FERAL CATS (*FELIS CATUS*) IN AN URBAN CONSERVANCY: UNIVERSITY OF KWAZULU-NATAL, HOWARD COLLEGE CAMPUS

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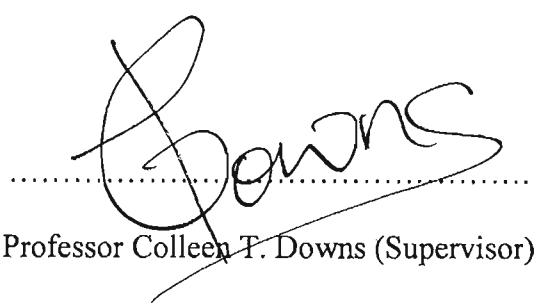
PREFACE

The experimental work described in this dissertation was carried out in the School of Biological and Conservation Sciences, University of KwaZulu-Natal, Pietermaritzburg, from March 2004 to December 2005, under the supervision of Professor Colleen T. Downs and co-supervision of Professor Helen Watson and Marilyn Bodasing.

These studies represent original work by the author and have not otherwise been submitted in any form for any degree or diploma to any other University. Where use has been made of the work of others, it is duly acknowledged in the text.

The thesis is structured with each chapter written in manuscript format with the aim to publish in certain scientific journals. Any repetition was unavoidable.

Jaclyn Kim Tennent (Candidate)



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ABSTRACT

The resident feral cat (*Felis catus*) population on the University of KwaZulu-Natal (UKZN), Howard College campus (HCC) in Durban, South Africa was studied from March 2004 to November 2005. This study was initiated as the HCC is an registered as an urban conservancy and so should be removing alien invasive flora and fauna and conserving the indigenous biodiversity of the campus. This research was undertaken to assist with recommendations for the control and management of feral cats on the HCC. A survey to determine public perceptions and opinions regarding the feral cats was conducted among various communities on the campus. Feral cats from the resident population on the HCC were trapped and fitted with radio-collars in order that their home range sizes and distribution could be determined. Monthly census counts were also carried out in an attempt to calculate population densities of the feral cats on campus, while data on behaviour patterns was collected opportunistically throughout the study period.

The survey showed that two extreme views existed on campus regarding the presence of feral cats. The university is a registered conservancy which some feel is no place for this exotic species. However, it is also situated within an urban surrounding and there are some cat enthusiasts among the public who feel that resources should be provided for the feral cats, both nutritionally and financially. While many people were unaware that the feral cats were a cause for concern on the HCC, the majority concluded that a management policy needed to be adopted to control feral cat numbers. Most were against the suggestion of eradicating the cats and strongly agreed with the implementation of a university funded feral cat

sterilising and feeding programme. Feeding the feral cats, however, needs to be stringently controlled.

In this study, the availability of an abundance of food resources was shown to be the primary influencing factor for home range size, cat distribution and population densities. It also had an overriding effect on the feral cats' behaviour patterns and activity levels. Once these had been initially established, other factors such as human activity, reproductive status and gender then came into play. Distribution of the feral cats around campus was not homogenous, and densities differed according to areas on campus. Highest cat densities were recorded in those areas on the HCC where permanent cat feeding stations had been established (usually the developed areas on campus), while no feral cats were sighted in the Msinsi Nature Reserve, a natural bush area on campus were no food resources (other than prey species) is available. Home range sizes of the feral cats were relatively small with a considerable amount of overlap between and within the sexes. There were also no seasonal differences in range sizes and diurnal ranges were only marginally smaller than nocturnal range sizes.

In terms of behaviour, the HCC feral cats were generally inactive, with passive behaviour such as lying down and sitting being most often observed. Although hunting activity was very rarely witnessed, the combined effects of feral cats supported at high densities by supplemental feeding may exert predation pressures that could be detrimental to both local prey and predator populations. Little social interactions were observed by the cats on the HCC. Other studies show that competition is greatly reduced if food is available in abundance and there is no need for territorial disputes if both food and a potential mate are located in close proximity. In the present study, this also means that immigrating feral cats from surrounding

neighbourhoods are tolerated; another factor contributing to the increase in feral cat numbers on the campus.

These findings suggest that the feral cat population on the HCC is being maintained at higher population densities than would be expected and management initiatives are needed to control the feral cat population at a minimum density through a sterilising and low key feeding programme so that it is acceptable to all concerned parties. However, the decisions need to favour the status of the HCC as a conservancy in an urban area as well as consider the well-being of the students and staff members in a public place.

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CHAPTER 1

General Introduction

Cats (*Felis catus*) were first domesticated at least 4000 years ago in Ancient Egypt (Lumpkin 1993). However, this is only a rough estimate. Archaeological evidence seems to suggest that tame cats may have existed 8000 years ago (Macdonald 1992). Others suggest that the first records of domestic cats date back to only 150 BC (Macdonald 1992). Whatever the case, it is accepted that cats were among the last animals to become domesticated, although some people believe that cats were never truly domesticated (Tabor 1980).

Classified as of the Order Carnivora and the Family Felidae, today's modern cat, in its wild state, is found throughout most of the world (Rosevear 1974). Man, however, introduced the domesticated cat into all areas of the globe.

A majority of the Carnivore species are primarily solitary (five out of the 7 families) (Sandell 1989), having very little to do with conspecifics. The African lion (*Panthera leo*) and the cheetah (*Acinonyx jubatus*) are accepted as the only social felids (Laundre 1977; Clutton-Brock & Harvey 1978). However, studies have shown that the domestic cat can vary in its spatial organisation-from solitary to living in groups (Apps 1986; Natoli 1994) and that these cat populations are truly structured and functional social groups (Macdonald 1992). Turner and Bateson (2005) have reviewed research on both domestic and feral cats, and have suggested that spatial organisation is strongly affected by resource availability and that population density, home-range size, home-range over-lap and group size are all affected by food/shelter distribution and abundance.

While it has been accepted that the domestic cat can live in social groups, no instances of group living has been reported when in a strictly feral state, beyond the

temporary mother-family bond (Laundre 1977). Page *et al.* (1992) defines feral cats as being "un-owned and unconfined", and they can be distinguished from stray cats, which are found in and around cities, towns and rural properties and may be semi-dependant on some resources provided by humans, but are not owned (Australian Draft Threat Abatement Plan 1997). In the present study all cats not considered as pets will be referred to as "feral".

Most cats are considered to be opportunistic hunters with the level of predation mostly based on the prey abundance (Coman & Brunner 1972; May & Norton 1996; Hutchings 2003). Also, the size of the prey is reported to be smaller than the predator in the case of smaller, solitary cats (Kleiman & Eisenberg 1973; Laundre 1977). However, these small cats have been known to bring down larger prey. Barratt (1997) and Churcher and Lawton (1987) showed that cats are primarily predators of small mammals and that in Australia and the UK, rabbits seem to be the most important dietary item (when available) (Coman & Brunner 1972; Apps 1986; Martin *et al.* 1996; Courchamp *et al.* 1999; Risbey *et al.* 2000; Hutchings 2003). Because of their predatory nature, they have also been implicated in the decline of local fauna in Australia, New Zealand and parts of the UK (Langham & Porter 1991; Martin *et al.* 1996; May & Norton 1996; Risbey *et al.* 1997; Risbey *et al.* 2000; Hutchings 2003). Feral cats are also seen as pests because they are the primary hosts of several parasites (Langham & Porter 1991) and other pathogens including rabies (Page *et al.* 1992).

There are suggestions that feral cats, if provided with food on a regular basis, will "extinguish predatory behaviour" (Barratt 1997), however, Churcher and Lawton (1987), showed that hunting still occurred, in spite of the ample food provided. Calhoon and Haspel (1993) found that cats in an urban area in Brooklyn had an excess of food available to them, and that only one instance of predation was recorded in over 180 hours of observations.

Although plenty of research has been done on free-roaming and feral cats, most of it has been limited to rural areas (Hall & Pelton 1979; Liberg 1980, 1984; Warner 1985; Martin *et al.* 1996). Urban areas have their own set of problems when it comes to feral cats. Feral cats help to control rodent pest populations (Gunther & Terkel 2002), but in Australia cats have no influence on the rabbit populations (Davies & Prentice 1980; Courchamp *et al.* 1999) and if other prey is available, rabbits would make up only a small proportion of the diet (Churcher & Lawton 1987). Natoli (1994) even went so far as to suggest that feral cat populations had an educational influence and constituted a source for animal behaviour and nature studies in areas undergoing urbanisation.

The Howard College campus (HCC) of the University of KwaZulu-Natal (UKZN), Durban, South Africa has a unique situation in that it is a conservancy situated in an urban environment. Indigenous plant growth has been actively encouraged for over 10 years and the land is utilized to conserve wildlife outside protected areas (Nudina 2002). The Oxford dictionary defines a conservancy as being "a body concerned with the preservation of natural resources." If feral cats hunt, as the literature above suggests, a feral cat population on a University campus that is a conservancy would seem to be defeating the objectives. It may seem that a simple solution would be to just remove all the offending cats from the site. However, the conservancy is situated within an urban environment and there would be a continued influx of cats from the surrounding areas, making eradication extremely difficult. Eradication programs have worked well on certain Islands (Bester *et al.* 2002). However, this method is not practicable in light of a recent study which have shown that cats will re-invade areas (Short & Turner 2005) and the "vacuum" (Tabor 1980) left on campus by the removal of the campus cats may result in cats from surrounding areas moving in due to the availability and wide distribution of food sources, and from the frequent introductions of a large number of unwanted pets (Davies & Prentice 1980). Other negative aspects

include health risks to both the public and the cats themselves (Gunther & Terkel 2002). Thus, the need for management of the existing feral cat population on the HCC is of importance in the context of its status as an urban conservancy. However, data about the cats in terms of population density, demographics, behaviour and home range are unknown.

Rationale

In order to quantify the influence of the Howard College feral cats on the local wildlife populations, and develop a suitable management strategy, a preliminary study needs to be done of the population demographics, home range, movement and behaviour of the feral cats. This data will then be used to develop efficient control measures, which would cause minimum disturbance to the campus's ecosystem.

Proposed study

The aim of a Conservancy is to protect the Natural resources of an ecosystem. The presence of feral cats on the HCC is viewed by some to have a negative effect on the population growth of certain birds, lizards and small mammals that are preyed on. Others believe that regular feeding of feral cats means that they do not pose a threat to the wildlife in the area and that a sterilisation program controls the numbers in the population. There is, however, very little data in South Africa that can be used to support either of these extreme views. Thus, the proposed aim of this study was to collect preliminary data on the feral cats of the HCC through public perceptions, population estimates and demographics, effects of feeding and sterilisation on population density, home range sizes and distribution and some behaviour patterns to assist with a management proposal. The following objectives were formulated:

- To examine the university public opinions and perceptions of the feral cats on the Howard College campus (Chapter 2). By means of a questionnaire and personal interviews, data from staff and students was recorded to assess feral cat visibility, activity and whether the campus community thought the cats posed a potential threat to the local fauna and management in a conservancy and an urban area.

- Compare the home and core range size and distribution of feral cats (Chapter 3) using radio-telemetry. A sample group of resident feral cats was radio tracked in order to determine what some of the main influencing factors of range size and location may be.

- Determine the population density and demography of the feral cat population on the HCC (Chapter 4). This included using various census techniques in order to calculate the feral cat population size on the campus and determine if there were any temporal changes in cat density.

- Examine the feeding and territorial behaviour of the cats on the HCC to assess if the feral cats pose a threat to the local wildlife on campus, either directly through hunting or more indirectly through competition for available resources (Chapter 5).

- To develop a proposal for managing the feral cat population on the Howard College campus (Chapter 6). This includes an appraisal of the status of the capture-neuter-release program currently being implemented on campus. Also, literature from other management programs was reviewed and used in conjunction with the results from this study.

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CHAPTER 2

Public perceptions of a feral cat population on a University campus that is an urban conservancy

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ABSTRACT

The Howard College campus of the University of KwaZulu-Natal is a registered conservancy whose aim is to protect its natural resources. It is located within an urban area, however, more importantly, the Msinsi Nature Reserve is situated within the campus grounds. The campus community expresses two extreme views regarding the resident feral cat population on campus. One view is that the presence of feral cats has a negative effect on the population growth of certain birds, lizards and small mammals within the reserve that are believed to be the main food source for these feral cats. Others, however, believe that regular feeding of feral cats means that they pose no threat to the local wildlife and that the sterilisation programme is controlling the population numbers. This study represents an assessment of the university publics' perceptions as a whole regarding the feral cat population on the campus. There were daily sightings of feral cats by the majority of the University public

mainly in those areas were feeding stations had been set up. Eating was the main activity observed and these stations appear to be the main source of nutrition for these cats. General feelings towards the feral cats tended to be positive and there were very strong feelings against the suggestion of eradicating the entire feral population. The main finding too, was that feral cats should not be considered an invasive alien species, but rather as a benign exotic species not subject to the eradication policies of a Conservancy.

INTRODUCTION

Interactions between feline cats (*Felis catus*) and humans have occurred for thousands of years and attitudes towards them have changed positively and negatively with time. The cats' cohabitation with man can be traced back to the Middle Kingdom of the Egyptian empire about 3600-4000 years ago (Lumpkin, 1993; Serpell, 2000; Smith, 1999) although there is evidence of earlier contact which has been found in a Neolithic site in Cyprus and dates back to between 7000-8000 years ago (Clutton-Brock, 1988; Macdonald, 1992; Serpell, 2000).

The process of domestication is described by Bokonyi (1989) as being both gradual and dynamic. It is, therefore, impossible to determine the exact time and place at which cats were domesticated. However, no matter how it all began, it is the attitudes of the people whose lives have been affected by these cats that are of interest.

Smith (1999) writes "Most anthropologists would agree that human attitudes to animals are projections of [their] attitudes to 'others' and [themselves]" and that "such anthropocentricism stems from the peculiar subject-object status accorded to animals in general."

By examining first, some Egyptian history, it is possible to further explore these attitudes and interactions between humans and cats, and follow them through the ages. From 1450 BC, images of cats in domestic settings have been found in many burial sites (Serpell, 2000), and while they appear not to have had any religious significance right up until the end of the third millennium; by 1500 BC, images of cats began to surface on blades, amulets and other artefacts. Thus, cats started off their early domestic existence being worshipped and assuming the status of minor deities (Serpell, 2000; Smith, 1999). Because of this elevated status, export of cats out of the Egyptian empire was illegal (Serpell, 2000). Eventually, though, the cat became widely distributed in many areas around the world (Gunther & Terkel, 2002) and it is believed that the Greeks were the first Europeans to recognise the cat as a vermin catcher (Smith, 1999). Thus, the next phase saw the cats move away from the temples and, either accidentally or deliberately introduced (Fitzgerald & Turner, 2000), into the "working world" were they were encouraged to keep the escalating rodent populations down to a minimum (Serpell, 2000; Smith, 1999).

Cats and humans lived in relative harmony in Europe up until the Middle Ages (Smith, 1999) and the rise and spread of Christianity (Serpell, 2000). It was during this time that attitudes towards the cats moved to the other extreme. Instead of being perceived as "godly" (Clutton-Brock, 1988; Serpell, 2000), the Church denounced the cat as an agent of the devil (Clutton-Brock, 1988; Smith, 1999) and companions of witches and necromancers (Serpell, 2000). During this time, the cats became a metaphor for female sexual depravity and social unruliness (Serpell, 2000).

It was only much later, in the mid-eighteenth century that pet breeding became fashionable amongst the upper classes of Europe (Smith, 1999), and Bradshaw *et al.* (1999) notes that it is only the various pedigree breeds of cat that can be

unambiguously classified as "domesticated." Because of their independent and aloof natures, the cat came to be associated with artisans and intellectuals (Serpell, 2000) and it was this final acceptance by the rich and famous that helped set the scene for modern day mixed feelings towards felines.

Over the past several decades the popularity of the domestic cat has steadily increased (Levy *et al.*, 2003). It has been noted that they are now more abundant in Western households than any other animal (Bradshaw *et al.*, 1999; Clutton-Brock, 1988; Levy *et al.*, 2003), with numbers in the UK being conservatively estimated at around 6 million in 1981 (Woods *et al.*, 2003). Thus, it would seem that attitudes towards [truly] domestic cats have come full circle, and once again border on worship.

Not all small feline cats however, are this lucky. Feral cat populations, like their domestic counter-parts, are abundant almost world-wide; especially in Australia (Coman & Brunner, 1972; Triggs *et al.*, 1984; Paltridge *et al.*, 1997) and New Zealand (Langham & Porter, 1991). In the US, domestic cat numbers in 1972 were already as high as 31 million (George, 1974). Even though feral cat numbers are hard to quantify because reliable estimates are not available due to the problems in definition and lack of data (Patronek, 1998), both Patronek and Rowan (1995) and Kays and Dewan (2004) have estimated that the stray/feral cat population lies between 25-40 million.

There is no single definition for the term "feral." It is derived from the Latin word meaning "wild," however, today it refers to those animals that were once domesticated but have since reverted back to its wild state (Tabor, 1980). Gunther and Terkel (2002) observed feral cats that were living without human contact in a

natural environment, but that were also scavenging on human garbage, while Kays (2003) stated that even truly feral cats will accept some food from humans.

It is only relatively recently that feral cats have been labelled as pests. Mainly because they threaten the livelihood of indigenous animals (Smith, 1999) and also because they can be a financial, emotional and health burden to most communities (Levy *et al.*, 2003). Most feral populations are comprised of unwanted (and thus abandoned) pet cats or cats born into a feral colony (Griffiths *et al.*, 2004) and these animals can easily revert back to their wild status. Many published papers on both domestic and feral cats refer to, or have shown that, feral cats can have negative effects on the environments they inhabit (Fitzgerald & Karl, 1978; May & Norton, 1996; Hall *et al.*, 2000; Hutchings, 2003).

In Durban, South Africa, the Howard College campus (HCC) of the University of KwaZulu-Natal (UKZN) (Fig. 1) has been registered as an urban conservancy since 1998. A conservancy is defined as "the voluntary, co-operative management of an area by its community and users, and in respect of which registration has been granted by the relevant authority". Since this is an urban area, the main focus of this conservancy has therefore been on the removal of alien invasive plants, awareness education and participation programmes, litter control and clean-up campaigns, monitoring and reporting of illegal and environmentally detrimental dumping and creating an aware and well informed pro-active community (UKZN website). The campus also has a feral cat population, the presence of which has recently been addressed by the Environmental Committee of the HCC. The management of these feral cats would also fall into the broader aims of the Conservancy.

The aim of this study was to determine the attitudes of students and staff on Howard College Campus (UKZN) towards the feral cat population and how they

thought the feral cats fitted into the scheme of a Conservancy within an urban area as well as what management was required. It was expected that students and staff would have different attitudes to the feral cats on the HCC as well as possible solutions to their management. Staff members were also expected to have a greater understanding of Conservancies and what this meant for the University.

METHODS

The questionnaires

A draft survey questionnaire was prepared and a pilot study was conducted on students from the Pietermaritzburg (PMB) campus, UKZN. Students had previously been based at the HCC (the study area) and thus had some understanding of the feral cat population on that campus. The pilot study was conducted to assess the draft questionnaire with respect to wording of questions, layout of questionnaire and amount of time it required to complete. Responses to these questionnaires, however, were not included in the actual survey. Using feedback from this study, two survey questionnaires were finalised to elicit attitudes and suggestions regarding the feral cat population on the HCC, UKZN; one for staff members (both academic and non-academic) the other for students (Appendix A and B). Only students and staff members from the HCC of UKZN were included in this study.

Both questionnaires had essentially the same basic questions and layout, and dealt with where and how often feral cats were noticed on campus, as well as their noticeable activities. They also enquired about possible management strategies of the feral cat population given the fact that the HCC is a registered conservancy. Attached to each questionnaire was a covering letter explaining the reasons for the survey as

well as a return address that staff and students could use to return their completed forms through the university internal mailing system.

We sought responses from most of the campus community, so questionnaires were posted on the university electronic notice board to all staff and students. The notice was run for two consecutive 21-day periods, during the University semesters. Responses to these notices were low, however, so we then e-mailed the questionnaires to the various school/departmental secretaries of the university, who were asked to distribute them to their staff and students via their electronic mailing lists. Hard copies were distributed to all the student residence buildings around the HCC and student researchers randomly selected students around the campus to approach and ask to complete the questionnaires.

The Interviews

As well as survey questionnaires, additional information about the HCC feral cat population was gathered during personal interviews. These were conducted with the members of the HCC, UKZN Environmental committee and members of the security staff, gardening staff and cleaning staff. Of special interest were those individuals who worked the night shift or had been employed by the University for 3 years or more.

