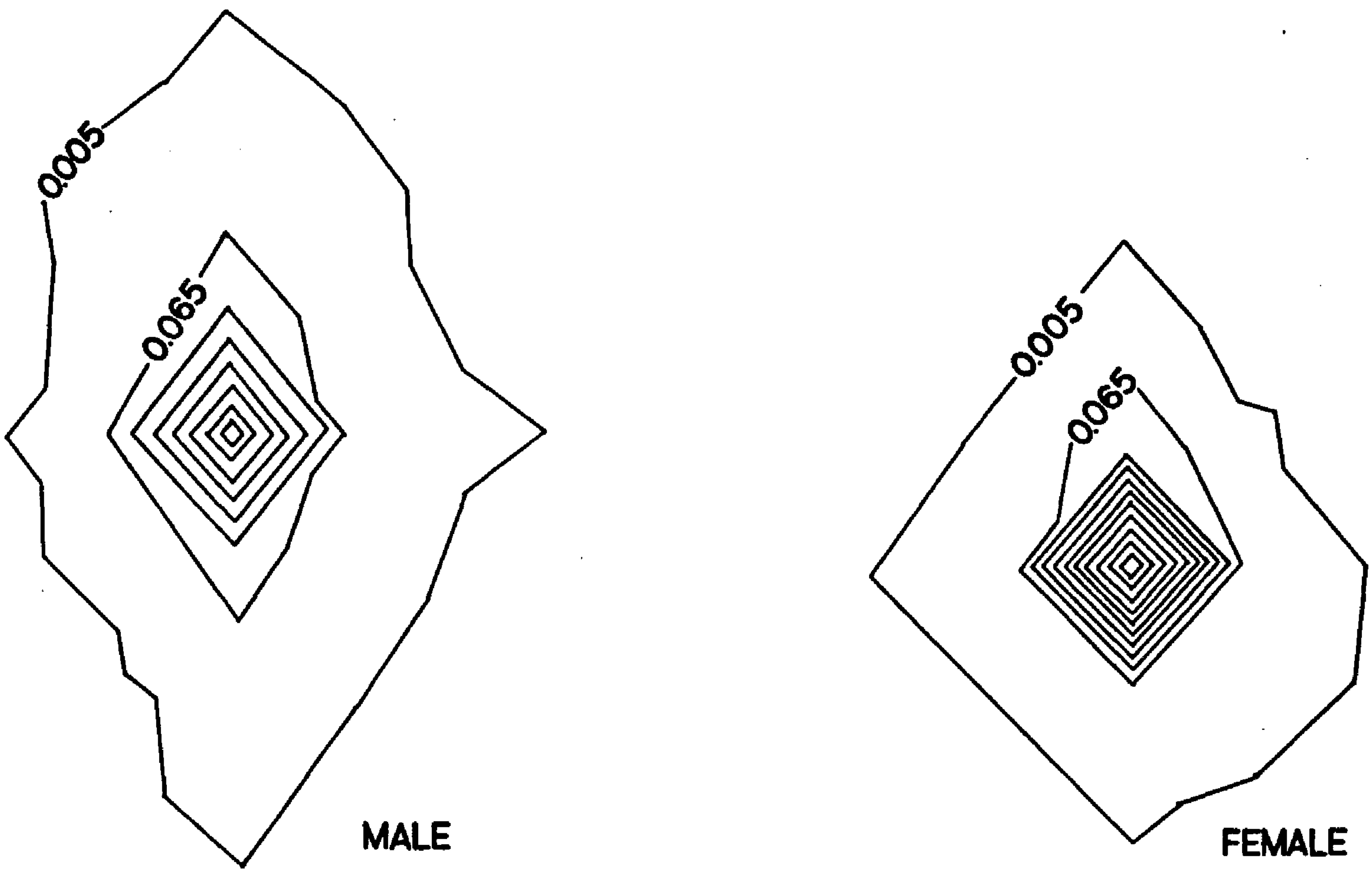


Figure 5. Land use patterns of free-ranging cats in Brooklyn, New York. The height of the columns represents the probability density of cat location within the home range. Females are significantly more likely to be found in the center.