The UKZN Environmental committee is comprised of members from all five campuses and it was felt that the input from all committee members would be beneficial to the survey, whether based on the Howard college campus or not. Appointments were set up and these members were interviewed individually by the author over a two week period. Security staff was interviewed towards the end of 2004, during their shifts, by first language Zulu-speaking research assistants who

were able to ensure that all security staff had a full understanding of each of the questions. These same research assistants then interviewed members of the cleaning and gardening staff on the HCC at the beginning of 2005 while they were at work. A separate, simplified, interview sheet was drawn up for the security, cleaning and gardening staff. In addition, some members of the Environmental committee were interviewed using the staff questionnaire that had previously been developed for the survey. They were, however, asked to elaborate or expand their answers and were encouraged to bring up any other information that they thought was relevant to the topic.

Data analysis

All responses to both the survey questionnaires and interviews were entered electronically. The responses were categorised and ranked and compared using descriptive statistics and Pearson's Chi square analysis.

RESULTS

The results obtained from both the survey questionnaires and the interviews are described separately. The Environmental committee's responses are included in the analysis for the questionnaires because the interviews for the committee members all followed the format of the survey questionnaire and not the simplified interview sheets that were used for the rest of the interviews.

Survey questionnaires

Responses from members of the University community

79 students and 35 staff members responded to the questionnaire. Of the students, 27% replied to the electronic version while the rest completed hard copies that had been distributed by student researchers. Nine of the staff members included in this section of the study were members of the University Environmental committee who were interviewed (following the format of the questionnaire) rather than simply asked to complete the questionnaire because it was felt that they had key information. Forty percent of the other staff replies were received by electronic mail whereas the rest printed out the questionnaire and returned it via the internal mailing system.

Most of the students lived on campus (72.2%) compared with the majority of staff members (91.2%) who, as expected, lived off campus. Of these students, almost half (47.1%) lived in the Albert Lutuli Cluster Residences while the rest were divided between 7 of the remaining 8 Residences found around campus (Pius Langa-19.6%; John Bews-9.8%; Florence Powell-7.8% and Ansel May-9.8%).

More females responded to the questionnaire than males and there was no significant difference between the two groups (Chi^2, $P > 0.2$). Also, 88.6% of the students were between 17-25 years compared with only a small number in the next three age categories. This was significantly different to the staff group (Chi^2, $P < 0.001$) which had a greater distribution across the six age groups; the majority of whom were between 41-48 years (31.3%).

While the majority of the staff members had been on the HCC in excess of three years (81.3%), students ranged between one and four years (Table 1). This is reflected by the varied responses, of attitudes and information pertaining to the feral cat population, which were received. Most of both students (83.3%) and staff members (71.4%) made use of the campus facilities after hours, while more students (48.7%) indicated that they spent most of their time in the area marked F (Fig. 1),

with the next most frequented areas being B (19.2%) and D (12.8%). None of the students reported having spent any significant amounts of time in the Msinsi reserve (Area C on Fig. 1).

Students from many different disciplines responded to the questionnaire (Fig. 3.). While a quarter of the academic staff respondents held Honours degrees, just over a third had a Bachelors or Masters Degree and only a few had achieved their PhD's.

Observations of the feral cat population

Just over half the students (57%) indicated that they saw feral cats every day or numerous times throughout the week (15.2%). Staff response was significantly different (Chi^2, $P < 0.001$); they saw cats only a couple of times per week (29.4%) or a few times per year (26.5%). Staff members only observed cats in 3 of the eight marked areas on campus, whereas, with the exception of area C, students made feral cat sightings in all other areas. Although most of the students and staff members reported that they had never noticed cats congregating in specific areas around campus, the data suggests that cats were most frequently observed in those areas where feeding stations had been established (Fig. 4).

The main feral cat behavioural activity noted by both groups of respondents was eating (students: 34.4% n = 53; staff: 27.3% n = 21), followed by other passive forms of behaviour, including sitting and sleeping. Staff respondents noted some other forms of behavioural activity (Table 2) which mainly included walking or running. Cat food from trays placed by members of the Feral Cat Management Committee was the main source of food noted by the students (59.7%) and staff members (63.3%). The second most available food source was rubbish scavenged from bins or left as litter (students-16.7%; staff-22.2%). While still a small amount, the percentage of

cats observed eating prey was almost double in the student group (12.5%) compared to staff (6.7%). For those staff members who did observe hunting activity, three quarters of them could not identify the prey groups while the remainder only noted birds as a prey species. Many of the student body were also unable to identify the prey (36.4%). However, those that did identified other species such as insects (27.3%), lizards (9.1%) and rats/mice (9.1%) along with birds (18.2%).

Sentiments regarding the feral cat population on campus

Of the student respondents, 83.3% did not own a cat, which was significantly different (Chi^2, $P < 0.0001$) to the number of cat owners within the staff group, although their responses were quite similar (51.4% yes vs. 48.6% no). The differences between the two groups in response to the statement "*I love cats*" were highly significant (Chi^2, $P << 0.0001$) with the overall feelings of the students in disagreement (43%) compared to a convincing 82.9% of staff members who agreed with the statement. A quarter of the students remained neutral or decided not to comment, compared to only 8.6% of staff who did not want to share their opinions. While significantly more staff members (Chi^2, $P < 0.001$) objected to the statement "*I love feral* cats" (28.6% vs. 8.5% for the previous statement), overall sentiments were still mostly in agreement with this statement (42.9%). A higher percentage of staff opted not to respond (28.6%). There was no difference between the student responses for questions 18 and 19 (see Appendix A).

Most students (61%) were unaware of any issues on the HCC involving the feral cats (Table 3), which was significantly different to that of staff members (Chi^2, $P < 0.001$); some of whom felt that the cats created problems (41.2%) or that the issues were to do with the management of the feral cat population (32.4%). When asked

whether they felt that it was the University's responsibility to get involved with the feral cat population and possibly take certain actions, responses both within and between the two groups varied significantly (Fig. 5).

Responses to the management options that were suggested in the survey questionnaire are given in Table 4. Overall response to eradication for both groups was very negative, however, staff responses were significantly higher (Chi^2, $P < 0.001$) compared to students. More students (32.9%) than the staff (14.3%) preferred to remain neutral or not to comment on this particular method of control. Response to sterilization of the feral cat population was the opposite – very positive. Again, staff responses were significantly higher (Chi^2, $P = 0.0002$) in support of this method, compared to the student body (74.3% and 46.8% respectively). A high percentage of all questionnaire respondents were in support of the establishment of a feeding program campus-wide. A similar response was seen of the suggestion made for the introduction of a combined sterilization and feeding program. However, 54.4% of students did not make a decision either way. Both students (35.4%) and staff members (60%) were strongly against the idea of leaving the feral cat population alone completely. However, large proportions of both students and staff members declined to comment and this may have caused a skew in the results.

Conservancy Issues

Responses to whether the surveyed groups were familiar with the term *Conservancy* were varied. A highly significant number (Chi^2, $P << 0.001$) of staff members were familiar with the term (97.1%) compared with only 46.7% of students. Similarly, only a small number of students compared to the vast majority of staff who did (91.2%) were aware that the HCC was actually registered as a conservancy (Fig. 6).

Interpretations of the meaning of the word were widely varied and most of the students were unable to fully explain the term as well as many of the staff members. Members of the Environmental committee made up the majority of the 22.6% who were able to give full definitions for the word.

In the questionnaire, the survey groups were asked if they were aware of the on-going program currently in place on the HCC to try to indigenize the vegetation. There was a direct difference between the groups with 66.2% of students not aware of any alien plant species eradication program being implemented on the HCC compared to 68.8% of staff who were aware and were either directly or indirectly involved. The majority of the surveyed group realized the importance of such a program, although many of the students thought the question was referring to the feral cat population rather than the exotic plant species on the HCC. Many students (34.4%) and staff (41.9%) felt that feral cats posed no potential threats to the wildlife on campus. Those students who felt the feral cats did have a negative impact listed hunting (57.9%) as the main influencing factor. No staff members who felt that feral cats negatively impacted on the local wildlife elaborated beyond yes.

Most of the students (44%) were undecided whether feral cats should be considered as exotic animals and removed from campus (Table 5). However, 37.3% were against the idea rather than for it. The same sentiments were shared by the staff members, as more than half (56.7%) replied in the negative.

The Interviews

Responses from members of the University community

A total of 62 maintenance staff on the HCC, UKZN (security; n = 29, gardening; n = 19 and cleaning; n = 14) were interviewed between December 2004 and February

2005. Only a few (32.3%) of the interviewees worked the night shift and this did not include the gardeners, all of whom worked day shifts. Those cleaning staff that had, up until the end of December 2004, only worked the nighttime shift is included in this result, even though they now work only day shifts. Only a small percentage (20.7%) of the security staff worked both shifts. The number of years that these staff members had been working on the HCC showed a broad range and those working for longer than 3 years were mostly permanent staff (Table 1). Of the security staff members who were interviewed, 92.9% were males, compared with the majority of gardeners and cleaners, who were female (52.6% and 64.3% respectively).

Most areas on campus were covered by both the security staff (on their patrols) and the gardening staff, however, cleaning staff interviewed only worked on the main part of the campus (blocks F and G in Fig. 1). All the security staff worked in 4 day shifts with the exception of their supervisors, the gardening and cleaning staff who all worked 5 days a week.

Observations of the feral cat population

Feral cats were observed at least once a day by 83.9% of all interviewees (security 82.8%; gardeners 73.7% and cleaners 100%), although some security (17.2%) and gardening staff (21.1%) stated that they very seldom (or never) saw feral cats in the areas they worked. The blocks where the feral cats were often seen congregating (Fig. 4) by these interviewees were those areas around the main lecture and office buildings (F in Fig 1; 50%), the Albert Lutuli cluster residences (area A in Fig 1; 17.7%) and the Jubilee gardens (area G in Fig 1; 17.7%).

Eating was the overall main activity (Table 2) of feral cats noticed by all three groups (38.5%; n = 62), followed by walking (33.1%), hunting (13.1%), sleeping

(8.5%), sitting (4.6%) and then fighting (2.3%). Of those interviewees who listed eating as an activity, 73.3% observed the feral cats eating from supplementary feeding trays, 11.1% saw the cats scavenging out of bins and refuge bags and 8.9% observed the cats eating leftovers from student meals. Only 6.7% of these staff members stated that they had observed the cats eating animal prey. When asked if they had ever fed the feral cats themselves, 85.5% replied in the negative, compared to the 14.5% who said yes. Of these, 3.2% (all security staff) stated that they shared their food with certain cats.

Sentiments regarding the feral cat population on campus

There was a significant difference between attitudes (Table 6) towards feral cats among the different interviewed groups (Chi^2, $P < 0.001$). There were many staff members, cleaning staff especially, who had negative feelings towards feline cats in general although a small percentage of the security staff was apathetic and had no feelings either way. A majority of the gardening staff had positive feelings towards cats (68.4%) and many of them owned them as pets (52.6%). Even though overall feelings appeared to be negative, just less than half (46.8%) of those interviewed believed that the feral cats on the HCC should be left to their own devices compared with the 33.9% who stated that these cats should be removed (Fig. 8).

Only 35.5% of all security, gardening and cleaning staff knew that the HCC was a registered conservancy, and it was mostly the gardeners who contributed to this total (57.9%; $n = 19$).

DISCUSSION

As mentioned, the associations between cats and people are very old (Turner 2000). The issues surrounding feral cats are even more emotive and to date, finding an acceptable management solution that appeals to cat care-givers and environmentalists alike, has proved to be rather difficult. The purpose of the interviews and questionnaires was to collate information from members of the HCC, UKZN community in order to have a better understanding of their attitudes towards the resident feral cat population, as well as to collect some information about the behaviour of the feral cats.

Despite the problems faced in getting a sufficient response to the questionnaires, a high number of residence students (72.2%) did complete them. Some may argue that they are a small percentage of the HCC community, however, as a consequence of the interviews that were conducted, the people that were most likely to see feral cats were well represented. Research from Australia and New Zealand has shown that cats are most active at dusk and dawn (Izawa, 1983; Haspel & Calhoon, 1993; Langham & Porter, 1991; Langham & Porter, 1992; Konecny, 1987). Thus, since many of the security staff worked either both day and night or night shifts only, and the majority of the student respondents had stated that they spent a lot of their time on campus after hours, accurate accounts of feline activity could be expected.

In the present study, feral cats have been on the HCC for many years, but it is only recently that issues about feral cats and their status as a potential pest have been raised (Smith, 1999). For this reason, it was hoped that the majority of interviewees and questionnaire respondents would have been on campus for more than one year in order for their information to reflect if and how circumstances surrounding the feral cat population had changed over the past years. Table 1 shows the majority of

cleaning and gardening staff were permanent employees (having worked on campus for more than 3 years). Security personnel are rotated between different work sites regularly, thus it is very rare to find these staff members with 3 years of experience on the HCC. Their information, however, was considered vital because they spent a considerable amount of time outside patrolling. Only 3.1% of the staff members and 29.1% of students had not been on campus longer than a year, so the data collected from both the interviews and the questionnaires is thought to be very relevant.

From the questionnaire results it can be seen that the majority of student respondents were studying Science related courses (this includes those studying Engineering) and this explains why the majority of cat observations were made in the main lecture area on campus, and the areas around the Science buildings (F and B in Fig. 1). In addition, since most of the students came from the Albert Lutuli Cluster Residences, the high number of cat observations in this area (A in Fig. 1) was also expected.

Daily cat sightings were observed by the security, gardening and cleaning staff, most of whom had many opportunities in which to observe cats since their jobs required them to be outside for most of the day and night. In addition, many of these staff members resided in staff housing which is situated within the HCC grounds. A possible reason for the difference in sighting frequency between the student and staff groups may be that the students covered more areas on campus than the staff members covered and so got more of an opportunity to observe the cats. Students tend to walk around the campus grounds more often than staff; between lectures and sporting facilities, as well as food areas.

A large number of the security, gardening and cleaning staff said that they very seldom, or never, saw cats in their work areas. This seemed rather out of the ordinary

since the presence of feral cats was very obvious to the researchers during the duration of the study. A possible reason for this unexpected result may be due to the fact that these staff members did not work in areas where the feral cats were shown to inhabit. This suggests that the distribution of feral cats on the HCC is not uniform and that population densities on different parts of the campus grounds are varied.

The main feral cat sightings were on the main part of campus where the Students union and food facilities are located (F in Fig. 1). This area has a constant flow of people and thus waste products (from the food stalls). This may be one of the reasons cat sightings are so high in this area, as availability of edible resources influences population density patterns (Denny *et al.*, 2002; Gunther & Terkel, 2002; Natoli, 1994). The areas where cats were not sighted by staff are student housing and gardens – places not frequently visited by members of staff. Data collected from these areas for Chapter 4 show however, that feral cats do gather in those areas on campus where supplemental feeding trays are provided daily at a fixed time. The congregation areas that are shown in Fig. 3 match those of known feeding stations.

Eating was the overall main activity noticed by all the interviewees and questionnaire respondents. The groups that were interviewed spent most of their working hours outdoors and they noticed more cat movement such as roaming and hunting. The students and staff members responding to the questionnaires however, observed the feral cats mostly sitting around or sleeping. Fighting between the feral cats was seldom witnessed.

Cat food from feeding trays appears to be the main source of nutrition for the feral cats as it was listed first by both the interview and questionnaire groups. However, these figures were not as high as expected given the fact that a feeding program had been set up on campus with feeding stations distributed around the main buildings, the

science buildings and the residences. It was discouraging to see that food waste scavenged, either from bins or left as litter, was the next noticeable food source. Prey species did not make up a significant part of the feral cat diet in this study, with only 6.7% of the interviewed staff observing feral cats feeding on a prey species. The fact that questionnaire staff sightings of feral cats eating small animals was significantly less than the students is probably due to the fact that the staff sightings were mainly in areas where hunting was highly unlikely and also that student cat sightings were higher than staff. Thus it would seem that insects, in particular, and then birds are the first and second most important prey species respectively on the campus and, thus most likely to be affected by the presence of feral cats on campus. From this data, it cannot be seen whether the threat posed by the cats would be major since, firstly, the hunting numbers are so low and secondly, it is not known how many prey killings would constitute a problem (i.e. what is an acceptable mortality rate for insect and bird species on the HCC).

The results show that, while cat owners are a minority among the University public, feelings towards all cats are generally positive. This ties in with the findings of Levy *et al.* (2003) that cat owners are more likely to tolerate feral cats and could generally be found to feed them habitually.

From the responses to the various suggested management options (Question 22, Appendix A & B), there was a high percentage of both students and staff members who were in support of the establishment of a campus-wide, University funded feeding program for the feral cats. Although these figures may be skewed due to the fact that large percentages of both students (32.9%) and staff (28.6%) members refused to comment or make a decision as to which method was more suitable. It would seem that most of the respondents did not wish to make complete commitments

to any of the control methods suggested in the questionnaire, as many choose the "slightly" over the "strongly" option. The plight of the feral cat is very controversial and very public, and it seems that most people do not want to seem overly biased in any direction. Thus, given the chance, they will choose options as close to neutral but still try to get their point of view across – without seeming either too sensitive or too uncaring.

The strong opposition from the student and staff respondents to the suggestion of leaving the feral population to fend for itself was not reflected by the interviewed staff members. Most of these were in favour of leaving the cats (on campus) and not interfering with them. The most common reasoning given was that the feral cats did not cause any problems to the people on campus.

All surveyed groups were asked whether they were aware that the HCC was a registered Conservancy and if they understood what was meant by this term. The high percentage of gardening staff that were aware of this is probably because they are directly involved with the project, as the removal of alien flora species is a main objective of the UKZN Conservancy.

From the questionnaire respondents, it was expected that a higher percentage of staff members would understand the meaning of Conservancy so the results were surprising. However, it was not recorded what disciplines the staff members were from, thus complete understanding of this term could not be expected had most of the staff who replied been from areas of expertise that did not require the knowledge of certain science-related terms.

In the questionnaire, question 26 referred only to alien plant species and their removal. However, with some of the students thinking only about feral cats, many of the expanded responses dealt only with them and were harsh retorts on how the cats

were being mistreated and inhumanely controlled, while others felt that the feral cats created dangerous situations for humans on the campus and caused noise pollution. The issue of whether feral cats should be considered exotic is a main concern. Since Conservancies are dedicated to restoring indigenous flora and fauna, the answer would thus be a deciding factor for their removal or not. However, the majority of the public did not classify feral cats as an exotic species nor did they consider them to be a threat to the indigenous wildlife on campus. In addition, with observations of hunting activity so low, it would seem that eradication of the feral cat population is unnecessary. However, proper control and management would still be required.

In conclusion, there are many differing opinions on the HCC regarding the resident feral cat population. However, most of the different communities on campus agree that there is a problem regarding the feral cats, whether it is an issue about the cats themselves, or the way in which the population is being managed. Thus, many people on campus are divided as far as methods of management are concerned.

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Tables

Table 1. Number of years the different surveyed groups have been on the HCC, UKZN Results expressed in percentages and compiled from both the survey questionnaires and the personal interviews.

	Students	Staff	Security	Gardeners	Cleaners
<1 yr	29.1	3.1	55.2	21.1	21.4
1-2 yrs	21.5	9.4	17.2	0.0	0.0
2-3 yrs	40.5	6.3	20.7	15.8	21.4
>3 yrs	8.9	81.3	6.9	63.1	57.2

Table 2. Frequencies (%) of the listed activities of the feral cats that were observed by the different surveyed groups on the HCC, UKZN. Results compiled from both the survey questionnaires and the interviews.

Observed cat activities	Student	Staff	Security	Gardening	Cleaning
Sleeping	16.2	15.6	1.9	42.1	10.5
Eating	34.4	27.3	21.2	10.5	31.6
Hunting	14.3	5.2	23.1	15.8	0.0
Sitting	21.4	26.0	9.6	0.0	5.3
Fighting	5.8	1.3	5.8	0.0	0.0
Other	7.8	24.7	38.5	31.6	52.6

Table 3. Observations of student and staff questionnaire respondents of whether they believe that there are issues regarding the feral cats on the HCC, UKZN.

Cat issues on campus		
Negative	9.1	26.5
Positive	0.0	2.9
None	18.2	14.7
Not sure	61.0	23.5
Mgnt	7.8	17.6
1 & 5	3.9	14.7

Table 4. Responses to the suggested management options that were listed in the survey questionnaires distributed to students and some staff members of the HCC, UKZN, regarding the resident feral cat population.

Mng. Opt.	Strongly support	Partially support	Neutral	Partially against	Strongly against	No comment
Eradication	16.5	7.6	15.2	8.9	34.2	17.7
	11.4	5.7	0.0	0.0	68.6	14.3
Sterilisation	38.0	8.9	15.2	5.1	13.9	19.0
	68.6	5.7	0.0	0.0	11.4	14.3
Feed	29.1	16.5	11.4	5.1	16.5	21.5
	45.7	5.7	5.7	0.0	20.0	22.9
Sterilise & Feed	24.1	6.3	20.3	12.7	2.5	34.2
	48.6	5.7	2.9	0.0	20.0	22.9
No interference	8.9	10.1	12.7	8.9	26.6	32.9
	5.7	0.0	5.7	8.6	51.4	28.6

Table 5. The opinions (%) of the different surveyed groups regarding whether feral cats on the HCC, UKZN, should be considered as an alien invasive species.

Are feral cats aliens?	Student	Staff	Security	Gardening	Cleaning
Strong NO	18.7	26.7	28.6	29.4	27.3
No, don't cause problems	18.7	30.0	14.3	58.8	0.0
Don't know	44.0	6.7	25.0	5.9	27.3
Yes, make a mess	9.3	20.0	17.9	0.0	9.1
Strong YES	9.3	16.7	14.3	5.9	36.4

Table 6. Emotional responses (%) of three of the interviewed staff groups regarding all feline cats in general.

Feelings towards feline cats	Security	Gardening	Cleaning
Negative	41.4	31.6	64.3
Positve	51.7	68.4	35.7
Neutral	6.9	0.0	0.0

a)

b)

Fig. 1. Aerial photographs of the Howard College Campus, University of KwaZulu-Natal. Fig. 1a. shows the entire campus grounds and Fig. 1b. shows only those areas included in the study. The campus has been divided into alphabetisied blocks for ease of reference.

Figures

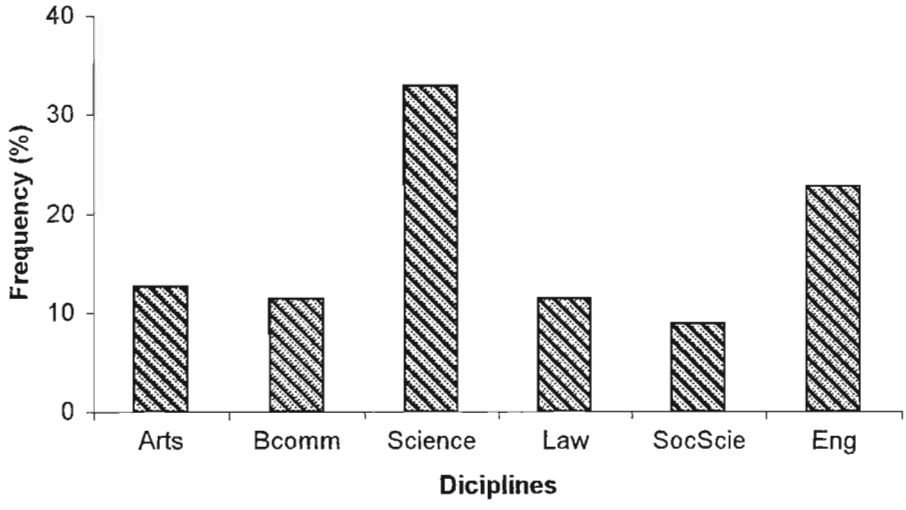

Fig. 2. The various disciplines of the student respondents on the HCC, UKZN, regarding the resident feral cat population. "Bcomm" refers to all commerce courses; "Science" refers to all courses dealing with physical, biological and computer sciences; "SocScie" includes all social science courses and "Eng" refers to all engineering courses.

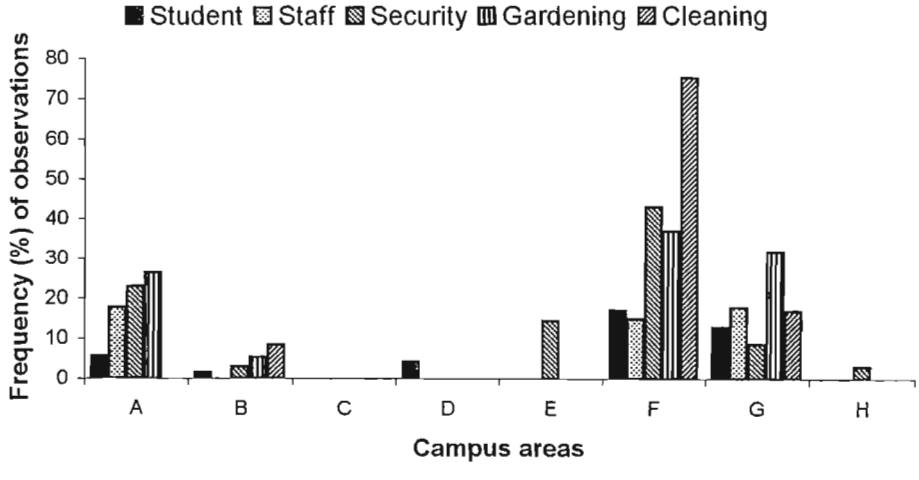

Fig. 3. Areas on the HCC, UKZN were feral cats have frequently been seen congregating. Results included all groups surveyed form both the questionnaires and the interviews. See Fig. 1 for descriptions of Campus areas

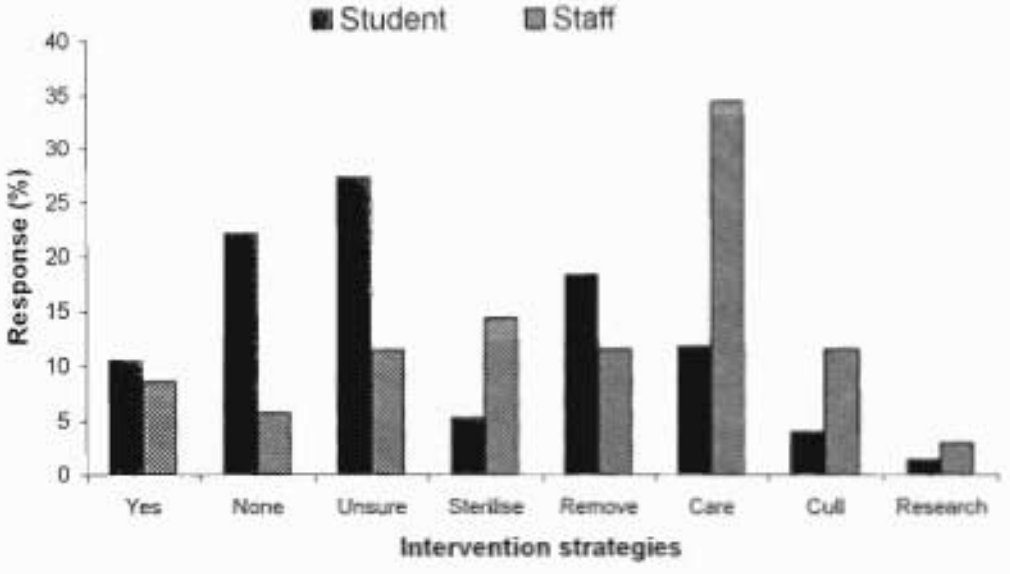

Fig. 4. Responses of students and staff from the HCC, UKZN, regarding a question from the survey which asked whether they believed that the University should take responsibility for the management and control of the resident feral cat population.

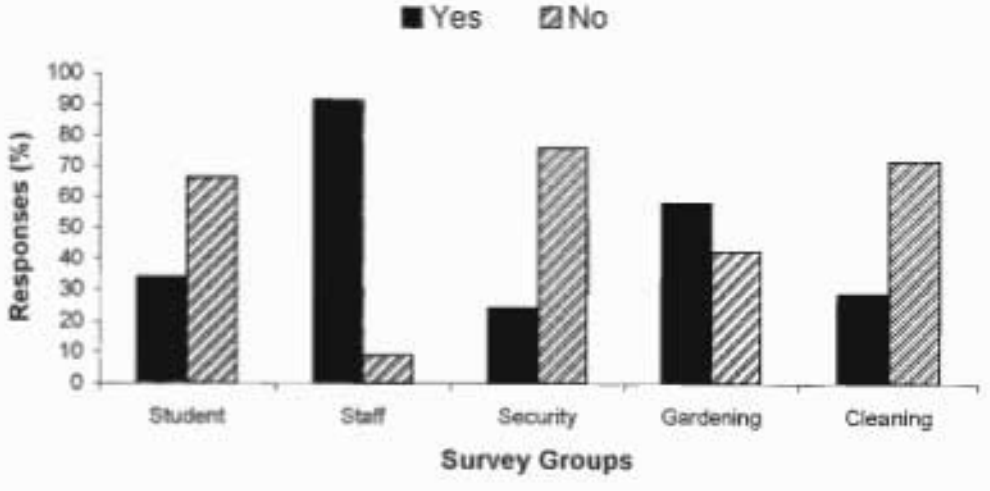

Fig. 5. The responses of all the surveyed groups from the HCC, UKZN, showing the number of respondents who understood the meaning of the term "Conservancy"

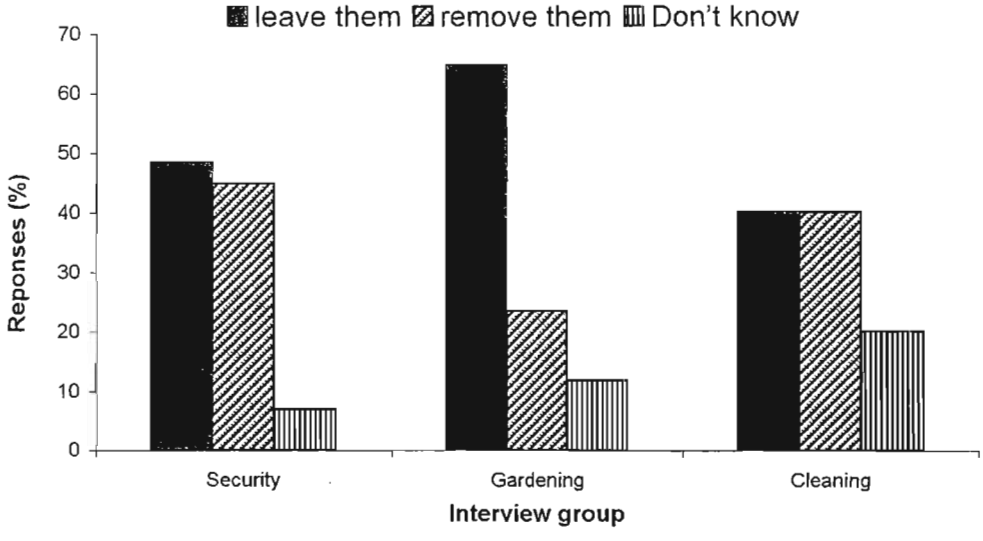

Fig. 6. Interview responses on how feral cats on the HCC, UKZN should be dealt with.

APPENDIX A

Circulated questionnaire for students with attached covering letter

Dear Student

RESEARCH: MASTERS DEGREE IN ZOOLOGY

I am presently doing research on the feral cat population of the University of KwaZulu-Natal's Howard College campus.

To follow is questionnaire which I kindly ask you to complete and return to me via email (Groupwise) or Internal mail before the end of August.

The Questionnaire will be used to assist in drawing conclusions about the feral cat population on campus and also to help in drawing up a possible management proposal.

Your time in completing this questionnaire is very much appreciated.

Yours sincerely

Jaclyn Tennent

School of Botany and Zoology,
University of KwaZulu-Natal,
P/Bag X01,
Scottsville, Pietermaritzburg,
South Africa,
3209.
Tel: 260 5127 (w)
083 758 7677 (cell)

FERAL CAT QUESTIONNAIRE

Date _____

1) Year of study: ☐ 1 ☐ 2 ☐ 3 ☐ >3

2) Studying/working hours: Tick one option

Part-Time	Full-Time

3) Where do you reside during the University semester? Tick one option

On-Campus	Off-campus

4) If "On-Campus" name the residence you live in _____

5) Do you utilise the University facilities at night /after 5pm?

YES	NO

6) Where do you spend most of your time when on campus? _____

7) Gender:

Male	Female

8) Age: (Tick one option)

☐ 17 – 25 years ☐ 26 – 32 years ☐ 33-40 years ☐ 41 – 48 years

☐ 49 – 55 years ☐ 56 – 63 years ☐ 64 years +

9) Course being studied: _____

10) Degree/s held (if applicable): _____

11) How often do you see/ notice feral cats on Campus? (If you answered 'never', proceed to Q.17)

- ☐ Every day or more
- ☐ Two-six times/week
- ☐ About once a week
- ☐ About once a month
- ☐ Few times a year
- ☐ Never
- ☐ Unable to say

12) Where have you observed the feral feral cats?

- ☐ Science Block
- ☐ Old Mutual
- ☐ Residence/s (Name) _____
- ☐ Main campus (Specify) _____
- ☐ Sporting Facilities (Specify)_____
- ☐ Other _____

13) Are there areas on campus where you have observed feral cats congregating?

YES	NO

If yes, where do they converge? _____
_____
_____
_____

14) What activities have the feral cats been involved in?

- ☐ Sleeping
- ☐ Eating
- ☐ Hunting
- ☐ Sitting
- ☐ Fighting
- ☐ Other- specify _____

15) If you have seen a cat eating, identify the food if possible:

- ☐ Cat food / food placed by caretakers at specified spots
- ☐ Rubbish from / near bins
- ☐ Food from students
- ☐ Animals / insects
- ☐ Cannot say / unable to tell
- ☐ Other – specify_____

16) If the cat was observed consuming an animal, please specify if possible:

- ☐ Rat / mouse
- ☐ Lizard
- ☐ Mongoose
- ☐ Chameleon
- ☐ Bird (Specify if possible) _____
- ☐ Insect (Specify if possible) _____
- ☐ Unable to identify
- ☐ Other – specify _____

17) Do you own a cat/ feral cats?

YES	NO

18) Does the given statement represent your feelings/ attitudes towards cats? Circle one.

1. 'I love cats.'

- ☐ Strongly Disagree
- ☐ Slightly Disagree
- ☐ Neutral
- ☐ Slightly Agree
- ☐ Strongly Agree
- ☐ No Comment

19) Does the given statement represent your feelings/ attitudes towards **FERAL** cats? Circle one.

1. 'I love feral cats.'

- ☐ Strongly Disagree
- ☐ Slightly Disagree
- ☐ Neutral
- ☐ Slightly Agree
- ☐ Strongly Agree
- ☐ No Comment

20) Are there issues regarding feral cats at the University of KwaZulu-Natal?

YES	NO	I DON'T KNOW

If yes, expand: _____

_____

_____

_____

_____

21) Do you feel the University of KwaZulu-Natal should take action regarding the feral cats on the campus?

YES	NO	I DON'T KNOW

If yes, what actions do you feel should be taken?

_____

_____

_____

_____

22) A number of management options have been suggested for feral cat populations in urban areas (such as Durban campus). What are your feelings on the following (tick the appropriate boxes)?

ACTION	Strongly support	Partially support	Neutral	Partially against	Strongly against	No comment
Eradication of feral cats						
Sterilisation of feral cats						
Feeding of feral cats						
Sterilisation and feeding						
No interference						

23) Are you familiar with the term 'Conservancy?'

YES	NO	PARTIALLY

24) Do you know that the University of KwaZulu-Natal's Durban campus is a 'Conservancy?'

YES	NO

25) What is your understanding of the fact that the University of KwaZulu-Natal's Durban campus is registered as a 'Conservancy? '

_____

_____

_____

_____

_____

26) Are you aware that large amounts of effort, both money and time, goes into the eradication of invasive alien plants from UKZN?

YES	NO

27) Do you feel that this eradication is a good thing? Motivate answer.

_____

_____

_____

_____

_____

_____

28) Do you think that the UKZN, Durban, feral cats have the potential to affect the indigenous wildlife?

- ☐ Yes
- ☐ No
- ☐ I do not know

If yes, expand: _____

_____

_____

_____

_____

29) Do you think that feral cats should be regarded as invasive alien animals given UKZN's status as a Conservancy?

YES	NO	I DON'T KNOW

Motivate your answer: _____

APPENDIX B

Circulated questionnaire for staff members with attached covering letter

Dear Staff member

RESEARCH: MASTERS DEGREE IN ZOOLOGY

I am presently doing research on the feral cat population of the University of KwaZulu-Natal's Howard College campus.

To follow is questionnaire which I kindly ask you to complete and return to me via email (Groupwise) or Internal mail before the end of August.

The Questionnaire will be used to assist in drawing conclusions about the feral cat population on campus and also to help in drawing up a possible management proposal.

Your time in completing this questionnaire is very much appreciated.

Yours sincerely Jaclyn Tennent

School of Botany and Zoology,
University of KwaZulu-Natal,
P/Bag X01,
Scottsville, Pietermaritzburg,
South Africa,
3209.
Tel: 260 5127 (w)
083 758 7677 (cell)

FERAL CAT QUESTIONNAIRE

Date _____

1) Academic staff ☐ Non-academic staff ☐

2) Department: _____

3) Years on Durban campus: ☐ 1 ☐ 2 ☐ 3 ☐ >3

4) Title:

- ☐ Prof.
- ☐ Dr.
- ☐ Mrs
- ☐ Miss
- ☐ Mr
- ☐ Other-specify _____

5) Gender:

Male	Female

6) First name and surname (Optional):

_____

7) Staff Number (Optional): ☐☐☐☐☐☐☐☐☐

8) Age: (Tick one option)

☐ 17 – 25 years ☐ 26 – 32 years ☐ 33-40 years ☐ 41 – 48 years

☐ 49 – 55 years ☐ 56 – 63 years ☐ 64 years +

9) Degree/s held (if applicable): _____

10) Working hours: Tick one option

Part-Time	Full-Time

11) Where do you reside during the University semester? Tick one option

On-Campus	Off-campus

12) Do you utilise the University facilities at night /after 5pm?

YES	NO

13) How often do you see/ notice feral cats on Campus? (If you answered 'never', proceed to Q.19)

- ☐ Every day or more
- ☐ Two-six times/week
- ☐ About once a week
- ☐ About once a month
- ☐ Few times a year
- ☐ Never
- ☐ Unable to say

14) Where have you observed the feral cats?

- ☐ Science Block
- ☐ Old Mutual
- ☐ Residence/s (Name) _____
- ☐ Main campus (Specify) _____
- ☐ Sporting Facilities (Specify)_____
- ☐ Other _____

15) Are there areas on campus where you have observed feral cats congregating?

YES	NO

If yes, where? _____

_____

_____

_____

_____

16) What activities have the feral cats been involved in?

- ☐ Sleeping
- ☐ Eating
- ☐ Hunting
- ☐ Sitting
- ☐ Fighting
- ☐ Other- specify _____

17) If you have seen a cat eating, identify the food if possible:

- ☐ Cat food / food placed by caretakers at specified spots
- ☐ Rubbish from / near bins
- ☐ Food from students
- ☐ Animals / insects
- ☐ Cannot say / unable to tell
- ☐ Other – specify_____

18) If the cat was observed consuming an animal, please specify if possible:

- ☐ Rat / mouse
- ☐ Lizard
- ☐ Mongoose
- ☐ Chameleon
- ☐ Bird (Specify if possible) _____
- ☐ Insect (Specify if possible) _____
- ☐ Unable to identify
- ☐ Other – specify _____

19) Do you own a cat/ feral cats?

YES	NO

20) Does the given statement represent your feelings/ attitudes towards cats? Circle one.

1. 'I love cats.'

- ❑ Strongly Disagree
- ❑ Slightly Disagree
- ❑ Neutral
- ❑ Slightly Agree
- ❑ Strongly Agree
- ❑ No Comment

21) Does the given statement represent your feelings/ attitudes towards **FERAL** cats? Circle one.

1. 'I love feral cats.'

- ❑ Strongly Disagree
- ❑ Slightly Disagree
- ❑ Neutral
- ❑ Slightly Agree
- ❑ Strongly Agree
- ❑ No Comment

22) Are there issues regarding feral cats at the University of KwaZulu-Natal?

YES	NO	I DON'T KNOW

If yes, expand: _____

_____

_____

_____

_____

23) Do you feel the University of KwaZulu-Natal should take action regarding the feral cats on the campus?

YES	NO	I DON'T KNOW

If yes, what actions do you feel should be taken?

_____

_____

_____

_____

24) A number of management options have been suggested for feral cat populations in urban areas (such as Durban campus). What are your feelings on the following (tick the appropriate boxes)?

ACTION	Strongly support	Partially support	Neutral	Partially against	Strongly against	No comment
Eradication of feral cats						
Sterilisation of feral cats						
Feeding of feral cats						
Sterilisation and feeding						
No interference						

25) Are you familiar with the term 'Conservancy?"

YES	NO

26) Do you know that the University of KwaZulu-Natal's Durban campus is a 'Conservancy? '

YES	NO

27) What is your understanding of the fact that the University of KwaZulu-Natal's Durban campus is registered as a 'Conservancy? '

_____

_____

_____

_____

_____

28) Are you aware that large amounts of effort, both money and time, goes into the eradication of invasive alien plants from UKZN?

YES	NO

29) Do you feel that this eradication is a good thing? Motivate answer.

_____
_____
_____
_____
_____
_____

30) Do you think that the UKZN, Durban, feral cats have the potential to affect the indigenous wildlife?

- ☐ Yes
- ☐ No
- ☐ I do not know

31) Do you think that feral cats should be regarded as invasive alien animals given UKZN's status as a Conservancy?