Figure 5

A THREE-DIMENSIONAL REPRESENTATION OF MALE AND FEMALE CATS HOME RANGE UTILIZATION IN BROOKLYN, NEW YORK

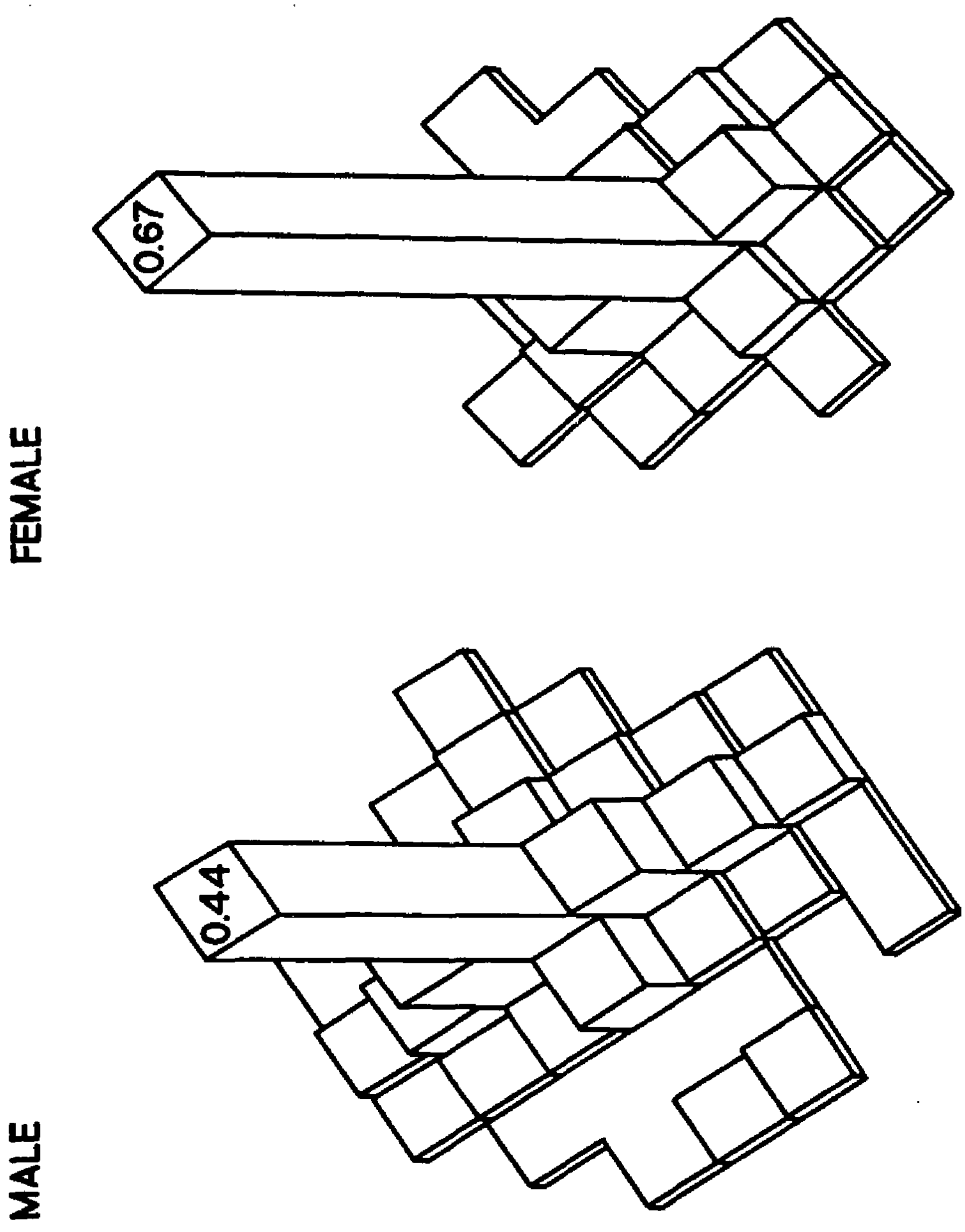


Figure 6

MEAN PERCENT OF COLLARED CATS VISIBLE WITH REGARD TO SEASON AND SECTOR

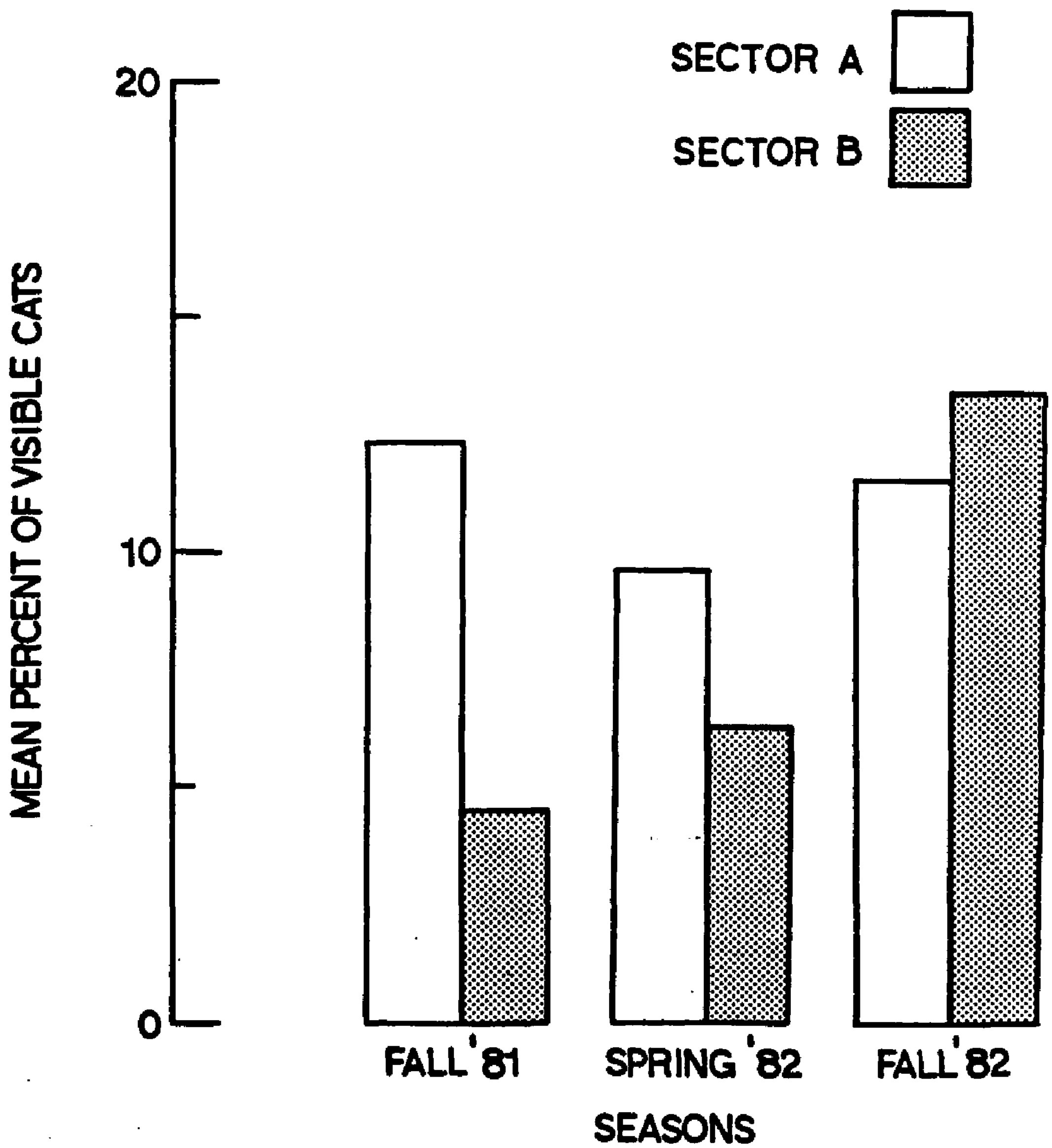


Figure 7

MEAN PERCENT OF COLLARED CATS VISIBLE
WITH REGARD TO SEX AND SEASON

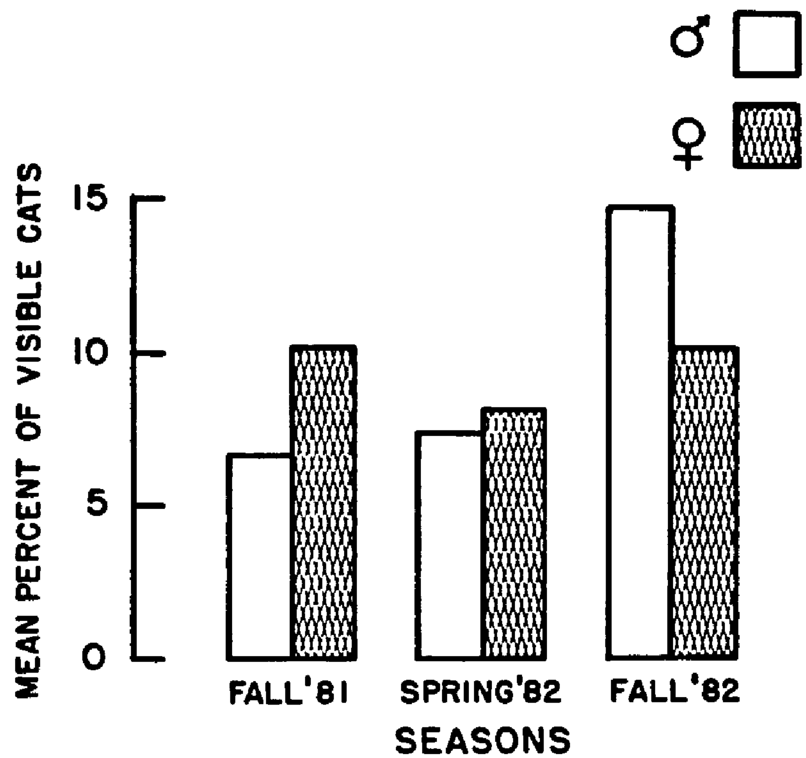