YES	NO	I DON'T KNOW

Motivate your answer: _____
_____
_____
_____
_____

Chapter 3

HOME RANGE SIZE AND USE OF A FERAL CAT (*FELIS CATUS*) POPULATION IN AN URBAN CONSERVANCY: IMPLICATIONS FOR CONSERVATION MANAGEMENT

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Formatted for the journal of *Animal Ecology*

Summary

The University of KwaZulu-Natal's Howard College Campus in the Durban Metropolitan area is a registered conservancy located within an urban environment. Eradication and management of exotic species are some of the main foci of this conservancy and thus, the issue of the resident feral cat (*Felis* catus) population needs to be addressed. Home ranges and population densities of cats are known to be influenced by resource availability and in this paper we present how regular supplemental feeding, when it is one of the primary sources of nutrition, can affect range size and core distribution of cats residing within an urban conservancy. Eight of the resident feral cats were radio-tracked for 13 months using direct observations and triangulation techniques. Home ranges sizes were calculated using Kernel method analysis. Total home range sizes were small, with considerable overlap between and within the sexes. The cats' total home ranges clustered mainly in areas where permanent feeding sites had been established and many of these sites were

contained within the cats' core ranges. There were no seasonal differences in home range size. Diurnal home ranges were similar to nocturnal ones for both sexes, suggesting less activity at night than is expected of cats.

Introduction

Feral cats (*Felis catus*) have been defined as being un-owned, unwanted and unconfined (Page *et al.* 1992). They are a population of domestic cats that have either adopted or been born into a free-living lifestyle (Remfry 1996). Studies show that these cats can exploit a range of different ecosystems, from sub-Antarctic islands (Say *et al.* 2002) to the semi-arid deserts of Australia (Apps 1986; Denny *et al.* 2002; Devillard *et al.* 2003). These free-living cats appear to be a worldwide problem with studies on their negative aspects being conducted in Australia (Jones & Coman 1982; Denny *et al.* 2002), New Zealand (Langham & Porter 1991; Gillies & Clout 2003), America (George 1974; Patronek 1998; Levy *et al.* 2003) and Europe (Liberg 1984; Mirmovitch 1995). Both rural and urban feral cat populations have been extensively researched with much of the results being summarised by Turner & Bateson (2000). However, some free-living cat populations do not inhabit such clear-cut environments.

Feral cats in rural areas, where their population densities are low, have large home ranges that do not generally overlap (Turner & Bateson 2000) unless the cats are related (Liberg 1980; Langham & Porter 1991). In urban habitats, however, feral cats occur at much higher densities because of the relatively high abundance of edible resources and home ranges tend to be much smaller with some degree of overlap, even between unrelated groups (Page *et al.* 1992; Mirmovitch 1995; Turner & Bateson 2000). These overlaps usually occur around feeding sites, where the cats will tolerate interactions as long as there is sufficient food (Turner & Bateson 2000). Contact between unrelated feral cats is minimised if the cats use different areas of

their overlapping home ranges at different times during the course of the day (Warner 1985; Mirmovitch 1995).

In South Africa, the University of KwaZulu-Natal's Howard College campus (UKZN, HCC) offers a unique environment because it is a registered conservancy within an urban area. Thus it essentially offers two types of "sub-habitats"; a well developed area, with high levels of human activity and supplied with an abundance of edible resources; and a nature reserve frequented less often by humans, with a number of prey species (see Boon & Neal 1999; Boon 2002) (pers. obs.). This study arose because of conflicting opinions from some members of the campus community of whether feral cats belong in this type of environment. The campus has a feral cat population that is currently being fed by a committee made up of some members of the University staff. There are diverse views between members of this 'Feral cat Management' committee and those of the Conservancy committee who are responsible for the conservation management of the campus. Interviews with both staff members and students showed that two very extreme views existed on the campus (Chapter 2). Some members of the university public believe that the feral cats are hunting or competing with the indigenous wildlife inhabiting the campus grounds, and have suggested complete removal of the feral population from the University grounds (Chapter 2). Other members of the campus community, however, are of the opinion that these cats should be allowed to remain on campus and are the responsibility of the University; i.e. that they should be provided with a constant food source, shelter and inoculations. Many of these people feel that if all the feral cats on campus are sterilised their numbers will not increase, and that if they are all fed they will have no need to hunt (Chapter 2).

Research has shown however, that even domestic cats (supplied with a constant and plentiful food source) will still hunt (Davies & Prentice 1980; Warner 1985; Haspel & Calhoon 1993; Gunther & Terkel 2002), but this does not show that the

local wildlife is necessarily at risk from predation as their survival mechanisms may have already "evolved" over the generations (Fitzgerald & Turner 2000).

It is more likely that competition by the feral cats for resources (such as prey food, habitat etc.) may negatively affect the local predator population because supplemental feeding is considered to be a primary factor accounting for large cat population densities (Mirmovitch 1995; Denny *et al.* 2002). However, other research has shown that food placed by cat feeders only brings about a redistribution of the cats (Haspel & Calhoon 1993) without changing their population size (Haspel & Calhoon 1993). Supplemental feeding does allow cat populations to remain constant and this may have detrimental affects on prey numbers during those times of the year when numbers naturally decrease; opportunistic hunting helps to keep prey numbers at these low levels (Hall *et al.* 2000).

Initially, it was thought that two distinct feral cat populations existed on the campus *viz.* the sterilised, fed group and the non-sterilised, non-fed groups. However, during a pilot study carried out in June 2004, observations showed that not all cats in the feeding program were sterilized and that all feral cats on campus had access to the various feeding stations located around campus and thus could be considered as part of the feeding program (pers. obs.).

The objectives of this study were to determine the distribution of home ranges of certain radio-collared feral cats residing within the boundaries of a University campus that is an urban conservancy. It was expected that these home ranges would be determined by resource availability and that there would be some degree of overlap at feeding sites. It was also expected that home range size of the feral cat population would be affected by the University semesters as well as time of day; that the cats would range further during university vacations and during the night when chances of human contact on the campus would be at its lowest (Haspel & Calhoon 1993).

Furthermore, an increased knowledge regarding range use of feral cats is important for the development of more effective and ecologically sound management methods within urban environments that are conservancies.

Methods

STUDY AREA

The study was carried out on the grounds of the University of KwaZulu-Natal's Howard College campus (Fig. 1) (S29.867; E30.981), in Durban, South Africa. Most of the central campus of the HCC has either been developed or is in the process of being developed and is mainly used for student residences, lecture and food halls, and sporting, academic and administrative activities. However, most of the eastern and western parts of the HCC are undeveloped, although there are many buildings, roads, car parks and domestic residences with gardens as well as the landscaped campus gardens. The vegetation is classified as coastal forest, which is at various stages of succession (Boon & Neal 1999). Mostly, they are still regenerating, but on some parts of the campus, these forests have reached climax forest conditions and there are a number of large old, relict forest trees. In some of the more disturbed areas, bushclump successional pathways are evident. The HCC has a high environmental value as it plays a significant regional role in the Durban Metropolitan Open Space System (D'MOSS) and it is a dispersal corridor for fauna and flora to the nearby Pigeon Valley Park and the Cato Manor parks, as well as a habitat for urban wildlife (Boon 2002). It is also registered with KZN Wildlife as an urban conservancy and it has the Msinsi Nature Reserve included in the campus grounds. For over 10 years there has been an initiative by the campus community (and WESSA) to remove aliens and indigenize the campus. Eventually this led to a commitment on the part of the University management (see UKZN website). Presently, about 90% of the Central campus areas have indigenous vegetation (excluding the Jubilee gardens and reservoir

areas), and perhaps 80% of the eastern campus. The western campus has both indigenous vegetation and invasive exotics, and has not been cleared. The importance of the indigenous plant and animal life in the conservancy is central to the objections to the presence of feral cats.

There is prolific avifauna on campus, found mostly (surprisingly) in the areas heavily invaded with alien plant species (Boon 2001). There have also been sightings of banded mongoose (*Mungos mungo)*, genets (*Genetta sp.)* and black-headed dwarf chameleons (*Bradypodian melanocephalum*) (Boon 2001).

Some of the developed areas are densely populated by people at all times (staff / student residences), while others are only in use during the day (lecture halls, offices, shops and canteen) or only at certain times (sports fields) (pers. obs.). Permanent feral cat feeding stations have been set up in some of these areas (Fig. 1) and are attended to every day by various staff members who have set up a Feral Cat Management program and by some residence students. Areas like the Msinsi Nature Reserve (Fig. 1) and other bushed areas around the campus are frequented on a much smaller scale by humans and only at certain times of the day.

EXPERIMENTAL PROCEDURE

Ethics approval was first obtained from the UKZN Ethics committee. Adult feral cats from different locations around the HCC were used in this study. It is extremely difficult to trap feral cats (Molsher 2001) and only 8 cats were trapped and collared within a 2 month period. Both male and female cats were trapped using live-capture cat traps (900cm x 300cm x 300cm) baited with either cat pellets or raw chicken pieces. The traps were set away from the public view and checked every four hours to ensure that any animal caught would not have to spend an excessive amount of time caged up. Once caught, the cages were covered with a dark blanket (to keep the cats calm) and taken to the Animal Facility in the George Campbell on the HCC. The

cats were then transported to a veterinary hospital where they were operated on by a veterinarian. Chanazine 2% and Anaket-V (Bayer) injections (0.3 – 0.5ml, depending on body size) were administered to anesthetise the cats. None of the cats caught on campus during the study had been sterilised so the first four cats were sterilised, making up the "experimental" group. The last 4 cats were left intact and were the "control" group.

Once anaesthetised, cats were fitted with radio-transmitting collars so location and behaviour could be tracked and monitored. No other invasive procedures were undertaken as per demands made by the Feral Cat Management Committee on the HCC. The collars were first tested on various cats at the SPCA in Pietermaritzburg under supervision from a veterinarian and two veterinarian nurses. These material collars were designed to be lightweight (< 5% of total body mass) and they consisted of a radio transmitter on the 150 MHz band, a 1 AA battery pack (designed to last more than 12 months). The actual collars had small holes in the strap to allow the aerial to be woven into the fabric to reduce chances of it being caught in bushes etc. While anaesthetised, each cat was photographed, sexed, weighed and measured. Additional observations of reproductive status and body condition were also recorded. No blood samples were taken as this invasive procedure had met with much resistance from the Feral cat management committee. For the purpose of this study and judging from the size and weight, all cats included in the study were classed as adults. Cats were monitored until they had regained consciousness, and were released at their point of capture.

A pilot study was done for the month of June 2004 to determine the best method of radio-tracking the feral cats and to get an idea of their core habitats. As Langham & Porter (1991) noted, the cats in their study travelled several hundred metres once released (after processing) before returning to the area where they were trapped. Thus

location fixes recorded during this pilot study were not included in the present study to avoid bias caused by trapping and handling.

The radio-collared cats on HCC were tracked for 4 consecutive days per month from June 2004 to June 2005. A hand-held aerial and wideband receiver (Arlinco) were used to monitor the cats. Two teams of three researchers worked in approximately 6 hour shifts in order to locate and collect data on all the collared cats every hour starting 19h00 the first evening through to 06h00 of the last morning; a collective time frame of 30 consecutive hours excluding the 1 hour breaks in between each shift. The tracking was done on foot by two members of each team while the third member drove the vehicle owing to the inaccessibility of most areas on the campus. Torch light was seldom used and was mostly unnecessary due to ambient lighting around the campus.

Time, date and GPS co-ordinates (using a Garmin eTrex personal navigator), as well as activities, presence of food and number of other cats present were recorded. Although we attempted to get a visual on each cat every hour, due to some areas on campus being covered in dense bush, it was necessary to use triangulation on occasion.

RANGE DETERMINATION

Home ranges were estimated using ArcView 3.1 (ESRI GIS and Mapping Software, USA) with the kernel analysis function in the home range extension (HRE). Smoothing parameter (bandwidth-*h*) is the most important step in deriving a kernel density estimator (Worton 1989), but there seems to be no generally accepted method available for determining the right *h*- value, so the smoothing factor was determined as follows. First, the location points for each cat were analysed via the adaptive kernel estimator, using the "*h*-ref" parameter and the program's default raster resolution value (70) (Rodgers & Carr 1998). A range of *h*-values were achieved for

each cat ($n_t = 48$) and the median of these values was then used as the final smoothing factors to determine diurnal and nocturnal range sizes for each University term (2 semesters and 2 vacation periods), with a fixed kernel density estimation (Worton 1989; Barg *et al.* 2005; Wronski 2005).

Diurnal and nocturnal home range sizes for each university term were obtained for each collared feral cat. Day and night ranges were determined where day fixes were from 05h00 to 16h00 and night fixes from 17h00 to 04h00. This was kept constant throughout the year, so depending on the seasons, sunrise fell into the day category and sunset into the night category for some of the autumn and winter months only. Core ranges are described as exclusive areas (Maher & Lott 1995) within an animals home range that are used intensively (Barg *et al.* 2005). Total home range size as well as core range size (see Barg *et al* 2005) were determined and tested for significant differences using repeated measures (RMANOVA; STATISTICA, Stat Soft Inc, USA.).

Results

Of the 8 feral cats caught at the beginning of the study, 2 had their collars removed by unknown persons, hence only 6 cats (3 males; 3 females) kept their radio-collars for the full duration and will be discussed in detail. For these cats, a total of 2275 location points were recorded monthly over the year, of which only 757 (33%) were obtained through triangulation because there was no visual observations of the focal cats. An average of 346 location fixes for each cat was included in the analysis of their home range size. Overall, there were significantly more location fixes recorded at night (t-test; $p < 0.001$) and only 33% ($n = 255$) of these were recorded through triangulation.

White and Garrott (1990) stress the importance of tracking data being statistically independent. They report how in some instances intensive data collection serves only

to inflate sample size, but rarely do the consequent location points contribute any additional information on the study animal's home range. While we are certain that the monthly home range estimates are independent of each other, the hourly location fixes may have raised some concerns. Feral cats in this study were often located in the same position for consecutive sightings, however rarely were they disturbed by the trackers when they were located. If they were, they only moved off a few meters from their original positions and then settled again. Thus, observations recorded at least an hour apart were felt to be sufficient to assume statistical independence.

TOTAL HOME RANGE SIZE AND DISTRIBUTION

Estimates of total home range of the 6 monitored feral cats on the HCC are given in Table 1. These ranges were determined using all the location fixes recorded from the entire study period (over 360 hours of surveillance). All cats were seen at every monthly tracking session and information from security staff helped to determine that these cats were all residents of the HCC. All the feral cat home ranges occurred on the eastern part of campus, near the student residences and administrative buildings where permanent feeding stations had been established (Fig. 2). There was no visual evidence of feral cats in the Msinsi Reserve area, although calculations show that a part of the reserve was included in cat 550's outer range (Fig. 2). No significant differences were found between the total home range sizes of all the feral cats (t-test, $p > 0.01$), and there was substantial overlapping of all ranges outside the core areas (Fig. 2). Core ranges are shown as filled in areas (Fig. 2) and there was no overlap between the HCC cats as these were small areas, according to our calculations. Some feeding stations occurred either within certain core areas (cats' 500, 020 and 120) or in close proximity. Some core areas of the feral cats are within range of more than one feeding station (discussed in detail in Chapter 5).

COMPARISONS OF HOME RANGE

Changes in home range and core range size of the HCC feral cats between University terms were investigated for both day and night categories (Tables 2 and 3). There was no significant differences in home (RMANOVA; f = 0.07909, df = 3, p > 0.01) and core range sizes between semesters and vacation times (RMANOVA; f = 0.15260, df = 3, p > 0.1). Overall mean size for nocturnal home and core ranges were larger than the diurnal ranges (Fig. 3), but the differences were also not significant (RMANOVA; home range: $F = 0.36$; $p > 0.2$; core range: $F = 0.18$; $p > 0.2$). The cats did not seem to be affected by the changing frequencies of human activity and they visited all areas of their home range, and made use of all parts of their core range, during the day and at night (activity is discussed in detail in chapter 5).

Because some of the study animals had their collars removed, we could not determine whether any difference existed on the HCC between sterilised and non-sterilised feral cats. Also, the reduced sample size (n = 6) meant that seasonal differences between the sexes could not be tested either. Cat 020 (the oldest intact adult male) did show an overall larger day and night core range during the winter and spring months (Table 3).

Feral cat feeding stations are located at various sites around campus. Some are maintained regularly by certain members of staff, while others not so regularly by some members of the student body. Food trays (with rice and wet cat food) at the staff monitored feeding stations were usually filled between 14h00 and 16h00 daily throughout each semester but only one of these was maintained during the vacation times. This same station, however, was not supplied with food for a period of approximately 2 months (part of S3 in Table 3) and cat 500, a female feral cat born in the area after the station had been established, had home and core ranges sizes that were smallest diurnally and greatest nocturnally over this period (aside from this period, her diurnal ranges were bigger for both home and core ranges than her

nocturnal range sizes). Another of the cat's, Cat 550, transmitter was found to be faulty during the time period S2 (a signal could only be located if the batteries in the receiver were more than half charged) thus values in this time period are less than expected due to the small number of fixes.

Discussion

Home ranges of the HCC feral cats were only distributed on the eastern side of campus and the authors observed no evidence of the cats visiting the nature reserve. The developed area that the feral cats frequented, offers plenty of shelter and many open refuge and supplemental feeding sites. Here, food was easily accessible and more consistent during the semesters so it seems that, given a choice, these cats would tolerate humans in return for readily available resources. This is in direct contrast to Calhoon & Haspel (1993) who showed that the addition of supplemental feeding stations did not modify home range size in their study. They were, however, comparing two sub-habitats, both within the urban sector. Although, factors such as food and shelter were varied for their research, it is not clear if daily requirements were over-estimated and consequently both sub-habitats may have had an excess of available resources. The present study was done in an urban area that is a conservancy and has a nature reserve within its grounds, thus offering feral cats a choice of different environments.

In their summary table of range characteristics, Liberg *et al.* (2000) show how high population densities for cats are negatively correlated with home range size. In urban areas, population densities are usually in excess of 300 cats/km^2 and female range sizes vary between 300 and 42 400 m^2, while males range between 800 and 240 000m^2 (Liberg *et al.* 2000). However, cats at population densities which are between rural and urban numbers usually have home range sizes between 7000 and 150 000m^2 (females). Male and female range sizes were no different in this study, varying

between just over 37 000 and 108 000m^2, with one of the sterilised female cats occupying the largest home range.

Home ranges of the HCC cats also overlapped considerably, with both the intact males occupying almost the same areas (cats 020 and 990), although they still maintained exclusive core ranges. The implications of this are that food is not a limiting factor and that, in fact, it is probably in excess so there is no need for territoriality through competition (Calhoon & Haspel 1989; Maher & Lott 1995).

Total home range size of feral cats on the HCC did not differ with respect to gender either, which is similar to some studies (Jones & Coman 1982; Langham & Porter 1991). However, other studies have shown that gender does have a significant effect on home range size (Haspel & Calhoon 1993) and usually total home range sizes are presented according to the sexes (Liberg *et al.* 2000). Generally, female home range is affected by resource availability (Macdonald 1992) and male home range by the distribution of receptive females (Liberg *et al.* 2000). Thus, the lack of difference between the sexes for both home and core range size in the present study may be because, without territorial responses, the cats are living within close proximity to one another and males, therefore, do not need to roam in search of a receptive mate. This raises questions about the effectiveness of the sterilisation program that is occurring on campus, especially since none of the cats caught for the purpose of this study had been previously sterilised. Some may argue that one would only expect non-sterilised cats to be caught because cats become trap-shy and are not easily re-trapped (Molsher 2001). However, cat 020 and one other cat not used in this study were both trapped twice within a 2 week period, so this can be excluded as a reason for no sterilized cats being caught.

Cats are generally more active nocturnally (Izawa 1983; Konecny 1987), however, home and core range size of the feral cats on the HCC were not significantly different between day and night. They did not change between semesters either. There were

still a number of people on campus during the night (mostly residence students and security staff) and many students stayed on campus in the July vacation period (pers. obs.). It appears that in the present study, instead of hiding away from humans during the day as in other studies (Calhoon & Haspel 1989), these feral cats are active and moving around despite high levels of human activity. They may be moving more in order to avoid direct human contact, causing day range size to be larger than expected and similar to night range size as there was some evidence of this during the radio-tracking sessions. It was often noted that as soon as the observers got too close to the cats (or seemed to be taking too much notice of them) they would only move out of the direct path of the observers, usually out of sight. So it is more likely that human activity is not an influencing factor, and that the expectation of food before nightfall is causing the cats to become more diurnal thus the similarities in day and night ranges. Calhoon & Haspel (1989) also reported larger ranges for those cats using feeding stations. The fact that night time range sizes were only slightly bigger than the day time ranges, suggests that the feral cats are not ranging as far nocturnally, as expected and the day range sizes are slightly larger than the expected average for feral cats.