Figure 8

MEAN PERCENT OF COLLARED CATS VISIBLE WITH REGARD TO SEX,
SEASON AND SECTOR

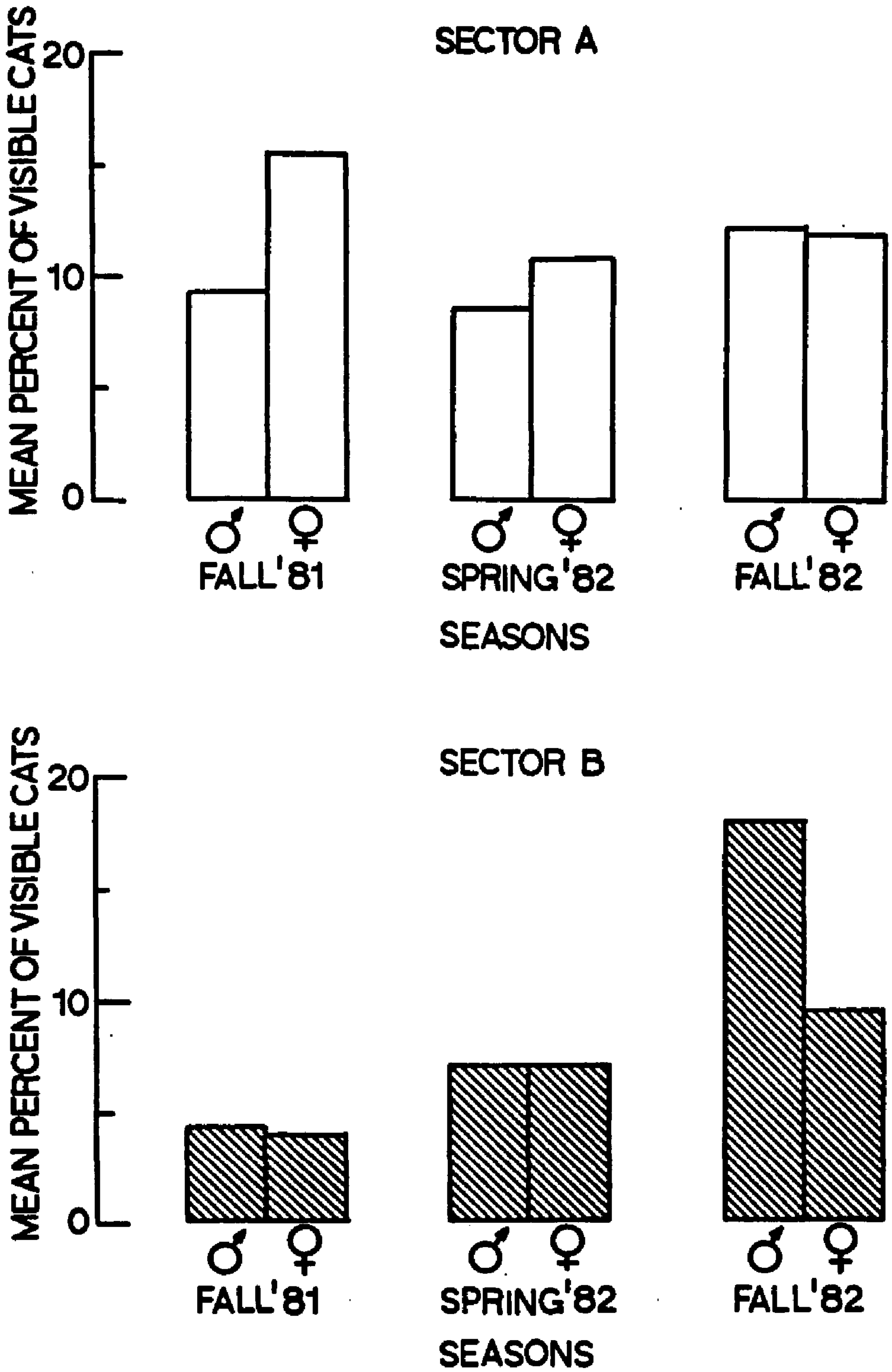


Figure 9

MEAN NUMBER OF TOTAL CATS VISIBLE WITH REGARD TO SEASON AND SECTOR

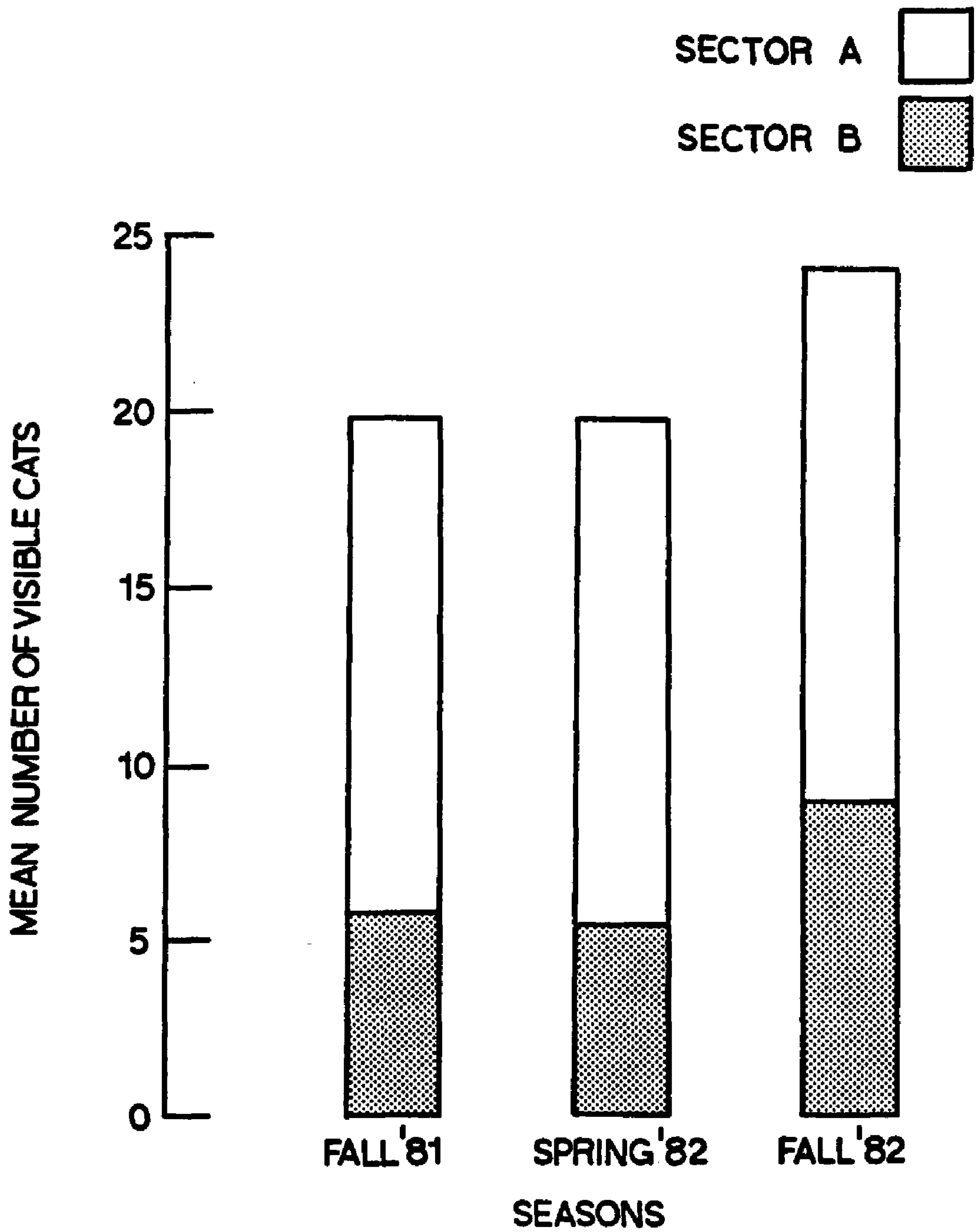


Figure 10

MEAN NUMBER OF TOTAL CATS VISIBLE WITH REGARD TO WEEK AND SECTOR

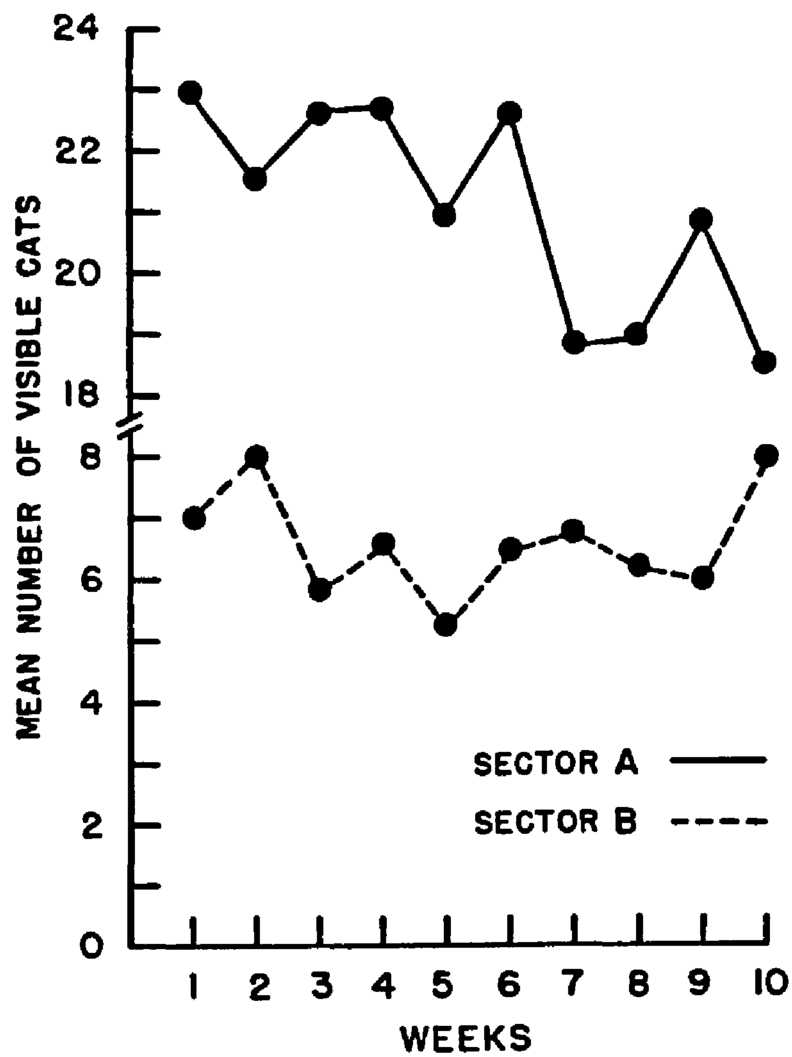


Figure 11

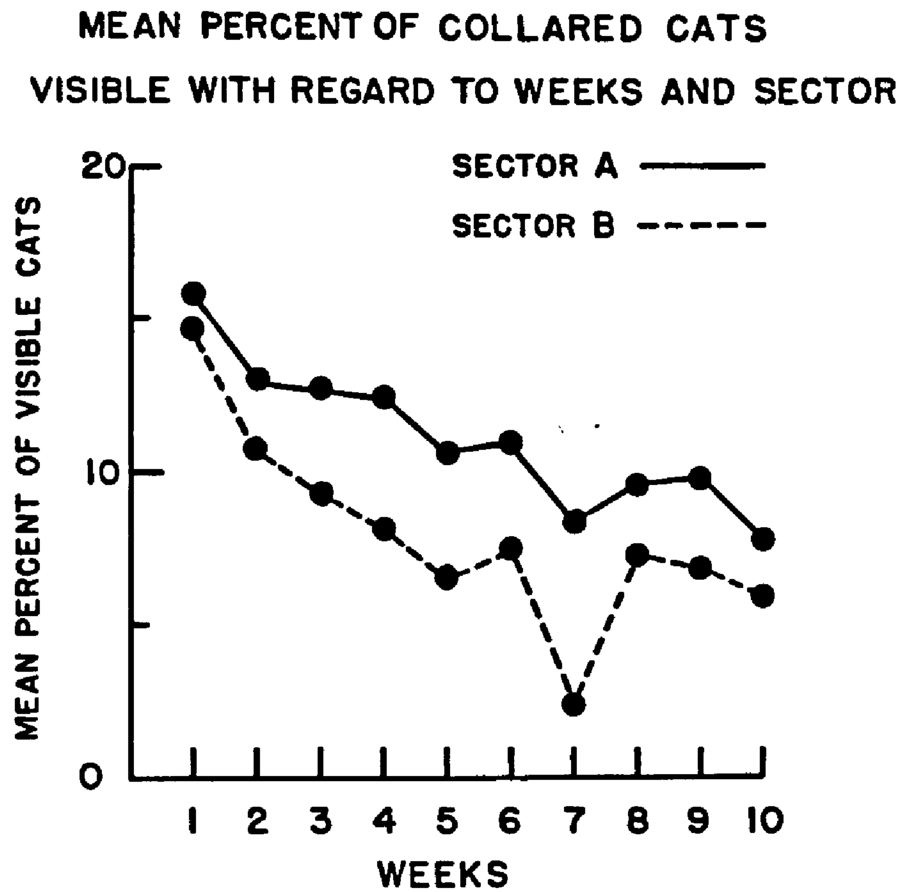
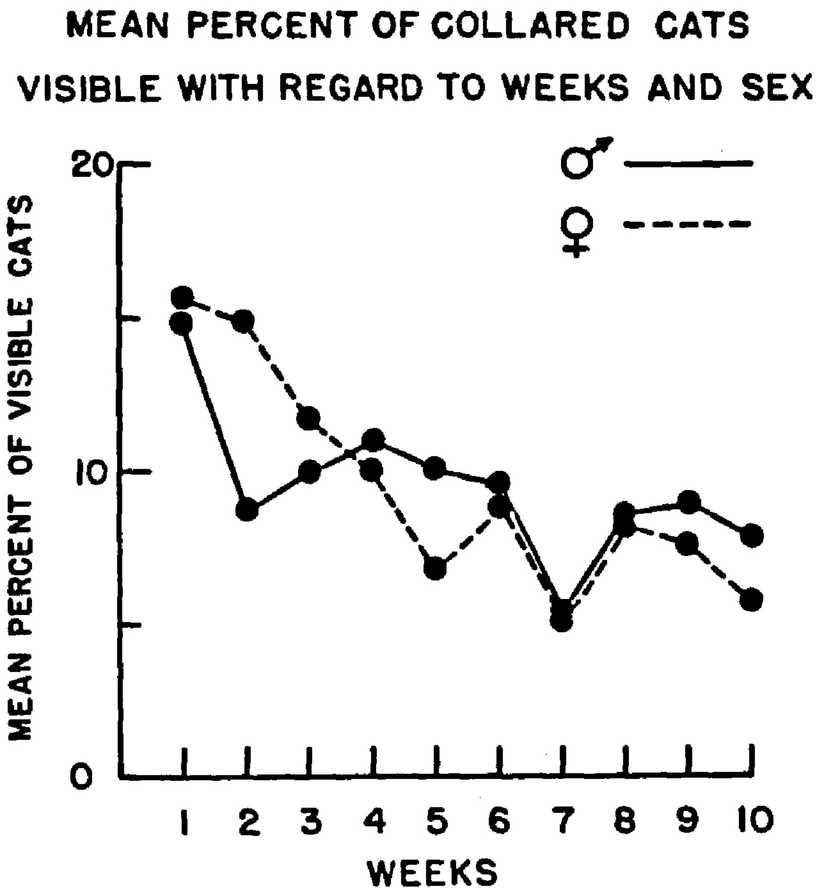

MEAN PERCENT OF COLLARED CATS
VISIBLE WITH REGARD TO WEEKS AND SECTOR
SECTOR A
SECTOR B
MEAN PERCENT OF VISIBLE CATS
20
10
0
1 2 3 4 5 6 7 8 9 10
WEEKS

Figure 12



MEAN PERCENT OF COLLARED CATS
VISIBLE WITH REGARD TO WEEKS AND SEX
♂
♀
20
10
0
MEAN PERCENT OF VISIBLE CATS
1 2 3 4 5 6 7 8 9 10
WEEKS