In conclusion, excess food resources appear to have a major influence on home and core range size for feral cats on the HCC which is an urban conservancy. The readily available food, supplied constantly by the feeders seems to have influenced the location of home ranges, while the abundance of this resource appears to be affecting both the nocturnal and diurnal range sizes. The presence of humans, as well as reproductive status and gender of feral cats, all appear to have little significant effects in the presence of the overriding effects of too much food. This study indicates that food is the primary influencing factor for the establishment of home range location and size. All others factors only come into effect after the fact.

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Tables

Table 1. Total home range sizes for feral cats (*Felis catus*) on the Howard College Campus calculated by the fixed kernel method. Shown are the numbers of locations (*n*) and the smoothing factor (*h*) used to generate these estimates.

Cat	Status	Gender	*n*	*h*	Total home range (m^2)
020	I	M	321	0.382	65454.859
120	I	F	330	0.380	62037.394
500	S	F	390	0.370	37233.795
550	S	F	316	0.383	108314.491
570	S	M	341	0.378	59803.967
990	I	M	374	0.373	104623.903

(I = intact, S = sterilised; M = male, F = female.)

Table 2. Seasonal home range sizes (m^2) for feral cats (*Felis catus*) on the HCC calculated by the fixed kernel method. Semesters 1 and 2 are included in the autumn and spring months respectively, while Vacations 1 and 2 fall into the winter and summer months respectively.

	Semester 1	Semester 1	Vacation 1	Vacation 1	Semester 2	Semester 2	Vacation 2	Vacation 2
Cat	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**	**Day**	**Night**
020	77766.379	63736.622	24752.642	68846.247	59466.875	56301.179	77458.258	101587.900
120	39001.899	55705.846	14811.583	65352.979	55988.981	63791.717	31568.541	48852.308
500	31233.584	29016.128	40899.475	33210.493	17684.280	50022.825	28463.579	33317.745
550	11108.093	174585.235	7059.970	45162.979	16018.847	72796.692	13475.268	151201.339
570	9876.105	75428.393	10293.891	65052.542	45424.309	32904.952	27216.565	63808.524
990	36409.045	54831.078	80495.684	76154.478	19784.992	75878.203	58178.016	75256.743

Table 3. Seasonal core range sizes (m^2) for feral cats (*Felis catus*) on the HCC calculated by the fixed kernel method. Semesters and Vacations are the same as Table 2.

Cat	Semester 1 Day	Semester 1 Night	Vacation 1 Day	Vacation 1 Night	Semester 2 Day	Semester 2 Night	Vacation 2 Day	Vacation 2 Night
020	12726.417	3741.589	12976.162	14599.646	9205.489	13183.430	8186.422	16188.469
120	5634.671	9258.156	3173.740	6693.314	11437.847	13910.181	6412.853	7988.404
500	4968.280	3884.337	6568.974	5453.138	2505.999	10835.660	5066.905	4588.315
550	1034.424	29443.682	735.471	7603.145	1558.783	14694.720	1341.659	25031.385
570	1218.160	11224.319	1200.229	16018.036	6129.493	5925.744	4284.660	7484.775
990	5851.667	10522.297	19321.270	13918.812	4024.545	11699.908	8163.202	1334.724

Figures

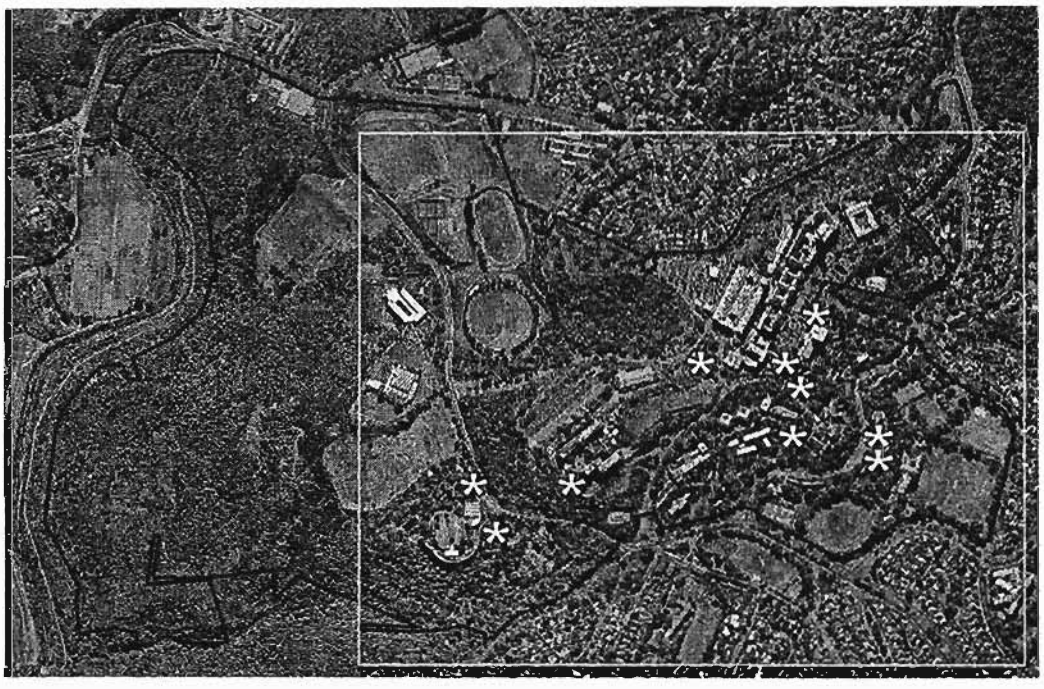

Fig 1 Aerial photograph of the Howard College Campus, UKZN, showing regular cat feeding stations (*). The white box indicates the area shown in Fig. 2.

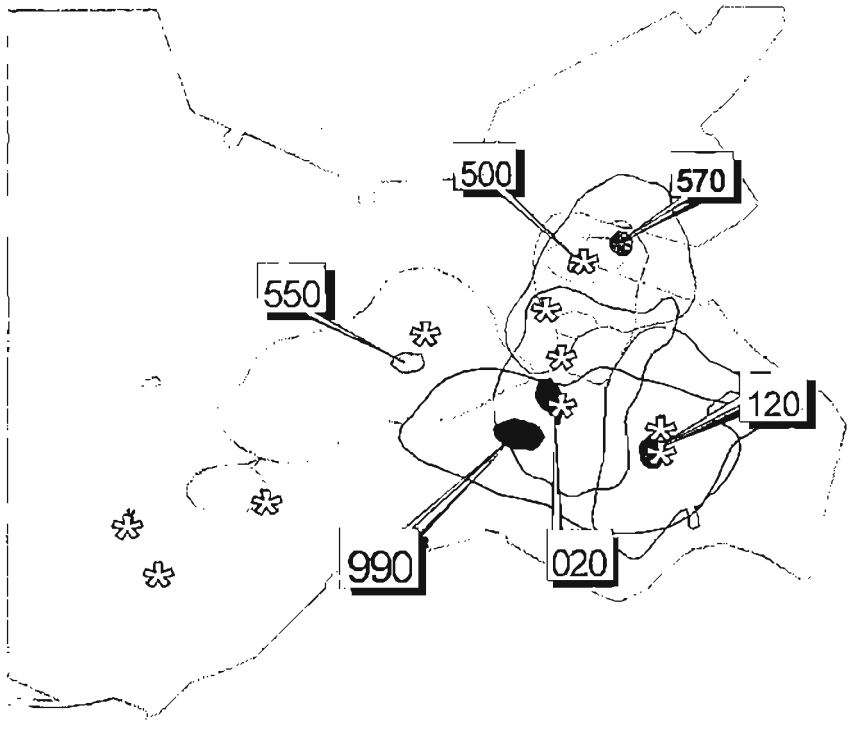

Fig. 2. Total home and core ranges of the 6 collared feral cats radio-tracked in this study. Shaded areas represent the core areas and contour lines indicate total home range. The area depicted is that within the white box from Fig 1. For clarity, the background detail has been excluded. The numbers in the callout boxes are the identity numbers given to each cat and refer to the frequency that each cat's collar was transmitting on.

CHAPTER 4

Estimation of an urban feral cat population: a comparison of various census techniques

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ABSTRACT

Estimating population abundance is an important part of devising a management plan for exotic species. The feral cat population on the University of KwaZulu-Natal's Howard College Campus was studied for 10 months. Both direct and indirect methods for estimating their monthly population densities were used. The University is a registered urban conservancy, which has many reintroduced flora and fauna species, as well as a resident feral cat population. Using various census techniques (modified for use in urban environments), we showed that feral cat population estimates varied according to the method of calculation used and the area on campus where the cats were located. The feral cats were not randomly distributed in the study area. Instead, they had active spacing patterns that were related to resource (food and shelter) availability. Feral cat population numbers ranged between 32.5 – 67.3 cats/km^2.

INTRODUCTION

The domestic cat (*Felis catus*) is a widespread coloniser that has become established on all continents except Antarctica (Denny *et al.* 2002). Woods *et al.* (2003) stated that these pets were the most abundant small carnivores in Great Britain; household owned cats being estimated at about 7.8 million in the year 1998 (Turner & Bateson 2000). Additionally, over 800 000 cats are believed to live in a feral state in Great Britain, making the estimated total cat population for 2003 in the region of 9 million (Woods *et al.* 2003). Because these figures are representative of only one country, numbers could realistically be much higher in South Africa and other countries. There is not a wide separation between domestic felines and their feral counterparts (Hall & Pelton 1979) which have successfully colonised a wide range of contrasting ecological conditions (Tabor 1980; Devillard *et al.* 2003) and as the number of cats as pets increases, so too could the feral populations.

The domestic and feral cat, once both celebrated worldwide for its capabilities of controlling pests (Fitzgerald & Karl 1978; Molsher *et al.* 1999; Smith 1999; Gillies & Clout 2003), have now become regarded as a major contributing factor in the decline of a range of mammalian and avian species (Fitzgerald & Karl 1978; Churcher & Lawton 1987; Dickman *et al.* 1993; May & Norton 1996; Woods *et al.* 2003; Kays & DeWan 2004) as well as for the minimal success of many reintroduction projects (Dickman *et al.* 1993). Predation by cats is the assumed threat, however, competition between cats and other predators can also have negative effects on wild populations (George 1974).

Food abundance is an important factor related to cat density and an excess of available food can maintain cat numbers when local prey numbers are at a minimum (Turner & Bateson 2000), thus creating a situation of hyper predation (Woods *et al.*

2003) where, by virtue of their numbers, feral cats are a major predator. While feeding stations have been shown to normally only bring about a re-distribution of the cats instead of actually increasing their numbers (Haspel & Calhoon 1993), the constant supply of food encourages the formation of social groups (Laundre 1977) around these feeding sites and reduces territorial interactions which could give new cats to an area a better chance of taking up residence. Also, any form of medical care could help to increase cat numbers by reducing infant mortality rates which are usually very high in feral cat populations (Jones & Coman 1982; Devillard *et al.* 2003) and perhaps increasing longevity of adult felines (Warner 1985).

Estimating population abundance is central to sound management and is an important part of most wildlife research programmes (Jachmann 2001). Basic techniques used to count mammals include total counts (of large, conspicuous animals; breeding sites; roosts/nurseries), strip and line transects (ground-based and aerial), individual recognition, counting/mapping calls and trapping (Sutherland 1997). More recently, many researchers are now using the distance sampling method to calculate density estimates. This is a type of plotless sampling useful in a variety of contexts (Anderson *et al.* 1983). The type of census techniques one would use to estimate ecological populations depends, however, on the reasons for the data collection (Sutherland 1997), as well as the species being studied.

Small to medium-sized carnivorous mammals are usually hard to monitor as they can be shy and solitary (Edwards *et al.* 2000). In the past, models of capture-recapture and removal studies have been used to estimate small-mammal populations, producing, mostly, estimates of population size (N) (Anderson *et al.* 1983) which is only useful to biologists if the geographic area (A) related to N is known (Anderson *et al.* 1983). Population size (or absolute density) is difficult to obtain, but necessary in

certain circumstances when the study animal could pose a threat to local wildlife and the public.

The University of KwaZulu-Natal, Howard College campus (UKZN HCC) is a registered urban conservancy dedicated to the conservation of indigenous flora and fauna. It has a resident feral cat population and a group of cat-enthusiasts have formed a committee in order to implement "A feral cat management programme". They are currently running a feeding and sterilising programme for these felines (Hart 2004, pers. comm.). Aside from the feeding stations, the feral population has access to large amounts of organic refuge that is poorly contained, as well as many different prey species which occur around campus (especially the nature reserve located within the campus grounds) (pers. obs.). These felines are not indigenous to South Africa and therefore, theoretically, they do not have a place within the indigenous nature reserve. However, eradication of this species within an urban conservancy would not be a solution because it is likely that feral cats from the surrounding urban settlements would immigrate (Short & Turner 2005) and re-populate the campus grounds? (Todd 1978). Management concerns of the Conservancy committee would thus have to take into account the size of the feral cat population as well as its population dynamics for sustainability purposes, regardless of whether the cats were considered indigenous or not. Thus, population density estimates would show whether the feral cat population is stable or decreasing as a consequence of the sterilisation programme or whether it is increasing to levels likely to negatively affect the other wildlife on campus. It would also contribute to future studies of what factors may be contributing to feral cat abundance in urban conservancies, if their population dynamics was better understood.

In the present study, specific aims were to determine a monthly estimate of the feral cat population size and its distribution on the UNZN HCC to determine cat densities. It was expected that, as a consequence of cat sterilisations on campus, feral cat numbers would be stable and possibly declining, if migration of other feral cats from and to nearby urban areas was low. It was expected that if the cats were not breeding, then few kittens would be seen. Because of the abundant food resources available on campus, high feral cat densities were expected, but not increasing with time. Various methods were used to estimate feral cat abundance on the HCC and each is discussed separately and then the results compared to determine if predictions were supported.

METHODS

A feral cat census was carried out on the UKZN, HCC grounds (S29.867; E030.981) from November 2004 to September 2005 in order to estimate the population size of the feral cat population that is resident within this urban conservancy.

The campus, UKZN, covers approximately 1.69 km^2 (Fig. 1), including the Msinsi nature reserve, and the forested areas behind the Albert Lutuli Cluster residences and the golf driving range. Most of the land area on the central campus has been developed and has many buildings used for student residences, lecture and food halls, and academic and administrative purposes. It also has cultivated areas, some used for sporting activities and others as landscaped gardens. There are also numerous car parks, roads and some residential homes situated within the campus grounds (For a full description of the HCC vegetation and fauna, see Boon & Neal 1999; Boon 2001, 2002). Access to the campus is restricted, however, stray dogs and cats, as well as other wildlife are not generally excluded.

A group of university staff members, concerned for the welfare of cats, proposed the formation of a committee on the HCC to establish a "Feral cat management" strategy. Members of this committee are mostly responsible for the regular feeding of some groups of cats and permanent feeding stations at various sites have been established around campus. They have also implemented a "sterilise and return" programme as part of their management scheme. There is little scientific information regarding the HCC cats. However, sterilisation records from the committee reflected that there were at least 36 resident, sterilised feral cats on campus before this study commenced. The committee has claimed to have sterilised most of the campus cats, thus this figure is expected to be close to the present number of cats on campus. Unfortunately, this committee did not contribute further to or support this study, and thus further information was not forthcoming.

Population estimates

Initially, the researchers had hoped to use the distance sampling method to calculate density estimates. However, feral cat census in an urban conservancy did not meet the criteria for this method of analysis. The technique assumes straight line transects that do not follow any man-made roads or established paths, and unrestricted access to the entire study area. This would have been extremely difficult to execute on the HCC as much of the campus is made up of roads and pathways. Access is also restricted to most areas, and there are usually only a few points through which entry to many areas on campus can only be gained; usually requiring campus security. Anderson *et al* (1983) adapted the distance sampling method for use with capture-recapture and removal data, and other studies have used standard techniques such as intensive trapping and removal of the study species from the study site to estimate

population densities. However, in the present study, census techniques were limited to only those that require no intrusive techniques. Thus, intensive trapping for methods such as mark-recapture (Hayne 1949; Hall & Pelton 1979; Anderson *et al.* 1983; Langham & Porter 1991; Denny *et al.* 2002) and baiting (Short & Turner 2005) were not appropriate. Many researchers have modified the mark-recapture method so that, once marked, cats are only re-sighted and not re-caught (Haspel & Calhoon 1993). However, this technique still requires intensive trapping just prior to the census counts. Another standard method of estimating feline abundance is to use vehicle spotlight counts (Jones & Coman 1982; Molsher *et al.* 1999) and other studies have estimated cat densities through individually recognising the study animals (Langham & Porter 1991; Page *et al.* 1992). Mirmovich (1995) made comprehensive drawings and described in detail every cat he observed during the study. Today, individual recognition is made easier with the use of digital photography.

Individual recognition

Although absolute counts are difficult to execute because they can be expensive and time consuming (Jachmann 2001) (also, in the present study access to some areas on campus are restricted), a direct method of estimating population abundance, a total enumeration of the feral cats over time, was conducted using individual recognition. Use of digital photographs, together with full descriptions of all cats encountered on the HCC during the census and the radio-telemetry study (chapter 3), allowed identity profiles for all cats observed on the HCC to be catalogued. Cats were recognised from their markings and any other notable features like clipped ears, scars and short tails. Geographical co-ordinates of the exact locations where the cats were observed

were also used to assist with identification. These profiles were used to determine a total count of feral cats on the HCC.

Transect counts

The campus grounds were divided into sections according to accessibility and difference in vegetation (4 "sub-habitats" in all) (Fig. 2). This was done for monthly comparative purposes of feral cat numbers and because cat densities vary greatly depending on habitat type (Liberg *et al.* 2000). These areas were separated by roads and fences, and permanent cat feeding sites were found in 2 of the 4 areas. Five permanent transects, of varying length, were established on the HCC across these 4 areas (Fig. 1) and they mostly followed existing roads and pathways. In certain areas transects cut across open parks, sporting grounds/courts and the open air theatre. Transect 1 was located in Area C, the Msinsi Nature Reserve which had no established feeding stations. Transects 2 and 3 were situated in Area A, which contained a large area of indigenous vegetation and the University's student residences. Two permanent feed sites were located in this area. Transect 4 was in Area B which was the central part of the HCC. All the lecture venues, administration buildings etc. were situated in this area and it had several permanent feeding stations at various sites in the area. Transect 5 was located in Area D, an area on campus that has both student residence and sporting facilities, and also underwent some development during the study period. Here, some of the open grass areas were converted into parking lots.

Small felines are known to be crepuscular (Izawa 1983; Konecny 1987; Langham & Porter 1991), thus dusk and dawn were deemed to be the most suitable times to observe cats. The monthly census group consisted of 3 researchers (2 identified any

cats along each transect, and 1 who recorded these observations). All 5 transects were walked between 2 - 6 times each month for 10 months; from 16h00 – 19h00 and again from 04h00 – 07h00. A time zone of 3 hours for each collective walk was chosen to ensure that all 5 transects would be covered within the dusk/dawn time zones. The walked transects are a form of sample ground counts, with random sampling of variable sized transects (Jachmann 2001).

All cats that were seen were counted and allocated to an approximate (and somewhat subjective) age class *viz* kittens – younger than 4 months; usually still with their mother, juveniles – no longer accompanied by their mother but still too small to be classified as an adult or adults). Once a cat was observed, its exact position was recorded using a hand held personal navigator (Garmin eTrex, USA). Because the HCC is well lit both in the early mornings and in the evenings, a large area was visible to the observers at any given time while following the transect line. Thus, the GPS co-ordinates for each cat were taken on the spot that they were observed and the total observed area around each transect was used to calculate density estimates for each area (Fig. 2). Dusk and dawn population estimates were obtained with each method used.

RESULTS

Feral cats were not present in all areas of the HCC. No cats were seen in the Msinsi Reserve (Area C, Fig. 2) throughout the entire study period and Security staff claimed that there were no resident cats in this area (chapter 2). Since no values were obtained, this transect was not included in the final analysis. However, as it is still part of the campus grounds, its area was still included as part of the total area for the HCC. Transects 2 and 3 both occurred in Area A and they were divided by the

driving range to which we did not have access. Feral cat counts for these two transects were combined and a population estimate using the sum of these counts was obtained for this area. This sub-habitat, as well as Area D (transect 5), were both considered medium-density areas on campus, because they have large open areas that are either all bush or cultivated sports fields. Area B (transect 4) is considered a high-density area for feral cats because it is built up and has large amounts of resources available.

The total count of feral cats on the HCC showed at least 55 resident feral cats that were individually recognised from digital photographs and descriptive records. Included in this count were the 8 cats initially collared for a radio-telemetry experiment (Chapter 3). Appendix A is a list of the feral cats according to their coat colour, other unique markings and the location were they spent most of their time. From the total count, a cat density of 32.5 cats/km^2 (for the entire campus) was calculated. We continued to add new cats to the list right to the end of the field work and there were no apparent signs of numbers stabilising.