Figure 13

MEAN NUMBER OF TOTAL CATS VISIBLE WITH REGARD TO SECTOR AND TIME BLOCK

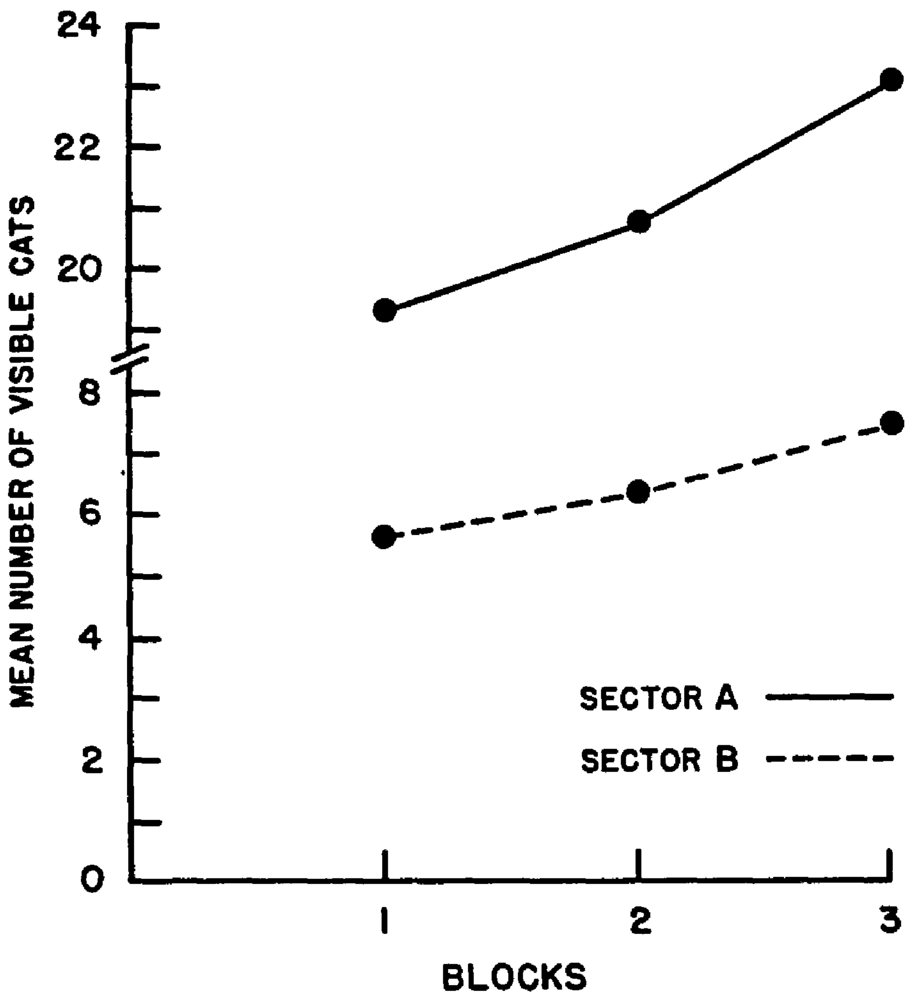


Figure 14

MEAN PERCENT OF COLLARED CATS VISIBLE WITH REGARD TO SECTOR AND TIME BLOCK

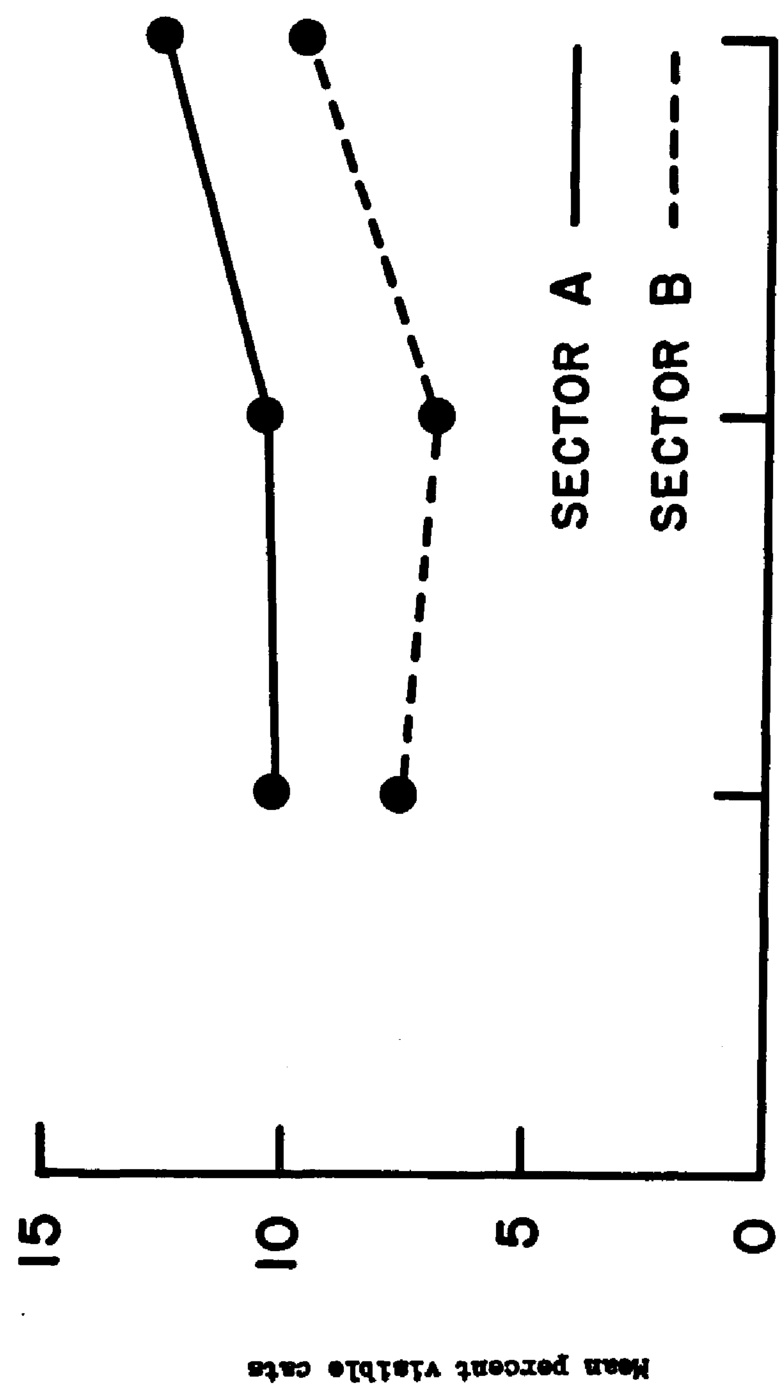


Figure 15

MEAN PERCENT OF COLLARDED CATS VISIBLE WITH REGARD TO SEASON AND TIME BLOCK

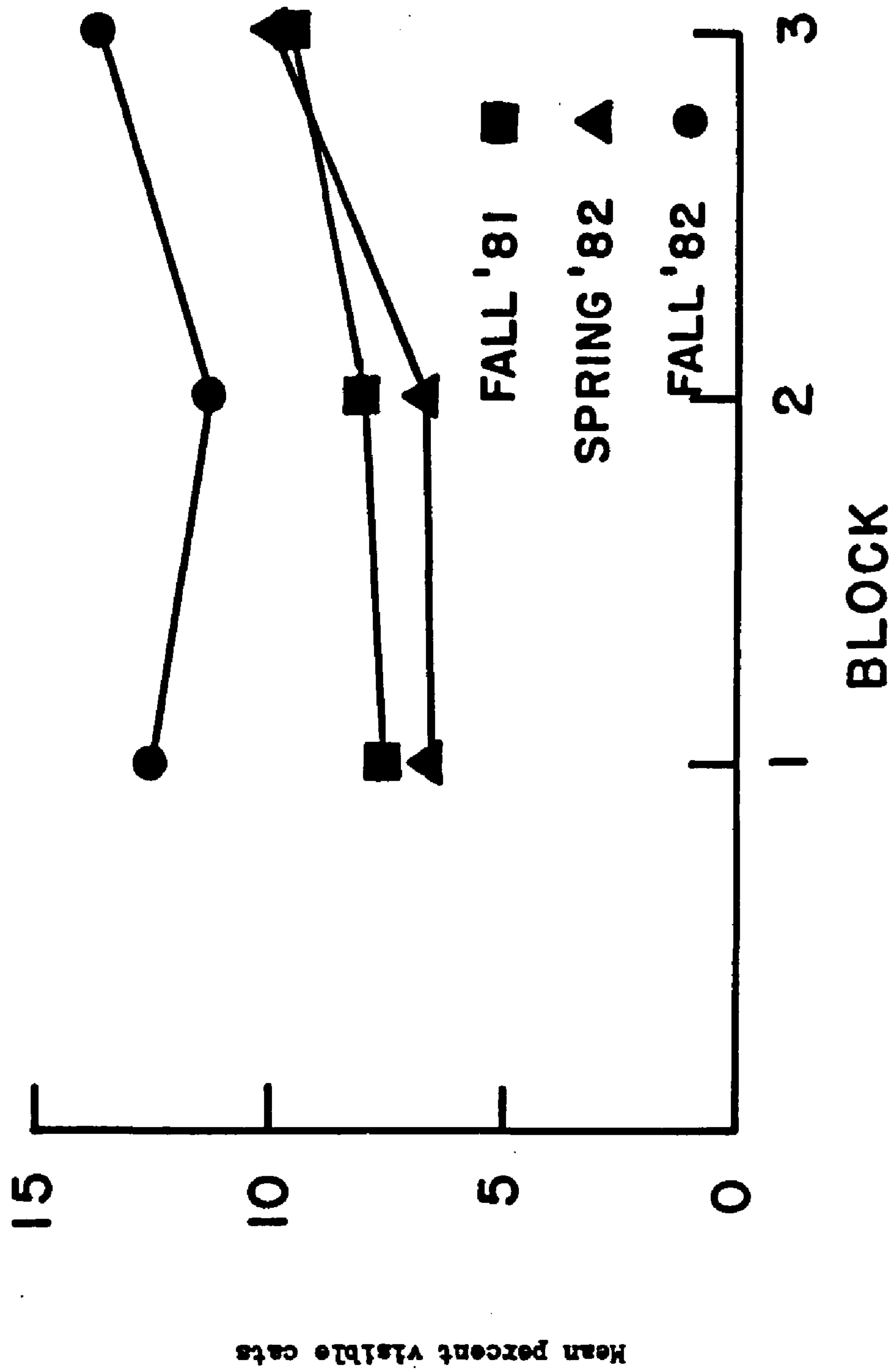
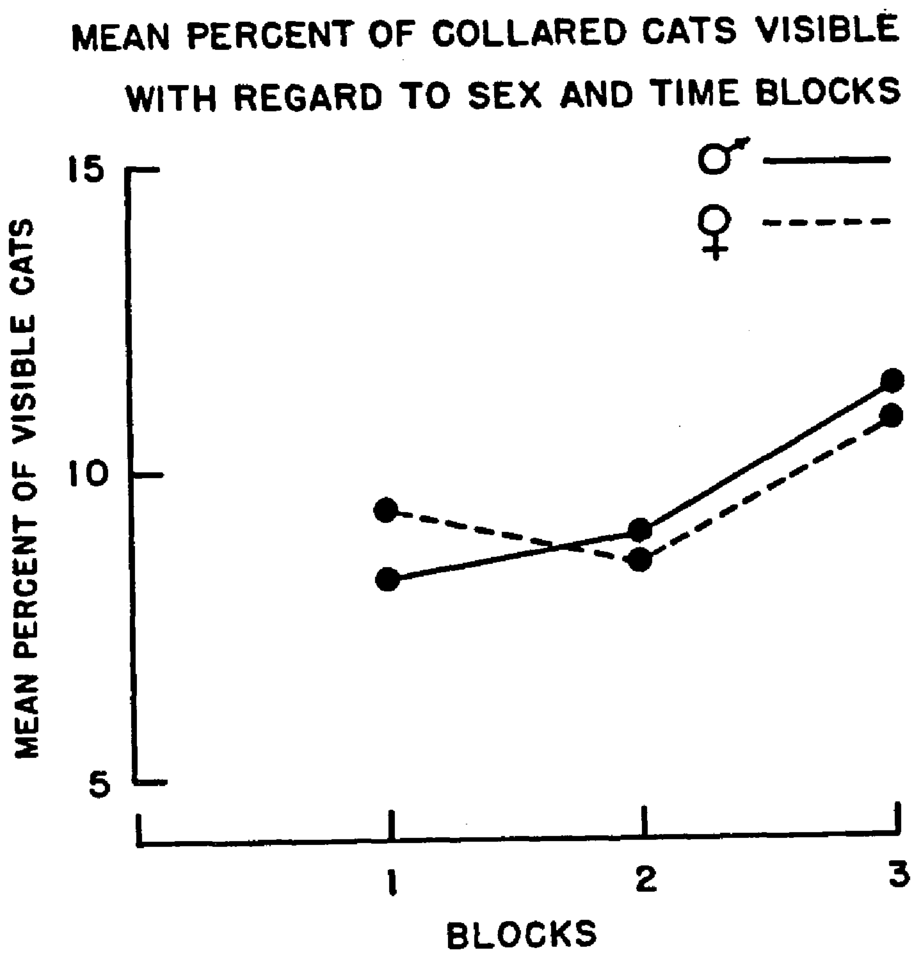
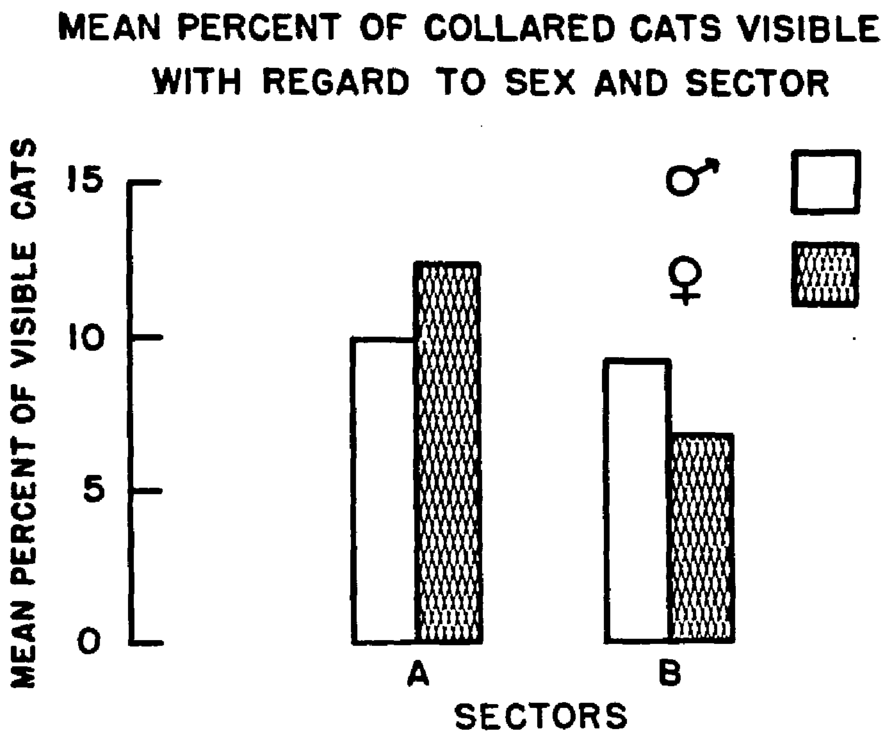