The numbers of feral cats counted along the transects were used to estimate total feral cat abundance for Areas A, B and D of the HCC. These monthly feral cat population estimates for dusk and dawn are given in Table 1. A total of 591 cat sightings were made during the transect walks; 63% (n = 371) occurred in the evening and only 37% (n = 220) during the morning count. A higher number of cats were observed in the evening when compared with morning in areas A and B (Pearson's chi^2; $p < 0.001$), but there was no significant difference in feral cat numbers detected between the times of day for Area D. No significant differences were observed between the months for calculated feral cat abundance in all areas, suggesting that the population was stable throughout the study period. All cats observed (including

kittens and juveniles) were recorded and used in this analysis (Table 4). Both kittens and juveniles were observed almost every month but their inclusion does not have an affect on the population size. Counts from Areas A and D were expected to have similar feral cat densities because of there habitat structure. However only 0.054km^2 (6.41% of Area A; total area = 0.842km^2) was observed during the transect walks compared to 32.09% in Area D (obs. area = 0.043km^2), giving calculated cat densities of 79.4 and 19.0 cats/km^2 respectively (Table 2). Sampling intensity is the sample area size expressed as a percentage of the total area and for Area B was 18.95%, which was considered high enough, and cat density is higher here at 100.7 cats/km^2 than in the other 2 Areas, as expected. Summation of the feral cat numbers obtained from each sub-habitat gave an estimated overall population abundance of 67.3 cats/km^2.

Using only the descriptive data obtained from the transect walks, a total of 34 feral cats could be positively identified from each count. This allowed for a form of mark-recapture for the data analysis to be used. While none of the feral cats were actually caught or marked with any visual aids (aside from the collared cats used for the radio-telemetry experiment), the full descriptions of these 34 feral cats allowed for a form of "marking" which then lead to a "sight-resight" type of analysis. For areas A and B, 15 and 17 "marked" cats were identified respectively; Area D had 2 "marked" cats. Using the Petersen estimate (Greenwood 1997), monthly population estimates for dusk and dawn was then calculated (Table 3). As with the transect walks, no significant differences were obtained between the months for these population estimates of the feral cats on the HCC, and there was only a significant difference between morning and evening counts in Area D (Pearson's Chi^2; $p < 0.001$). Similarly for Areas A and D, the estimated population abundance for the whole study

period was 28.4 cats/km^2 and 26.9 cats/km^2, respectively. As expected, Area B had the highest calculated density, at 92.6 cats/km^2. An overall population estimate from the sight-resight calculations gave total cat density at 42.2 cats/km^2 for the whole HCC.

When feral cat density estimates derived from the transect walks and the sight-resight census techniques were compared, there was no significant differences between the two (RMANOVA; $f = 2.0814$, $df = 8$, $p > 0.01$), although the transect method did give higher overall estimates (Fig. 3) and showed more difference between time of day than did the sight-resight method of calculating population abundance (Fig. 4).

DISCUSSION

It is clear that feral cat distribution on the HCC is not homogenous. Area C is the Msinsi nature reserve – an important part of the conservancy on the campus and a major influencing factor for the present study into the management and control of the feral cat population. No feral cats, however, were observed in this reserve throughout the course of this study and only one feral cat sighting was recorded by an HCC lecturer after the radio-telemetry and census counts had been completed (Uken 2005, pers. comm.). It could be that indigenous fauna within the reserve are actively defending their territories, however, this is undocumented. Most likely, it appears that the feral cats are concentrating on parts of the HCC where there are more available food resources in the form of feeding stations and poorly contained refuse, and shelter compared with the reserve. Acquiring these resources requires very little effort by the cats and the availability means less competition for these resources (pers. obs.).

The total enumeration method of estimating feral cat numbers on the HCC identified at least 55 individual resident cats. The advantages and disadvantages of this method of population density are discussed in "Ecological Census techniques" (Greenwood 1997). Although this type of count is discredited as it has been found to give inaccurate results, in the present study it appeared a reliable method. The estimate was supported because we became very familiar with the study area (having spent much time there during the radio-telemetry study and through the census counts) and the study animals were encountered frequently enough to allow them to become recognisable as individuals. Thus, the profile collated for the total count of feral cats on the HCC appears representative of all the feral cats on campus.

As mentioned, for both the transect counts and the modified mark-recapture method of estimating feral cat abundance, the campus grounds were divided into sub-habitats in order to make overall population estimates more reliable by taking into account the different resource situations in each area. For the sample ground counts, whole areas around the transect lines were observed while walking (Fig. 2). Thus, this method was more representative of a sample area that is then extrapolated to calculate feral cat abundance of the entire area (Greenwood 1997).

We modified the mark-recapture method (Jachmann 2001) of population estimation since the study animals could be recognised individually and thus capture and marking were unnecessary (Greenwood 1997) (and would also have been very difficult and time-consuming-see Chapter 3). We were able to record descriptive data of most of the cats that were sighted over the census period and these data were then used to determine which of the same cats were re-sighted within each transect walk. In this way, the Peterson's method of mark-recapture (Greenwood 1997) was used to determine population numbers by using the "marked" individuals from each sub-

habitat, identified at the end of the study, as the first capture session and each transect walk as the second or recapture session. Overall population density for each habitat was then calculated using the average of all these values.

Feral cat numbers on the campus were fairly consistent irrespective of the methods used to calculate population density estimates. Kitten sightings were included for analyses in the transect walks but were not included in the analysis for the sight-resight method, as one of the main assumptions for this method is that the population is a closed one (Greenwood 1997; Jachmann 2001). Kittens and juveniles were observed throughout the study period, and some kittens were seen right through to their sub-adult stage. Since no intensive searches were conducted for kittens, it is possible that many of them may not have survived beyond infancy (Brothers *et al.* 1985; Denny *et al.* 2002) or that they dispersed out of the study area once they were old enough (Devillard *et al.* 2003). This may be a reason why the feral cat population on the HCC appears to be stable.

In their summaries of various cat density and abundance studies, Liberg *et al.* (2000) defined 3 rather broad categories of cat densities, according to the distribution of local food resources (Table 4). Our calculated cat densities from each sub-habitat of the campus fall within the range of cat densities for these categories, even with the different values from each different method of estimating feral cat abundance. Area B is the central part of the campus, with more buildings than vegetation, thus higher cat densities were expected in this truly urban part of campus. The transect walks in this area gave a cat density just above 100 cats/km^2, however, the sight-resight method gave a calculated density just below this, although it was still the highest estimate between all the areas. Deciding which areas to include when measuring population densities is difficult to achieve and on the HCC, areas A and D consist mostly of

vegetation or sports fields, much of which is inaccessible to humans. We included these parts of the sub-habitats in our calculations in order to achieve more realistic results since they would have been more accessible to the cats. Areas A and D had density estimates in the intermediate category as expected, for both the transect walks and the sight-resight methods. However, while the transect walks put area A in the very top half and Area D in the very low half of the category range, the sight-resight method gave both densities towards the lower range of the intermediate category. This suggests that since the 3 categories are only a rough guideline, our assumptions were probably correct.

Estimated population numbers for the whole campus are different for each method. 55 different cats were recorded in the total count and averages of 117.2 and 71.5 cats were calculated in the transect and sight-resight counts, respectively. Sub-habitats on the campus were separated by main roads and fences, however, these did not offer physical barriers to the cats. Thus, although unlikely, some of the cats may have moved between the habitats and this could be the reason for the elevated numbers in the last two methods of calculation. Indeed, during the radio-telemetry study, one of the male collared cats was seen to disperse from area D (Block E in Chapter 3) to area B (Block D in Chapter 3) and a big ginger male was sighted in both area A and area D during the study. When converted to densities, there was no statistical difference between the numbers of cats/km^{-2} calculated for each method and all three fall into the intermediate category of cat densities as defined by Liberg *et al.* (2000).

There were no statistically significant seasonal differences in the monthly population estimates for either the sample ground count or the sight-resight method. However, the differences between evening and morning counts are probably a result of both redistribution (Haspel & Calhoon 1993) and immigration (Short & Turner

2005), as these differences were only observed in areas A and B, where permanent feeding stations have been established. Area D does not have an established feeding station but food is readily available in the form of open refuge and scraps available form the take-away café and various students' residence buildings. Two new cats were observed to take up residence at one of the feeding sites in area B during the study period. Both kept to themselves (pers. obs) and did not seem to have any family ties with any of the other resident cats in that area (pers. comm.). This indicates that the population is probably stable throughout the year and that kitten mortalities and sub-adult dispersal rates are probably being balanced by the immigration of new feral cats or the dumping of unwanted pets.

In conclusion, the feral cat population of the University of KwaZulu-Natal's Howard College campus is stable for now, although fluctuations in numbers occur at and around feeding sites. The different sub-habitats within the university grounds give varying estimations of feral cat density – the lowest being in the area without a permanent feeding station. Thus it would seem that the provisioning of food from those interested in feral cat welfare may support such high densities persistent on the central part of campus and area A. Even though cat numbers did not increase during this study, it may represent an asymptote that had been reached due to the establishment of the feeding programme and that now, feral cat numbers are being kept stable at a higher density than would be expected if the feeding sites were not present.

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Tables

Table. 1. Monthly population estimates (cats/km^2) for the feral cat population of the HCC, UKZN for dusk and dawn calculated from the sample ground counts. 1 = diurnal and 2 = nocturnal population density estimates. Tran. = transect name (refer to text for details of transect locations)

Tran.	Nov1	Nov2	Dec1	Dec2	Jan1	Jan2	Feb1	Feb2	Mar1	Mar2	Apr1	Apr2	May1	May2	Jun1	Jun2	Aug1	Aug2	Sep1	Sep2
2_3	41.2	46.4	67.0	30.9	134.0	108.3	92.8	23.2	139.2	46.4	92.8	46.4	61.9	61.9	116.0	46.4	67.0	15.5	69.6	30.9
4	67.2	51.3	37.1	58.3	88.4	71.6	74.3	39.8	42.4	15.9	26.5	37.1	45.1	21.2	29.2	23.9	60.1	53.0	58.3	55.7
5	4.2	2.1	1.1	1.6	1.1	0.0	6.3	4.7	9.5	0.0	6.3	6.3	1.6	1.6	4.7	0.0	0.0	0.0	0.0	0.0

Table. 2. Overall calculated population densities for each area on the HCC, UKZN calculated from the sample ground counts. Tran. = transect name (refer to text for details of transect locations)

Tran.	Obs. area	Tot. area	Sampling intensity	Density (cats/km^2)
2_3	0.054	0.842	6.41%	79.4
4	0.090	0.475	18.95%	100.7
5	0.043	0.134	32.09%	19.0

Table. 3. Monthly population estimates for the feral cat population of the HCC, UKZN for dusk and dawn calculated from the sight re-sight method of estimating population abundance. 1 = diurnal and 2 = nocturnal population density estimates. Overall population density for each area is also included. Tran. = transect name (refer to text for details of transect locations)

Tran	Nov 1	Nov 2	Dec 1	Dec 2	Jan 1	Jan 2	Feb 1	Feb 2	Mar 1	Mar 2	Apr 1	Apr 2	May 1	May 2	Jun 1	Jun 2	Aug 1	Aug 2	Density (cats/km^2)
2_3	27.4	23.0	23.9	23.0	25.7	19.0	23.0	31.0	17.7	15.0	25.7	47.0	18.4	20.3	21.7	15.0	27.0	25.7	28.4
4	44.0	50.8	38.8	53.0	26.0	39.5	26.0	71.0	47.0	31.4	26.0	26.0	18.8	32.0	41.0	98.0	68.0	59.0	92.6
5	5.0	5.0	3.0	2.0	6.5	3.5	8.0	2.0	2.0	2.0	3.5	3.5	8.0	2.0	3.0	2.0	2.0	2.0	26.9

Table. 4. The mean number of monthly sightings for the different age classes of the feral cats on the HCC, UKZN.

	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep
Kittens	1.0	2.0	3.0	5.0	0.0	1.0	1.0	0.0	1.0
Juveniles	1.0	1.6	1.0	1.0	0.0	2.5	3.0	2.3	6.0
Adults	11.8	21.0	13.5	10.0	12.5	9.0	8.5	13.0	11.8

Table. 5.* General food situation in three density categories of cat populations

Density Catergory (cats/km^2)	General characteristics of the food situation
More than 100	Rich clumps (garbage bins, fish dumps, cat lover handouts).
.5 - 50	Thinner clumps (farms and other households, bird colonies on islands, or rich dispersed prey).
Fewer than 5	Scarce dispersed prey, might occur in patches, but no rich concentration of food.

* Adapted from Liberg *et al.* (2000) In: The Domestic Cat; The biology of its behaviour. (Eds. Turner & Bateson)

Figures

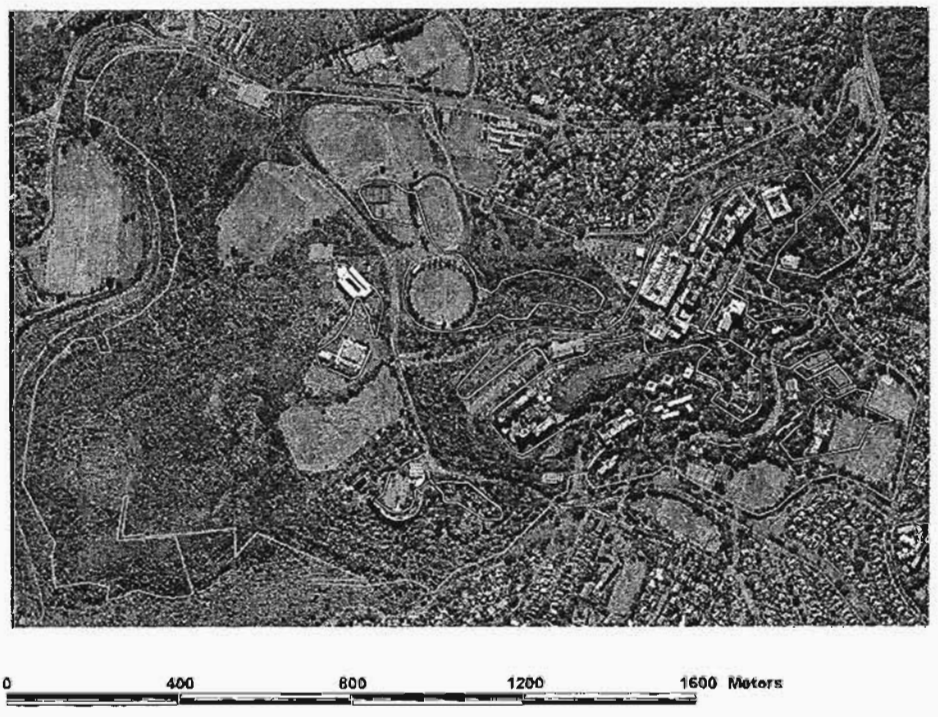

Fig.1. An aerial photograph of the Howard College Campus, University of KwaZulu-Natal. The area within the bold demarcated line is all part of the campus grounds.

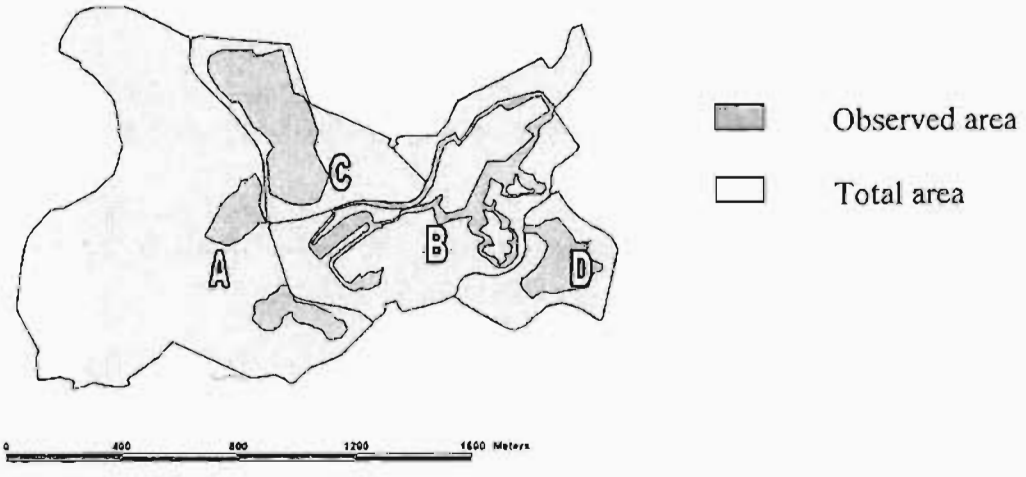

Fig. 2. The campus grounds of the HCC, UKZN. The grounds have been divided into 4 sub-habitats for analysis. This is a modified diagram of Fig. 1, and background details from the aerial photograph have been excluded for simplicity.

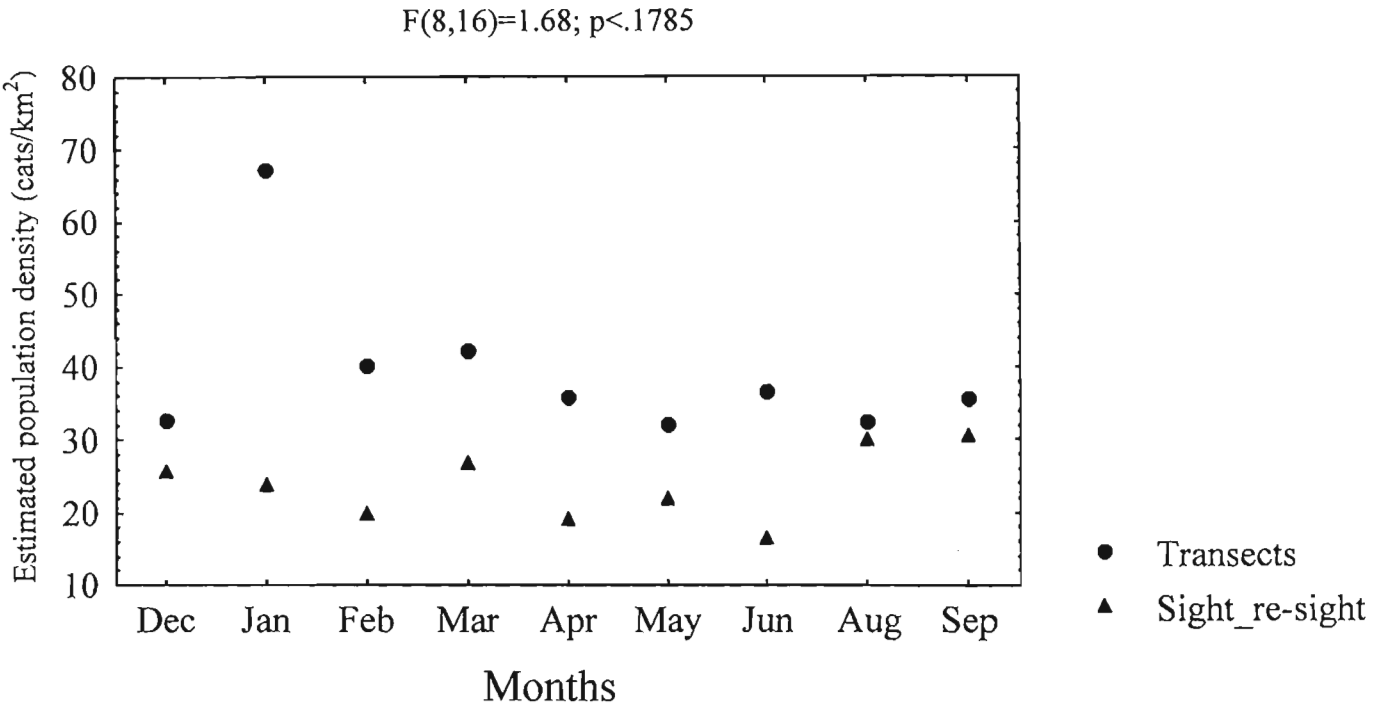

Fig. 3. Comparison of overall calculated population densities of feral cats on the HCC, UKZN, for both the sample ground counts and the sight re-sight methods of estimating population abundance.