Figure 16



MEAN PERCENT OF COLLARED CATS VISIBLE
WITH REGARD TO SEX AND TIME BLOCKS
♂
♀
15
10
5
MEAN PERCENT OF VISIBLE CATS
1
2
3
BLOCKS

Figure 17



MEAN PERCENT OF COLLARED CATS VISIBLE WITH REGARD TO SEX AND SECTOR
MEAN PERCENT OF VISIBLE CATS
15
10
5
0
♂
♀
A
B
SECTORS

TABLE 1

CHARACTERISTICS OF CAT'S ENVIRONMENT

	SECTOR A	SECTOR B	G	DF
<u>Types of Housing</u>				
Private	7	37	35.894**[a]	1
Multiple Dwelling	78	38		
<u>Garbage</u>				
Season Total Unlidded Cans & Open Bags	17564.4	8330.0	3366.0**	1
<u>Abandoned Buildings</u>				
Number of Buildings	14.0	6.0	3.29ns	1
Number of Buildings x Height in Stories	62.0	20.0	22.56**[b]	1
<u>Human Residents</u>				
Black:White:Other	31:15:33	34:17:16	4.025ns[a]	2
Others:White	64:15	50:17	0.531ns[a]	1
<u>Longevity in Sector of Humans</u>				
Less Then One Year	8	5	0.925ns[a]	3
Two to Five Years	27	22		
Six to Ten Years	22	18		
Greater then Eleven Years	35	36		

a)Information gathered by telephone survey of residents in study area.

b)Assuming that internal staircases allow free passage for cats once inside an abandoned building, differences in building size reflects more accurately available space.

Table 2

FREQUENCY OF CAT FEEDING AMONG RESPONDENTS TO SURVEY

	Daily	Occasionally	Never	Total
Respondents	5	37	135	177
% of Sample	2.82	20.9	76.28	100
Daily Food,kg+ci	1.471±.435	0.315±0.076	None	1.786±0.150

Table 3

ESTIMATES OF CAT FEEDING OCCURRING IN THE STUDY AREA[a]

	Daily	Occasional	Never	Total
Estimated number residents + ci	72.27±16.43	535.67±40.35	1955.06±42.21	2563
Estimated Daily Food, Kg + ci	21.30±1.655	4.56±0.288	none	25.86±0.576
Estimated Food kg/h/day + ci	1.145±0.384	0.245±0.021	none	1.39±0.134
Estimated cats per hectare+ci				
@ 184 g/cat	6.22±2.08	1.33±0.14	none	7.55±0.89
@ 150 g/cat	7.63±2.55	1.63±0.11	none	9.26±0.72

[a] Estimates based on 2563 households and a study area of 33.19 hectares.

Table 4

RESOURCES, OTHER THEN FOOD, PROVIDED FOR CATS BY RESPONDENTS OF SURVEY

	Shelter	Medical	Adoption
Respondents	13	21	28
% of Sample	7.34	11.86	15.80
Estimated Residents±ci	188.24±25.88	304.08±32.08	405.15±36.19
Estimated Residents/ Block Face±ci	6.49±4.81	10.48±5.96	13.98±6.72

Estimates based on 2563 households,29 block faces and 177 respondents

Table 5

PROFILE OF A CAT FEEDER

	Categories	Feeder	Non-Feeder	G Statistic	Signif
Sex	Male-female	18:24	54:77	0.035(1df)	0.8517ns[a]
Race	Black-white	15:6	53:26	0.146(1df)	0.3000ns
	Black-white-other	15:6:15	53:26:32	1.586(2df)	0.4526ns
	All others-white	30:6	85:26	0.357(1df)	0.4400ns
Sector	A-B	22:20	72:62	0.023(1df)	0.8784ns
Previous pet owner	owned-never owned	66:29	68:13	5.167(1df)	0.0230*
Feeder of:	Dogs-no Dogs	16:26	7:127	25.688(1df)	0.0001**
	Squirrels-no squirrel	15:27	23:111	6.012(1df)	0.0142*
	Birds-no birds	23:19	39:99	11.362(1df)	0.0007**
Provider of other services	Some-none	21:12	7:133	53.833(1df)	0.0001**

a)This test represents a combining of occasional and daily feeders.Daily feeders in our sample were 4 females and 1 male.

Table 6

COMMUNITY ATTITUDES REGARDING THE FEEDING OF STRAY CATS

	Categories	Positive	Indifferent	Negative	Chisq	Signif
Race	Black-white	29:8	29:12	6:10	8.824	0.0121*
	Black-white-other	29:8:23	29:12:21	6:10:0	20.625	0.0004**
Housing	Renter-owner	56:11	43:25	11:7	8.089	0.0175*
Sector	A-B	46:25	35:42	7:12	7.701	0.0213*

Table 7

SIZE ESTIMATES OF A CAT POPULATION IN BROOKLYN, NEW YORK: TRIPLE-CATCH MARK-RECAPTURE METHOD

SECTOR	Fall 1981	Spring 1982	Fall 1982
A - MULTIPLE DWELLINGS	96.25 ± 16.24	63.15 ± 12.81	81.54 ± 12.95
B - PRIVATE ROWHOUSES	29.59 ± 23.97	35.19 ± 25.99	37.48 ± 9.35

Values given with 95% confidence intervals.

Extrinsic hypothesis: Sectors A and B are equal, G=37.3826** (1df), $\chi^2_{(1,.05)}=3.841$

TABLE 8

MEAN DAILY NUMBER OF GARBAGE RECEPTACLES BY SECTOR POOLED OVER SEASONS

	Sector A	Sector B	Total	Mean/hectare
Closed Cans±ci	80±3.24	300±16.51	380±215.59	11.44±6.50
Open Cans±ci	270±12.84	125±2.06	395±126.27	11.90±3.80
Closed bags±ci	275±12.25	105±2.73	380±166.60	11.44±5.02
Open Bags±ci	75±2.94	10±2.55	95±35.78	2.86±1.07

H: Sector A and Sector B have equal amounts of open cans and bagged garbage, G=3366.0**(1df)

Table 9

One-way analysis of variance of home range size with preselected main effects tested by orthogonal contrasts. Home range size is the minimum area with a probability of 0.50 of sighting a cat, Probability Utilization Distribution (Ford and Krumme, 1979).

Source of Variation	Treatment Group	Sample Size	MS	DF	F
Sex	male	47	0.7979	1	7.1534**
	female	48			
Sector	A	77	0.0562	1	0.4702ns
	B	18			
Season	1	27	0.0561	2	0.4663ns
	2	25			
	3	43			
within group			0.1115	83	

** Statistically significant, $p \leq 0.01$

ns Not significant

TABLE 10

RESULTS OF ANOVAS BY SEX AT DIFFERENT PROBABILITY LEVELS

Probability Level	MS	DF	F
0.95	2.3034	1,93	4.9817*
0.50	0.7979	1,93	7.1534**

Table 11

ANALYSIS OF DIFFERENCE IN VARIABILITY,
F TEST, OF HOME RANGE BY SEX

SEX	N	$\hat{F}$
Male	47	1.688
Female	48	

$F_{(0.05;46,47\ D.F.)} = 1.637$

TABLE 12

COMPARISON OF FREQUENCY OF CAT SIGHTINGS AT FEEDING STATIONS, FALL 1981 AND FALL 1982

Category	Season	Totals	DF	G
Total Cats	Fall 1981	3	1	110.00**
	Fall 1982	96		
Identified Cats	Fall 1981	3	1	17.46*
	Fall 1982	23		

Totals represents all sightings from all feeding stations

TABLE 13

NUMBER OF CATS COLLARED IN EACH OF THE THREE SEASONS OF STUDY

SEASON	SEX	SECTOR A	SECTOR B
FALL 1981	Male	19	8
	Female	19	9
SPRING 1982	Male	22	9
	Female	20	4
FALL 1982	Male	28	10
	Female	26	8

TABLE 14

COMBINED ANALYSIS OF VARIANCE TABLE OF ACTIVITY DATA:
TOTAL CATS AND PERCENT OF COLLARED CATS

	TOTAL		COLLARED	
SOURCE	D.F.	F	D.F.	F
SEASON	2	65.5975**	2	46.3118**
SECTOR	1	1320.3635**	1	217.2807**
SEX			1	1.8547ns
WEEK/SEA.	27	5.9971**	27	9.8867**
SEA. x SECT.	2	0.7895ns	2	30.6870**
SEA x SEX			2	30.9337**
SECT. x SEX			1	37.3929**
BLOCK/SEA.& WEEK	60	2.4931**	60	2.8156**
SECT. x WEEK/SEA.	27	6.6059**	27	2.9486**
SEX x WEEK/SEA.			27	3.3763**
SEA. x SECT. x SEX			2	4.5860*
SECT. x BLOCK/SEA.& WEEK	60	2.2715**	60	1.7349**
SEX x BLOCK/SEA. & WEEK			60	1.9159**
SECT. x SEX x WEEK/SEA.			27	3.1177**
SECT. x SEX x BLOCK/SEA. & WEEK			60	1.7172**
ERROR	360		720	

Appendix A - Questionnaire

Name________________________
Address______________________
Phone_______________________

I.D.#________________________

Column Code

1. How long have you lived in your neighborhood? 5
______________.

Codes
0-1 years.........1
2-5 years.........2
6-10 years........3
11+ years.........4

2. Have you ever had a pet? 6
yes.......1
no........2

3. How many pets do you live with now?
Kinds & numbers______________________

Codes
Dogs, use equivalent #s 0-9 7
Cats, use equivalent #s 0-9 8
Birds, use equivalent #s 0-9 9
Rodents, use equivalent #s 0-9 10
Rabbits, use equivalent #s 0-9 11
Reptiles, use equivalent #s 0-9 12
None.........................0 13
1-Dog, 2-Cat, 3-Birds, 4-Rodents, 5-Reptiles,

4. Do you ever give stray dogs food? 14
yes........................1
no.......Go to Quest. 6...2

5. How often? 15

Less than 5X a year..................2
Once a week..........................3
Every day............................4
More than once a day.................5

6. Do you ever give squirrels food? 16
yes........................1
no....Go to Quest. 8......2

7. How often? ______________ 17

Codes
Less than 5X a year......1
Once a week..............2
Every day................3
More than once a day.....4

8. Do you ever give stray birds food? 18
yes.......................1
no.....Go to Quest. 10..2

9. How often?______________ 19

Codes
Less than 5X a year......1
Once a week..............2
Every day................3
More than once a day....4

I.D.#__________

	Column	Code
10. How often do you give stray cats food? Never - Go to quest. 32 ....1 Less than 5X a year...Go to quest29.......2 At least once a week..Go to quest.29......3 Every day..................................4 More than once a day.......................5	20	
11. What do you feed the cats? Store bought cat food. What Kind?__________....1 Homemade food? What?______________________....2 Table scraps...................................3 All of the above...............................4 None of the above. I feed them__________....5	21	
12. Please describe what you usually give the cats to eat. (Kind & amount)______________________________ ______________________________ Codes	22 23	
13. Why did you start feeding the cats?______________ ______________________________ Codes Afraid they would starve................01 They are homeless.......................02 I can't stand to see things suffer.....04 They are living things too.............08 The weather was so harsh...............16 She was pregnant, or had kittens.......32	24 25	
14. How many cats do you feed regularly? __________ one................................1 two to four........................2 five to six........................3 7 to eight.........................4 9__ to ten.........................5 11 to twelve.......................6 13 __ to fourteen..................7 15 ___to eighteen..................8 19 ___to twenty....................9 More than twenty...................0	26	
15. Have you named the cats? yes..........1 no...........2	27	
16. Do your neighbors object to your feeding the cats? yes.........................1 no....Go to quest 18.......2	28	

I.D.#________________

	Column	Code

17. What do you do about your neighbor's complaint? — Column 29, 30
You may choose more than one.
    Ignore them..............................01
    Move the feeding place.............02
    Change the time I feed the cats......04
    Talk to my neighbors to explain......08
    Argue with my neighbors..............16
    None of the above, I_______________32

18. At what time do you feed the cats?_______________ — Column 31
Codes
    Before work.....................1
    After work......................2
    Around 6 A.M....................3
    After I get up..................4
    When I walk the dogs............5
    Before I go to sleep............6
    Whenever I can..................7
    When they look hungry..........8

19. Why, at that time? _______________ — Column 32
Codes

20. Have you provided the cats with some place to live? — Column 33
    yes.....................1
    no...Go to Quest. 22...2

21. What?_______________ — Column 34
Codes
    Handmade shelter...................1
    Let them into my basement.........2
    Let them into my lobby............3
    Take them into my home............4

22. Have you had any of the stray cats neutered? — Column 35
    yes........1
    no.........2

23. Have you helped a sick stray cat? — Column 36
    yes............................1
    no...Go to Quest. 25...........2

24. How?_______________ — Column 37, 38
Codes
    Taken them to a veterinarian........01
    Doctored them on the street.........02
    Doctored them in my home............04
    Gave them to someone else to doctor.08
    Called an animal rescue organizat...16

I.D.#____________________

Column | Code

25. If you have to be away from home for a few days, would you make arrangements for the cats to be fed? — 39
    - yes.................1
    - no..................2

26. Do you take the cats needs into consideration when making social plans? — 40
    - yes.................1
    - no..................2

27. Although you willingly feed the cats, is it too expensive? — 41
    - yes.................1
    - no..................2

28. Do you provide the stray cats with any of the following? You may choose more than one. — 42
    - water...............1
    - milk................2
    - none of above.......0

GO TO QUESTION 37

---

29. When you feed the cats, why do you feed the cats? — 43, 44

Codes

They look hungry......................01
They are kittens......................02
I can't stand to see things suffer...04
They are living things too...........08
The weather was so harsh.............16
She was pregnant, or had kittens.....32

30. When you feed the cats, how much food do you give? — 45

Codes

31. Where do you feed the cats?____________________ — 46, 47

Codes

On the fireescape.....................01
In the backyard.......................02
In front of the building.............04
Wherever I see them..................08
In the basement.......................16
In the hall way of my building......32

32. Do you provide the stray cats with any of the following, You may choose more than one. — 48
    - water...........1
    - milk............2
    - shelter.........4
    - none of the above..0

I.D.#________________

column code

33. Have you taken a stray cat into your home to keep as a pet? — 49
yes..............................1
no...Go to Quest. 35...........2

34. How many?________________ — 50

codes
1-2......................0
3-4......................1
5-6......................2
7-8......................3
9-10.....................4
11-12....................5
more than 12.............6

35. Have you provided medical help for a sick stray cat? — 51
yes.........1
no..........2

36. How would you feel if your neighbor fed stray cats? — 52, 53
____

codes
I would be very upset.................01
I would want him to stop.............02
I would be somewhat upset............04
I would not care......................08
I would like it.......................16
I don't know..........................32

-- Go To Question 39 --------------------------

37. How often have you taken stray cats into your home to keep as a pet? ________________ — 55

Codes
1-2..................0
3-4..................1
5-6..................2
7-8..................3
8-9..................4
9-10.................5
11-12................6
13-14................7
14-15................8
15+..................9

38. Why did, you adopt these cats? ________________ — 56, 57
____

Codes
Iliked the cat particularly..........01
It was pregnant......................02
It needed medical help...............04
The weather was harsh................08
It was helpless......................16
It selected me.......................32

I.D.#________________

Column | Code

39. Which do you think is true of stray cats? You may choose more than one answer. 58 59

They keep pest animals away(mice)..........01
Nice as Pets.................................02
Carry disease................................04
Are a nuisance...............................08
Have no value to me..........................16
None of the above............................32

THE FOLLOWING FEW QUESTIONS ARE ABOUT YOURSELF. AGAIN LET ME SAY THAT YOU DO NOT HAVE TO ANSWER ANY QUESTION YOU DO NOT WANT TO. SIMPLY SAY, "I PREFER NOT TO ANSWER".

40. What is your sex? 60

male.........1
female.......2

41. What is your age at your last birthday?__________ 61 62

42. Which group do you belong to? 63 64

Asian..............................01 Country________
South American.....................02 Country________
Central American..........04 Country____________
American Black............08
American White............16
None of the above, I am__________.........32

43. Do you own or rent your home? 65

own............1
rent...........2
neither........3

44. With how many people do you live?

adults____________ 66&67
children____________ 68&69

Appendix B - Pilot

Formulation of the basic questions and hypotheses of this study were derived from a pilot project the investigator conducted from November 1977 to August 1978. A population of free-ranging urban cats were studied in Brooklyn, New York.

The results of the temporal aspects of this study disclosed a shift in what is traditionally considered the daily pattern of small mammal activity (Brown, 1962); interference by humans was believed to be the cause. Cats were most active at 0100 and 0500 hours, exhibiting a middle of the night and a sunrise peak in activity, never a sunset peak. Seasonaly activity was highest in summer, lowest in winter and intermediate in spring and fall. In addition, sexual differences in total gross locomotion activity by season were suggested by the data but the small sample size prevented statistical verification.