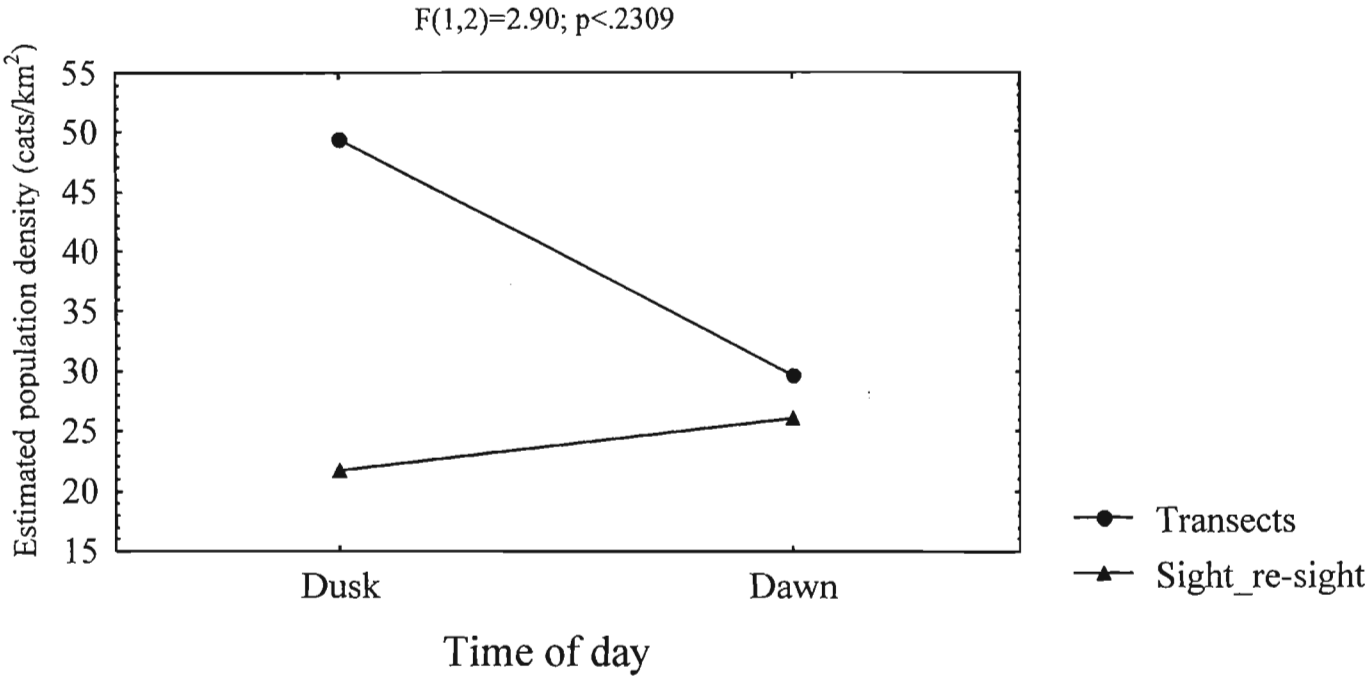

Fig. 4. Calculated population estimates of feral cats on the HCC, UKZN, from the sample ground count and the sight re-sight methods comparing dusk and dawn estimates.

APPENDIX A

Feral cats identified on the Howard College Campus

		Location
Black cats		
500	collared cat	Central campus
Friendly		Central campus
Black & White		
100's friend		Western campus
Al		Western campus
Sick		
Staff black	friendly	Central campus
Zoro	wide	Central campus
Third eye	thin	Central campus
Dark grey tabbies		
550	collared cat	Central campus
020	collared cat	Central campus
040	collared cat	Western campus
040 looklike		Western campus
120	collared cat	Eastern campus
550's friend		Central campus
550's other friend		Central campus
100's mom		Western campus
cricket field cat		Eastern campus
new male		Central campus
old mutual cat		Western campus
shop mom		Central campus
HCC female1	Al youngster	Western campus
Ginger cats		
young ginger	Al ginger	Western campus
Big ginger male		Western campus
Light grey tabbies		
100	collared cat	Western campus
990	collared cat	Eastern campus
mr photo		Central campus
HCC female2		Central campus
No white paw	tab with lotsa white	Central campus
Rose tabbies		
570	collared cat	Central campus
Al mom		Western campus
Big HCC cat		Central campus
devils dive		Central campus
nursery cat	rose twin1	Western campus
other HCC rose	rose twin2	Western campus
Smokies		
HCC smokey		Central campus
pool smokey		Eastern campus
Smokey Joe		Central campus
smokey 1		Eastern campus
smokey 2	Al smokey	Western campus

Chapter 5

Do urban feral cats hunt?

Feeding behaviour of feral cats in an urban conservancy with supplemental feeding

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Abstract

Behaviour data of the feral cat (*Felis catus*) population in an urban conservancy was collected opportunistically during a radio-telemetry study conducted on the University of KwaZulu-Natal's Howard College campus. Predation by domestic cats on indigenous urban wildlife is difficult to quantify. Activity patterns for these small felines are assumed to be crepuscular or nocturnal. Observed activities were categorised into four groups: "Resting" (passive behaviour), "Movement", "Feeding" and "Other" (all active behaviour). Results from the present study show that the feral cats of the HCC exhibit largely passive behaviour, spending considerable amounts of time either lying or sitting down. When active, the cats showed more mobile rather than feeding activity patterns and very little social interactions. Although active behaviour increased as the day progressed, there was no significant differences in diurnal and nocturnal activity. Hunting behaviour comprised only 9% of the "Feeding" category, a mere 1.2% of the overall observations. It seems that activity patterns of feral cats are regulated by the provision of food at established feral cat

feeding stations and that they may change from predominantly nocturnal to a more diurnal behaviour depending on the allocation of this resource.

Introduction

The possible impact on local wildlife by domesticated cats (*Felis catus*) is a contentious issue that is hard to absolutely quantify; this introduced animal has been implicated as a major contributing factor for the decline or extinction of many indigenous species (Dickman *et al.*, 1993; Fitzgerald & Turner, 2000; Hutchings, 2003). Dietary studies suggest that domestic cats are still hunting prey species (Churcher & Lawton, 1987) and have shown that they are opportunistic towards food acquisition (scavenging vs. hunting) (Tabor, 1980; Haspel & Calhoon, 1993). Cats are generalist predators (Fitzgerald & Turner, 2000; Hutchings, 2003) which will eat mammals, birds, reptiles, amphibians, fish, insects, carrion, human garbage and plant material (Davies & Prentice, 1980). They are capable of switching prey preferences (Fitzgerald & Turner, 2000) depending on relative prey availability, ease of capture and abundance (Coman & Brunner, 1972; Davies & Prentice, 1980). Those investigations into the diet of pet cats showed that even when fed regularly by their owners, cats will still hunt natural prey during all seasons (Liberg, 1984; Liberg *et al.*, 2000), although they may not necessarily eat all that they kill (George, 1974). Feral cats too, both rural (Liberg, 1984; Devillard *et al.*, 2003) and urban (Barratt, 1997; Gillies & Clout, 2003; Woods *et al.*, 2003), are also known to hunt, even if they have access to large amounts of rich refuge or supplemental food supplied by human feeders (Hutchings, 2003).

Mammals form the bulk of the cats' diet (Gillies & Clout, 2003; Biro *et al.*, 2005); followed by birds (Paltridge *et al.*, 1997; Biro *et al.*, 2005) which are more at risk in

urban environments (Churcher & Lawton, 1987) or on islands (Kirkpatrick & Rauzon, 1986). (Woods *et al.*, 2003) found that reptiles are a constant source of nutrition all year round-but in small quantities (Paltridge *et al.*, 1997). With their ability to switch prey preference and choose between various other nutritional sources, feral cats can maintain their population numbers even when prey species become scarce (Denny *et al.*, 2002). Thus, they are inflicting constant predation pressure (Hall *et al.*, 2000) on already low levels of prey species, effectively causing a "predator pit" (Molsher *et al.*, 1999).

The Howard college campus (HCC) of South Africa's University of KwaZulu-Natal (UKZN) is a registered conservancy. Thus, it offers the unique situation of an urban environment alongside a naturally kept habitat; home to various urban wildlife (Boon & Neal, 1999; Boon, 2001; Boon, 2002). The university also has a resident feral cat population, whose time of arrival on the campus can not be exactly traced. Feral populations are made up of stray, abandoned and already feral cats (Tabor, 1980) that inhabit areas which offer either food or shelter or both (Natoli, 1985). A few years ago, concerned staff members of the HCC community formed "The Feral Cat Management" committee to try to manage the feral cats through initiating a feeding and sterilisation program (Hart, 2002). This group believes that with a constant supply of food, the feral cats will curb their hunting ways and that through sterilising the entire population, their numbers will be kept under control (Hart, 2002). There is some support for this by Calhoon and Haspel (1993).

Prey activity is the primary factor that controls daily activity patterns and its seasonal changes in most carnivores (Izawa, 1983) and studies show that instead of having an activity pattern which is correlated to prey activities, most semi-dependent cats (i.e. those feral cats which have become accustomed to daily supplemental

feeding at a specific time) now have periods of activity which coincide with the appearance of the feeders with food (Fitzgerald & Turner, 2000).

A negative aspect of permanent feeding stations however, is that it is thought to cause a reduction in territoriality because there is now an abundance of edible resources (Tabor, 1980; Warner, 1985; Konecny, 1987). While still maintaining their personal space, cats have been seen grouping together, either on their way to a feeding site (Laundre, 1977) or at the site itself. Konecny (1987) did not observe acts of aggression at feeding sites while (Laundre, 1977) reported that aggressive behaviour was noted just prior to and only after food had been set down and finished. If cats are becoming tolerant of strangers, cat numbers may increase due to immigration as more cats are drawn by the promise of a guaranteed meal without the risk of attack from resident cats. A likelihood of increased feral cat numbers may be that local wildlife could be affected as the overall rate of hunting would increase with the combined effort of the increasing feral cat numbers. Feral cats could also indirectly affect natural predator populations through competition for the same prey species (George, 1974; Liberg, 1984).

Aside from predation and competition, feral cats also interact with native fauna through the transmission of disease (May & Norton, 1996). Congregating cats and contact with urban wildlife can assist in the spread of disease between cats and between cats and wildlife. Although incidences of transmission of most zoonotic diseases from feral cats to humans is not exactly known (Patronek, 1998), cats can be disease carriers (Baxter, 1973; Coman *et al.*, 1981; Warner, 1984) and many cat studies were initiated due to a concern for rabies and the need for sound management policies should an outbreak occur (Page *et al.*, 1992).

The main objective for this study was to ascertain whether the local wildlife was at risk from the feral cat population that was being fed on the HCC and to determine if such a feeding program would encourage more cats into the area; undermining the objectives of the conservancy. The authors did not wish to use any invasive procedures during this study therefore, behaviour data was collected opportunistically by visual observations. Thus, conclusions were drawn about the feeding habits of the HCC feral cat population by assessing their activity and behaviour patterns.

It was expected that evidence of hunting/killing of prey species by the feral cats would be observed on the campus even with the over-abundance of edible resources available. Felines were also expected to exhibit increased levels of nocturnal activity because of the high levels of human activity on campus during the day. It was assumed that the cats would hide or actively avoid people, but that crowding at feeding stations would occur when food was made available, irrespective of the time of day. It was hoped that this information could be used to assist with the development of a workable management proposal of the feral cat population to suit all interested parties on the HCC.

Methods

The UKZN, HCC (S29.867; E030.981) is a registered urban conservancy consisting of urban areas interspersed with conservationally sensitive natural bush habitats and a nature reserve on the Northern border (Boon & Neal, 1999; Boon, 2001; Boon, 2002). Conservancies aim to eradicate exotic flora and fauna, as well as manage existing populations and introduce more indigenous wildlife. The feral cats on campus can be described as an exotic species if one adheres strictly to the definition of indigenous.

However, ethical responsibilities, public sentiment and logic does not allow for the simple eradication of this animal.

From July 2004 to June 2005, 6 cats were radio-tracked monthly, during the day and at night to monitor their activity and behavioural patterns. The data was collected during a radio-telemetry study that was done to assess feral cat home ranges within an urban conservancy (Chapter 3). When a cat was located, its activity was recorded on a data sheet along with the number of other cats sighted in the immediate vicinity and the focal cats' distance from the nearest food source (either a feeding station, refuge site, garbage bin or a students residence). Each month, the feral cats were located approximately once every hour for 56 consecutive hours and both passive and active behaviour was recorded. Activity was recorded as "not known" if the cats were not located or if they were disturbed by the trackers before their activities could be noted. Night time observations were possible because of ambient lighting (Haspel & Calhoon, 1993) ; most areas on campus were well lit.

Behaviour patterns were categorized following Izawa (1983) who had four levels of activity; "resting" (sleeping, lying down, sitting and self-grooming), "feeding" (eating, foraging and all activities at the feeding site), "moving" (running and walking) and "others" (social behaviour, maternal behaviour and courtship and mating behaviour). As it was not always possible to determine the difference between a sleeping cat and one that was just lying down, all cats observed lying down were recorded as such. This did not make a difference to the analysis, however, since according to our grouping both would have been in the same category. "Standing" as an activity was included in the "feeding" category since it was most often observed at feeding stations; and climbing activity was included in the "moving" category. The one instance of recorded marking behaviour was placed in the "others" category.

"Feeding," "moving", and "others" make up the active behaviour of the cats, while "resting" has been referred to here as passive behaviour.

The Excel extension Poptools and repeated measures ANOVA (STATISTICA, Stats Soft Inc.) were used to determine the frequency of the categories of activity and behaviour of the feral cats observed during the period of study. Time of day of particular activities was also examined to test whether these cats still exhibited a crepuscular behavioural pattern or if the presence of supplementary food had caused them to adopt diurnal activities. Monthly behaviour was also analysed to establish if there was any significant changes in activity patterns between the university semesters and vacation times. Also, distance from nearest food source was recorded to deduce how much time the cats spent around feeding stations. Weather conditions were also assessed to see if they had any influence over feral cat activities.

Results

Activity identifications for the feral cats from opportunistic data collection, was very difficult, and almost half (42.5%; n = 966) of the observations yielded an "unknown" observation. 79.9% (n = 727) of these were due to the fact that the cats were not visually located during the tracking period, while 20.1% (n = 194) were because the cats were disturbed by the trackers, and therefore ran away, before their actions could be recorded. These occasions of unknown activity were excluded from further analysis.

A list of the observed feral cat activities and their respective frequencies of observation are given in Table 1. Overall, the HCC feral cats were a very inactive group of animals with passive behaviour being recorded 63.6% (n = 832) of the time.

The feral cats were most frequently observed sitting (34.8%; n = 455) or lying down (28.8%; n = 377), while walking around was the most frequent (Chi^2: $p < 0.001$) active behaviour (23.5%; n = 307). Hunting activity comprised a relatively small percentage of the behaviour in the feeding category (Fig. 1) but is still an important component that needs to be discussed. Social interactions were very few and far between – neither group bonding nor aggressive behaviour was witnessed at significant levels.

Frequencies of feral cat activity according to season are shown in Table 2. There was no significant difference for the number of sightings of feral cats made between the 4 seasons (t-test; $p > 0.2$). While passive behaviour was most often recorded in all seasons, active behaviour for the feral cats was significantly higher (Pearson's Chi^2; $p < 0.001$) overall in the summer months (44.6%; n = 132). The relatively high mobile activity contributed the most to the high active phases in all seasons, but especially in the summer (38.2%; n = 113). The autumn months showed the lowest overall activity levels. Feeding behaviour was highest in the winter months at 13.5% (n = 44), but the recorded instances of hunting activity was highest in spring. Seasonal behaviour patterns over a 24 hour period are shown in Fig. 3. The arrows on the graph show when tracker shift changes usually took longer than 1 hour, so activities were under-recorded at these times. Feeders initially arrived at around 16h00 to place cat food at the various feeding stations but these times were changed during the course of the study and thus first time feeding peaks are not consistent.

Although the feral cats showed high levels of passive behaviour both during the day and at night (Table 3), the diurnal active phases were significantly lower (Pearson's Chi^2; $p < 0.001$) than nocturnal active behaviour (8.5% vs. 27.9%). Moving behaviour began to increase as night fell ("moving" = 21.6%; n = 283), and

usually feeding behaviour followed the same trend (Table 3), but at lower levels (from 1.9%; n = 25 to 5.5%; n = 72). While observations of hunting behaviour were low (Fig. 1), there were more sightings of hunting activity at night than during the day.

More than half of the feral cat observations occurred at distances greater than 10m from any food source (51.9%; n = 679). The presence of food and feeding stations had some influence over the active behaviour patterns of the HCC feral cats (Table 4). These feral cats were highly inactive but passive behaviour was observed at increasing levels the further away they were from food (distance > 10 m; "resting" = 67.5%; n = 458). As expected, the most recorded active behaviour occurred at and around various food sources; feeding was highest within the 5m range and was comprised mainly of eating from the food trays or bins and self grooming. Standing action was initially included in the "feeding" group because the cats were most often sighted standing at the various feeding stations. However, the values at further distances from food sources where all recorded as "standing" activity but did not occur near any food items in these particular instances. The cats moved around more within 5 – 10m of any food source (Table 4).

Direct observations of the feral cats occurred less on overcast and windy days (Table 5) and especially when it was raining, thus behaviour patterns were only really a reflection of mostly fine weather, since just over half of the observations occurred on clear days, with no wind or rain. Both passive and active behaviour patterns were most often observed on clear days, when there was no wind or rain.

Discussion

The feral cats on Howard College campus exhibited mostly passive behaviour and there were no significant differences either seasonally or hourly. Konecny (1987),

observed similar behaviour with cats which also had an abundance of readily available food resources.

Active phases thus made up a very small part of the daily behaviour. When the cats were active, the levels were generally lower during the day and just like Izawa's (1983) cats in a fishing village in Japan (which showed similar patterns of increasing activity towards nightfall which coincided with the dumping of the day's fish waste and other refuse) they began to increase from about mid-afternoon (usually when feeders arrived to replenish the trays at the feeding sites) and were significantly higher during the night. This pattern was observed by the HCC cats in all seasons, although very definite peaks, during the dawn and dusk hours, were witnessed in the summer months. Crepuscular activity has been recorded in other studies (Izawa, 1983; Konecny, 1987; Langham & Porter, 1991), however, in no other months did the HCC cats demonstrate such obvious signs of bimodal activity. One of their nearest ancestors, the African wildcat (*Felis Silvestris lybica*) exhibit such patterns of activity, thus crepuscular or nocturnal behaviour is often expected of all domestic cats and especially feral ones since they "have reverted back to their wild state". Fitzgerald and Turner (2000) were surprised by this way of thinking since colony cats have been shown to have bouts of activity spread over the entire 24-hour period. We witnessed daily active behaviour, which increased as the day progressed. While Haspel and Calhoon (1993) showed no activity peak during the hours of dusk, this did not occur in this study, but their same reasoning can be applied here *viz.* that cats have the freedom to change their activity patterns according to other food sources, not only prey activity, thus the appearance of the feeders would have a greater influence over the behaviour patterns of these feral cats than other factors.

The HCC feral cats were the most mobile in the summer months and feeding observations were highest in winter. Summer is late mating season for felines, so increases in movement make some biological sense. However, the University's December vacation period falls within this season, thus human activity is at its lowest. There is also significantly less organic refuge on campus and only staff – monitored feeding stations are maintained through this period. Thus, these feral cats are more likely to be seen foraging, like island cats (Brothers *et al.*, 1985) and feeding less at food sites during this season.

Prey activity is the primary factor which controls the daily activity patterns and its seasonal changes in most carnivorous mammals (Izawa, 1983), but since hunting was not a major part of the feeding category, peaks in activity for the HCC cats were attributed to the appearance of food at the feeding stations. Because the sunset hours were included as night time observations, this explained the increased levels of movement and feeding behaviour during the night better than the biological predator-prey relationship. Winter feeding levels were not expected to be so high, however, and other than suspected declining prey populations, no other explanation for this could be found.

Tabor (1980) showed that a superabundance of food leads to a reduction in home range size and a greater cat density, however Haspel and Calhoon (1993) argue that this greater density does not mean an actual increase in population size, but rather a redistribution of the cats within the population. Our results showed that the cats preferred to rest in areas away from any food source but that when they were active, it was usually because they were feeding on site or moving with 5 – 10m of the nearest food source. Social interactions were minimal between all the cats on the HCC and very few instances of aggression were recorded. With the abundance of nutrient rich

resources and shelter, there is no advantage for territoriality and activity rates are also very low (Konecny, 1987). Unlike on certain islands, the HCC cats did not need to spend all their time foraging for food as it was brought to them at the same time and place, daily.

Weather conditions are known to have some affect on activity patterns (Izawa, 1983; Brothers *et al.*, 1985), however, we found it difficult to quantify because much of the unknown activities occurred under adverse conditions. In contrast, when cats were located, they showed a tendency for passive behaviour on clear, windless days. However, they also showed increased rates of activity for these fine conditions. It is possible that when no visuals were obtained when it was overcast, windy and raining quite heavily, that the cats were exhibiting passive behaviour such as sleeping or lying down while they were sheltering from the inclement weather conditions.

The few instances of social interactions between the feral cats on the HCC suggest that territorial defences have become diminished and that immigration by outside cats is a real possibility. In fact two previously unknown cats were seen to take up residence at one of the staff monitored feeding stations 2 months into the study.

It would seem, therefore, that the behaviour patterns of these feral cats are regulated by the arrival of the feeders with cat food, rather than those of the prey species known to inhabit parts of the campus. It also seems that hunting activity by the feral cats on Howard College campus does not occur at significant level. Gillies and Clout (2003) stated, however, that without knowledge of the natural mortality and breeding success of prey populations, it is impossible to quantify any effects of cat predation. It is prudent to remember that, for many rare species, one kill may be one to many.