The other results of the study pertain to home range. The cats were found to have small home ranges and high population density. Although differences in home range size by sex were observed, they were not found to be significant. A full description of the pilot and its results are given below.

Methods

To initiate a study of home range and activity patterns of the urban cat, the investigator undertook a one year pilot study from November 1977 to August 1978. A study area 7.95

hectares was designated in Brooklyn, New York; it consisted of brownstone rowhouses, large multiple dwellings, and commercial properties (Fig. 1). This area was selected because it offered a one block wide buffer zone around an area in which, a preliminary survey indicated, a large cat population resided. The purpose of the study was to evaluate the spatial and temporal distribution of a population of urban street cats. To accomplish this end, hourly surveys of the study area were conducted in which every visible cat was counted and recorded by location (number of the nearest building), sex, and individual identity. The method used involved walking through the study area along a specific route and recording every cat seen between the center of the road and the edge of the building line. Four consecutive hourly surveys were done daily, and so it took six days to complete twenty-four hours of surveying; three 24-hour periods (72 hours in total) were sampled per season. All seasons of the year were sampled as follows: Fall, 1-20 November, winter, 1-20 March, spring, 1-20 Mary, and summer, 17 July to 10 August. Temperature readings were taken at the start of each hourly survey.

Individuals were recognized by appearance using a) pelage color and pattern, b) body build and size, c) sex, and d) other individual differences. These criteria for identification were used by Beck (1973) and Dards (1978), both of whom did urban field studies.

Gender was identified by using direct observation of the genitalia whenever possible, in conjunction with pelage color and pattern (Monaloy, 1977), secondary sex characteristics, and mating behavior. Only 2/3 of the population could be positively identified by sex.

Results

(a) Population Parameters. My results indicated that the population size was stable; there was no significant difference in population size from season to season. The mean number of cats observed per season was 31.25 ± 5.9. Sex ratio was not found to differ from 1:1 for all seasons, though fall showed a $P = 0.10$ for the males as compared to the females. An analysis of activity by season explained this result; males were more active in fall than females.

Without regard to season, approximately 50%, or 16 of the 31.25 cats seen were residents (seen for more than one season), and the rest were considered transients. Of the 16 residents, half the cats were feral and half were maintained. A maintained cat was defined as an individual who was observed to receive a daily food allotment, although it did not necessarily have to be a pet. A feral cat was defined as an individual which had not been observed to receive any such food supplement. The seasonal density was found to be 3.93 cats per hectare, but when only resident cats were considered, it was 2 cats per hectare.

(b) Temporal Distribution. Temporal distribution was evaluated by comparing the visibility (occurrence) of cats on the street by hour, season, and sex. Visibility as an index of population parameters has been used by other investigators (Newman, 1959; Bidder, 1962; Osterberg, 1962; Beck, 1973; Ringelman & Flake, 1980). For an urban cat to become visible, it must emerge from the basement or backyards onto the perimeter of the street, and so visibility is an indicator of periods of gross locomotor activity.

The results were interpreted to mean that the daily visibility pattern was consistent and predictable. Time of day was found to have an effect on visibility, $P < .0001$ ($F = 7.98$:23/184 d.f.). The hourly pattern, without regard to season, showed highest visibility between 2200 and 0600 hours, with peaks at 0100 and 0500 hours, and lowest visibility between 1000 and 1400 hours EST (Fig. 2). The hourly visibility pattern conforms to the hourly activity patterns of small mammals (Brown, 1962) and Felids in general (Schaller, 1972; Knappe, 1959-60; Lindemann & Reick, 1953), except for the absence of a sunset peak. The absence of the sunset peak was interpreted to be an adaptation to the urban environment, facilitating avoidance of humans.

Kunz and Todd (1978) found cat visibility in a suburb of Athens, Greece, to be inversely proportional to human activity. Egughi (1980) found human avoidance also influenced the activity pattern of Japanese red foxes in central Kyushu.

Season also was found to affect visibility, $P < .001$, ($F = 19.23$:3/184 d.f.), seasonal and hourly affects were additive.

Seasonally visibility changed only in magnitude. A Duncan's Multiple Range Test revealed that summer was the season of highest visibility and winter that of the lowest; spring and fall were intermediate ($\alpha = .05$, ($F = 0.421$ with 184 d.f.).

Seasonal differences in activity by sex were not found to be significant, $P > 0.05$, however, a histogram of the resulting values did seem to indicate a trend (Fig. 3). Female seasonal visibility was found to follow tne overall pattern reported above, while for males, highest visibility occurred in fall with intermediate levels in spring and summer, only 2/3 of the population was of known sex. Comparison of seasonal environmental changes (Fig. 4) with changes in visibility by sex suggest that male visibility is more affected by changes in day length, while female visibility is more affected by changes in temperature, though there is an interaction of both parameters in both sexes (Figs. 3 & 4).

(c) Spatial Distribution. Spatial distribution was estimated and plotted using the bivariate normal home range technique, A_4 of Jenrich & Turner (1969) and the computational approach of Sokal and Rohlf (1969). This analysis was selected since it is an unbiased estimator of home range; it is not affected by the number of locational data points (Koeppl, 1975;

(Madden & Marcus, 1978). Home range was estimated seasonally for each individual seen three times per season, for a minimum of two seasons (not necessarily consecutive).

Results indicated that size and location of the urban cat's home range is very stable. No significant difference in home range size by season was found, $P > 0.05$, and for all but two cats, all seasonal home ranges overlapped (Fig. 5).

No significant difference was found in home range size by sex (Table 1). This finding was surprising since many home range studies report differences due to sex.

A significant difference in home range size did, however, occur between feral and maintained cats, $p < 0.001$ ($F = 14.54$: 1/58 d.f.). Without regard to sex, maintained cats had an estimated home range size of 0.43 ± .14 hectares while feral cats had a home range of 2.40 ± .56 hectares.

Within the study area, a minor and a major area cf cat concentration was found. Cat concentration corresponded to the type of housing (single vs. multile dwellings), and corresponding availability of garbage. Four of the 16 resident cats lived in the brownstone area, while the remaining 12 lived in the area of multiple dwellings. Cats living in one area were never seen in the other, and vice versa.

Discussion

As previously stated, Dards (1978) found, for a population of urban cats in Portsmouth Dockyard of Hampshire, England, male home range to be 8.4 ha. and female to be .84 ha.

Although the home ranges found were somewhat larger than those found in this study, they were comparable considering the differences in areas studied. She examined an urban area in which the amount and location of garbage and harborage was continuously changing while this study examined a residential area where the physical parameters of the environment were comparatively stable. The closeness of the estimates is even more apparent when compared to the home range estimates found for rural cats (Liberg, 1980; George, 1974; MacDonald & Apps, 1978), although as previously stated, within rural areas as well, feeding a cat reduces its home range size.

Beck (1973) found small home ranges for urban dogs in Baltimore and an approximately 10-fold difference in home range size between the truly feral and free-ranging pet dogs. The same animal that had a home range of 2.59 ha. when feral exhibited a home range of no more than 0.52 ha. once a free-ranging pet.

As reported by Beck the home range size of the dogs in Baltimore were smaller than what has been reported for dogs in rural areas.

The lack of significant difference in home range size between sexes is difficult to explain and inevitably calls into question the sex identification methodology. However, if one accepts the results, a possible explanation for them might be found in the work of Bowers & Smith (1979).

As previously stated, working with Peromyscus leucopus, they found sexual difference in home range size to be related to the heterogeneity of the environment. The urban environment, though filled with many man-made structures, has been found to have fewer niches than the non-urban environment and to be less biologically diverse (Lancaster & Rees, 1979), and so perhaps, from an animal's point of view, the urban environment is more homogeneous. When compared to the rural habitat, the uniform array of houses and so availability of resources (food and harborage) might lend a comparative uniformity to the urban habitat for an animal the size of a cat. If this is so, perhaps the lack of home range differences due to sex can be attributed to the homogeneity of the environment.

Conclusion

A more rigorous methodology is required to confirm the home range and activity patterns of the urban cat. The question of sexual differences in both the spatial and temporal distribution of the free-ranging urban cat has been raised by this pilot, however, in order to answer these questions a more extensive study must be initiated. The population must be resurveyed, but this time, the individuals must be trapped, tagged for individual identification, examined for sex, and released.

Appendix C

Cat trapping and identification data sheet

DATE	LOCATION ADDRESS	TIME	TEMP	CAT I.D. COLLAR COLOR, #	SEX A/J	WGT	HEALTH	REACTION AFTER REL	PHOTO #s	COMMENTS/OBSVR.

Cat sighting data sheet

(3)

REPETITION SECTOR TIME BL.	DATE	HOUR	BLOCK FACE	# OF CANS +	# OF CANS -	# OF BAGS +	# OF BAGS -	UNCONTAINED GARBAGE, YES OR NO ≥ ONE BAG FULL	COMMENTS/OBSERVATIONS

Garbage count data sheet

② REPETITION SECTOR ? TIME BL.	DATE	HOUR	TEMP.	CAT, NAME, NUMBER OR UNKNOWN	② LOCATION	ACTIVITY	COMMENT/OBSERVATIONS

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