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Tables

Table 1. Observed activities of the feral cats on Howard College campus over the entire study period. Frequencies for labeled actions were calculated using the observed total. "Unknown" is a percentage of the overall total and has been divided into its respective components.

Action	Frequency
Sitting	34.8%
Lying down	28.8%
Walking	23.5%
Running	4.3%
Eating	2.7%
Standing	2.1%
Cleaning	1.5%
Hunting	1.2%
Fighting	0.5%
Playing	0.4%
Climbing	0.2%
Marking	0.2%
Unknown	42.5%
disturbed	20.1%
out of sight	79.9%
Observed total	1308
Overall total	2274

Table 2. Seasonal changes in activity of the feral cats on the HCC, UKZN. The three components of active behaviour and their repective frequencies calculated from the total.

	Passive	Active	Feeding	Moving	Other	Total
Autumn	71.1%	28.9%	4.3%	23.7%	0.9%	329
Summer	55.4%	44.6%	5.1%	38.2%	1.4%	296
Spring	64.8%	35.2%	6.7%	27.4%	1.1%	358
Winter	62.2%	37.8%	13.5%	23.4%	0.9%	325

Table 3. Percentages of time spent in various activities compared by time of day for the feral cats on the HCC, UKZN.

Behaviour type	Category	Day		Night			
		465	**35.6%**	**843**	**64.4%**		
Passive Behaviour	**Non-active**	354	27.1%	478	36.5%	832	63.6%
Active Behaviour	**Feeding**	25	1.9%	72	5.5%	476	36.4%
	Moving	82	6.3%	283	21.6%		
	Other	4	0.3%	10	0.8%		
		111	8.5%	365	27.9%	**1308**	

Table 4. Frequency of various acitivities of the feral cats recorded at increasing distances from the nearest readily available food source on the HCC.

Distance (m)	Feeding	Moving	Other	Resting	Total
<5	19.5%	24.2%	0.3%	56.0%	25.9%
5.-10	3.1%	32.1%	1.4%	63.4%	22.2%
>10	3.2%	28.0%	1.3%	67.5%	51.9%

Table 5 Frequency of observations of the feral cats on the HCC under different weather conditions.

Weather characteristics			No. of observations	Total (%)
Clear	No wind	No rain	1169	51.4%
Clear	No wind	Rain	100	4.4%
Clear	Wind	No rain	455	20.0%
Clear	Wind	Rain	41	1.8%
Overcast	No wind	No rain	305	13.4%
Overcast	No wind	Rain	101	4.4%
Overcast	Wind	No rain	90	4.0%
Overcast	Wind	Rain	13	0.6%

Figures

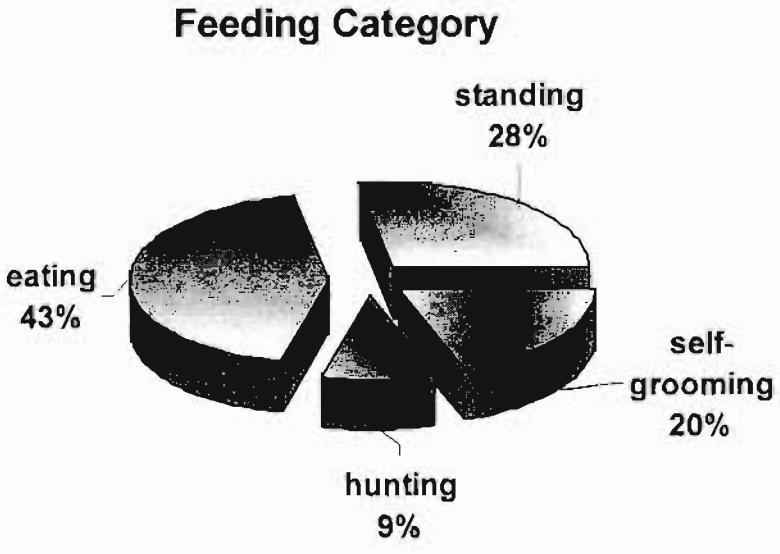

Fig. 1. "Feeding" category, for activity of the feral cats on the HCC, broken into its constituent parts. It includes all foraging behaviour and other activities that occur in and around the feeding stations.

CHAPTER 6

MANAGEMENT RECOMMENDATIONS FOR FERAL CAT (*FELIS CATUS*) POPULATIONS WITHIN AN URBAN CONSERVANCY

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Abstract

Feline cats' (*Felis catus*) ability to colonise most habitats of the world has led to increasing number of feral cat populations in many areas were resources are abundant and easily obtainable. The implications of high densities of feral cats in urban surroundings have negative effects on both human and local wildlife populations. Methods of population control for feral cat populations are reviewed with the view of formulating a management policy that would assist with feral cat control on the University of KwaZulu-Natal (UKZN), Howard College campus (HCC).

Introduction

Domestic cats (*Felis catus*), which became domesticated only recently[1] in comparison to other domesticated species, are opportunistic towards resource acquisition[1,2] and are widespread colonisers[3,4] of many contrasting ecological conditions[5]. In the past, the hunting ability of these cats was considered a favourable characteristic as it assisted with vermin control around many human settlements and so many predator characteristics of feline cats were selected for during the domestication process[6-8]. This feature, coupled with circumstances such as straying or abandonment of some cats, has allowed many to revert back to their "wild state" where they are either completely or semi- independent of man[9]. The degree of independency usually depends on the habitats, available resources (food and shelter) and the characteristics of the cats themselves.

These "wild" cats form feral populations that are maintained through prolific reproduction, immigration of other feral or stray cats and the introduction of abandoned/unwanted pet cats into the feral colonies (especially if cat care-givers are subsidising these colonies)[9]. These influencing factors assist in maintaining and increasing feral cat densities, which have negative affects on both the local human[10] and wildlife populations[11,12].

The presence of feral cats can have both positive and negative effects in urban areas[10]. Predation on local pests, while not scientifically certified, appears to regulate their populations, if only marginally[13,14]. Also, feral cats often have an important role in the lives of many cat-enthusiasts within many communities[15]. It has been suggested that positive interactions with these feral felines may be beneficial to many, reducing mental and physical stresses[10,16]. Feral cats, however, can be a source of a variety of zoonotic

diseases[16], the spread of which is dramatically increased in urban environments with a high concentration of cats. Both hygiene and noise pollution in these situations become a problem and the high densities of feral cats threatens local prey populations through constant predation pressure[10] and local predator numbers due to competition for resources[8]. The welfare of the cats themselves also becomes an issue, especially if they are seen to be suffering. No matter which way one looks at the situation regarding feral cats, it is important that these cat colonies are managed in a way that appeals to everyone concerned.

In Durban, South Africa, the University of KwaZulu-Natal (UKZN), Howard College campus (HCC) is registered as a conservancy and indigenising the campus grounds is a top priority. The campus is situated in an urban environment and has a resident feral cat population. Because of its status, there are conflicting views from the various communities on campus regarding the feral cats (Chapter 2) and this study was proposed to review control and management methods to assist with the application of a feral cat management plan for the HCC.

Control methods

Many different methods of feral cat population control exist and they can be divided into two general categories[10]: Eradication and Reproductive regulation.

Eradication

Usually complete eradication of feral cats is unsuccessful[15] and at best may only serve to reduce the populations to acceptable levels. One exception is the cats on Marion Island[17],

where intensive eradication measures were applied constantly and re-invasion of more cats was not a factor. This programme took over 17 years to complete, but no cats have been found on the island since the last cat was caught 15 years ago. Eradicating or reducing a population can be achieved by introduction of cat-specific viruses[13], poisoning[12], hunting[17,18] or the trapping and euthanasia of the cats. The last – mentioned is considered to be a more humane method of control[15].

Although eradication usually has the least amount of contact with the cat population[10] (except for "trap and euthanasia"), and costs are relatively low (depending on the type of eradication method used and the duration of the programme), the disadvantages of this type of feral cat population control are numerous[10], especially in an urban scenario. Aside from the probable anguish that eliminating a cat population would cause to individuals concerned with the well-being of these feline cats[1,10,15,19], introduction of infectious diseases and poisoning (even hunting) raises serious ethical questions as they often cause suffering and the cats can experience extreme agony before death occurs[10]. Attempted eradication methods can also have detrimental side-effects to both the environment and non-target species[10], especially in areas close to human populations[12]. However, a more serious ecological consequence to using this type of method for controlling feral cat populations, in an urban area in particular, is the creation of a 'vacuum effect'[1,10,12] which allows new individuals to migrate into the vacated niche that is a result of permanently reducing cat numbers[1,15,20].

Reproductive regulation

This strategy helps to maintain (and eventually decrease) feral cat population numbers through both surgical and non-surgical sterilisation techniques[10].

The surgical method (TNR - 'Trap-neuter-release'; TTVAR - 'Trap-test-vaccinate-alter-release') can be performed in two different ways, however, both result in the cats' permanent inability to produce offspring[10]. The differences are that the one method is said to lead to hormonal and behavioural changes in the cats, while the other does not. Advantages of permanent sterilisation is that contact with the cats is reduced to only one session of trapping and marking, which is less stressful for the cats and their care-givers (especially since the cats are then returned to the capture site)[10]. Also, some hormonal and behavioural changes have been known to occur. This may help to reduce anti-social and, in most cases, sexual interactions among the cats, resulting in reduced noise pollution (during breeding season)[15] and possibly the spread of parasites and infections resulting from territorial disputes etc. Some claim that preventing reproduction and the alteration of certain natural behaviour traits has a greater negative effect on the animals' well-being than does eradication[10]. However, using sterilisation techniques that do not lead to hormonal and behavioural changes means that the cats may still exhibit aggressive behaviour and so noise pollution is not reduced.

Non-surgical sterilisation makes use of chemicals and pills[15,20] which interrupt pregnancy. This medication is administered orally, usually through introduction into the cat food provided by cat feeders[10]. For this method, cats do not need to be trapped to control their reproduction, medication is reliable and is not detrimental to the cats or the environment (if proper procedures and the right kinds of drugs are administered) and

normal behaviour patterns are not inhibited. However, this method requires long-term dedication which is both time-consuming and costly to operate[10]. The procedure is also not permanent, so the cats return to fertility if treatment is terminated or the cats disperse out of the controlled areas. And, although non-sterilisation techniques prevent fertility, they do not diminish sexual urges as female cats continue to come into heat. Thus, noise during breeding season and odours still remain[10]. Perhaps the biggest disadvantage of this type of population control method, however, is that the cats are released back to the location were they were trapped and other negative factors such as public health and predation on local wildlife are not prevented[16].

There is some evidence to suggest that only partially tamed or cats with amicable characteristics tend to be trapped[10,15]. Thus, the 'trap and euthanasia' method, along with reproduction regulation may be selecting against those characteristics favoured for domestication. In other words, the more 'wild' and trap-shy feral cats are not being sterilised or eradicated (depending on the continued intensity of eradication measures) and because these traits are adaptive, partially learned and partially inherited, the long term effects of sterilising means that feral populations will become more unwilling to socialise with man.

Recommendations for urban feral cat control on the HCC, UKZN

The feral cat population on the HCC is estimated to be currently stable at between 32.5 – 67.3 cats/km^2 (Chapter 4). While not a truly urban environment since much of the campus is indigenous vegetation, feral cat densities are higher than would be expected due to the presence of various cat feeding stations that have been established around the

campus. These cats generally exhibit passive behaviour patterns such as sleeping and sitting, and active behaviour appears to be regulated by the appearance of the cat caregivers with food (Chapter 5). Home range sizes of the cats were between about 32 000 and 108 000m^2, and their distribution is centred around the various feeding sites. The status of the HCC as an urban conservancy means that there are various, conflicting opinions from the campus community regarding the feral cats' presence (Chapter 1). However, most of the people agree that managing the population is the only option. The type of management is the cause of debate, as cat enthusiasts believe the feral cats should be provided with resources and basic health care, while others believe that management should involve relocating the cat population off the campus.

Management is especially important in circumstances where feral cats may be threatening conservation efforts, but also where the health of the public is concerned. Eradicating alien plant species is a top priority for the conservancy, however, all flora and fauna species (both indigenous and exotic) are subject to strict control through management policies. The resident feral cat population should be no exception, whether they are considered as an exotic species or not. Usually, in those areas where local wildlife is at risk, feral cat control involves the killing of the cats[15] and this is usually justified by scientific progress[17].

Ethical considerations aside, a management plan must take into account all factors of feral cat population dynamics, but more importantly, the cat care-givers who may have claimed ownership rights to specific (if not all) cats in the colony.

Complete eradication of the feral cats on the HCC would not only offend members of the Feral Cat Management committee (and possibly other concerned members of the

public) but the 'vacuum effect' explained above may be a potentially bigger problem. It would be more costly both financially and in terms of the indigenous wildlife populations if migration of new, unsterilised cats were to take up residency on the campus. Research has shown that cats do disperse out of their natal areas (Chapter 3) and reinvasions have occurred in Sharks Bay, Australia[21] and elsewhere. Thus, eradication efforts of the feral cat population on the HCC are likely to be undermined by repopulation by feral cats from the surrounding urban areas.

TNR or TTVAR programmes offer a better alternative – at least at the moment. However, research on the success of such methods is limited. Studies have mainly involved cats in laboratory-based experiments or those confined to their place of residence, thus the free-roaming cats on the HCC offer a unique situation for population control. Scott et al. (2002) reported that out-door cats from a colony sustained by human caretakers showed a decreased tendency to roam and an overall increase in body weight and body condition score after they had been neutered. They took decreases in activity and increases in body fat as a sign of improved welfare rather than a detrimental side-effect. Sterilising the feral cats on the HCC seems a good alternative to complete eradication, however, it will require a continuous programme of trapping and sterilising.

A sterilising programme alone will not solve the situation on the HCC, however. For the proper control and management of the feral cats, they must be released into controlled environments where both food and shelter are adequately provided for. However, provision of resources is another contentious issue that must be addressed. Even when food is supplied by cat feeders in excess of daily requirements the desire to hunt is not inhibited. It does reduce territoriality, however, thereby supporting higher cat densities in

areas with available resources. These factors have negative effects on local wildlife purely in terms of predation pressure and possible competition for urban predator species. Spatial organisation and population distributions of feral cats are influenced by resources (food and shelter), and Haspel and Calhoon[2] showed only a redistribution rather than an actual increase in cat populations when they experimented with feeding stations. This suggests that when setting up feral cat feeding programmes on the HCC, those concerned should examine all possible locations and ensure that the feeding stations are only established at sites where they pose the least threat to local wildlife. In the case of the HCC, all feeding stations should be situated as far from the vicinity of the Msinsi Nature Reserve as possible (Chapter 5).

The provision of food on a daily basis may cause increased dependency on humans in order to survive. Thus, if one is going to provide a feeding programme, one must be aware of the long-term implications that are involved. This comes back to the ethical issues as the removal of a constant food supply after an extended period, may be construed as abandonment. It is prudent to remember that feral cats are not selective in their choice of food, and are capable of switching food preference (to the local wildlife?)[11,22,23] if their primary source of food becomes diminished. With the feral cat densities being maintained year round, and not fluctuating according to prey numbers, this may cause greater problems than at the outset. This is more reasoning for the establishment of a long-term feeding strategy. Feeding programmes, if not properly controlled and monitored, may also lead to other animals, not just feral cats, becoming dependent on human hand-outs. Hadedas (*Bostrychia hagedash*), feral pigeons (*Columbia livia*) and Vervet monkeys (*Cercopithecus aethiops*) have all been observed

eating from either the food trays put out for the feral cats, or scavenging from open refuge sites. And, in a society where many people are strongly against euthanasia, the provision of supplemental feeding tends to lead to the dumping of kittens and unwanted pets in these controlled areas because they know that food is provided. Thus, supplemental food should only be supplied at an amount acceptable to the maintenance of a minimum, stable feral cat population and the food trays should be removed after every feeding session-not left overnight for other animals to come and scavenge from.

Conclusions

In order to effectively control the feral cat population on the HCC, a suitable sterilisation programme needs to be implemented that is run in conjunction with a feral cat feeding programme. Care needs to be taken to ensure that stations are appropriately situated, monitored and properly funded. The feral cat population needs to be maintained at a level that allows the least amount of migration on to the campus grounds, as well as a predation rate that will not negatively effect the resident wildlife population. It is recommended that the management team work closely with the local SPCA and the cat caretakers to ensure that a long-term working solution is devised.

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Chapter 7

CONCLUSIONS

The cats' (*Felis catus*) cohabitation with man goes back between 3600-4000 years ago (Lumpkin, 1993; Smith, 1999; Serpell, 2000) and human attitudes to both the domesticated and the feral versions of the species have changed positively and negatively over time. While domesticated cats have become very popular companion animals, their feral counterparts can bring out the best and the worst in many people.

The feral cat population inhabiting the grounds of South Africa's University of KwaZulu-Natal (UKZN), Howard College campus (HCC) offers a unique situation. The campus is a registered conservancy situated within an urban environment, essentially offering the feral cats two types of 'sub-habitats'; an urban area as well as an open, non-developed area.

At present, the campus is running an alien invasive plant eradication programme (an initiative started 10 years ago, together with WESSA) with the hopes of completely restoring the indigenous flora and fauna to the campus. The resident feral cats are the cause of much concern and, at present, there exists two extreme views on campus regarding their presence on campus (Chapter 2). The survey carried out on the HCC showed the difference in opinions of some of the campus communities. Most of the people included in the survey were not aware that the feral cats were the cause of such emotive debates. Some of the residence students were not comfortable with the feral cats living on campus, and while overall feelings were positive towards cats in general, most of the questionnaire respondents were strongly in favour of implementing proper

management policies that would help to control their numbers (Chapter 2). The cleaning, gardening and security staff did not share this view, however, and saw no reason why the University should waste their resources (Chapter 2).

Results from the survey (Chapter 2), telemetry (Chapter 3) and the census (Chapter 4) studies showed that the presence of abundant resources has an overriding effect that influences all aspects of cat biology, even the expected normal behaviour patterns (Chapter 5) of feral cats on the HCC. The availability of abundant food resources that is available on the HCC in the form of open refuge sites and permanent cat feeding stations, is the primary influence for feral cat home range sizes, distribution and population density. Once these have been established, other factors such as human activity, reproduction status and gender then come into play.

Distribution of the HCC feral cats was not homogenous and cat densities were highest in areas were permanent cat feeding stations had been established. Lower cat numbers were observed in areas where only refuge was readily available and no cats were observed in the Msinsi Nature Reserve. This reserve is natural bush and is situated within the campus grounds. Aside from fences, there are no other barriers that serve to exclude the cats from this area. Prey species are the only available resources on this area of campus although this has little influence on the cats that seem to prefer to reside close to those areas on campus were food resources require the least amount of effort to acquire (Chapters 3 & 4).

Home ranges of the HCC feral cats were influenced not only by food resources, but also shelter availability (Chapter 3). With cats living in high densities, home range sizes were relatively small as is shown by Liberg *et al.* (2000) with considerable overlap

between and within the sexes. The cats did appear to keep exclusive core areas, however, and these were most often included one or more feeding sites. The home ranges of the cats did not change seasonally and there was also no difference in diurnal and nocturnal range sizes (Chapter 3). Unlike truly feral cats, such as those on islands (Brothers *et al.*, 1985; Konecny, 1987; Say *et al.*, 2002) that spend much of their time foraging, the cats on the HCC did not have to range very far to find either food or a mate.

The HCC feral cats were very inactive, most often observed exhibiting passive behaviour such as lying down or sitting (Chapter 5). Activity levels increased, however, just prior to and when food was provided by the cat care-givers. Both activity levels and home range sizes increased during the university summer vacations and this can not only be attributed to the breeding season. It is more likely that, because there was very few people on campus at this time of year and available food resources were relatively reduced (scraps and organic waste at a minimum and many of the student monitored feeding stations were left unattended), the cats had redistributed to those areas on campus were the feeding stations were being maintained.

Aggressive behaviour in feline cats is greatly reduced when there is an abundance of available resources and immigration of strange cats is tolerated with no signs of active territorial defences (Konecny, 1987). This is the main reason for high cat densities and large overlaps in home ranges in areas where food is supplied in abundance (Chapters 3 & 4).

On the HCC, the food provided by the cat feeders or scavenged from open refuge sites appears to be the primary source of nutrition (Chapters 2 & 5). Some hunting activity was observed, however. And even though it was rare in both the surveys and behaviour

studies, predation pressure by feral cats at high densities (maintained at stable levels throughout the year) will probably have a detrimental affect on prey populations and indirectly affect the local predator populations (George, 1974).

In the context of a conservancy, feral cats are an exotic species. This appeared to be an important point initially, with an obviously simple solution-eradication. There were many people who disagreed with this concept and this method of population control is not logical for feral cats inhabiting an urban environment. Attempting to remove all the cats on campus, would only serve to create a 'vacuum' (Tabor, 1980). Immigration of feral cats from neighbouring populations would eventually fill this vacant niche and they would also need to be removed, thus perpetuating the cycle. A better management option would be to control the feral cat numbers and maintain a population that is at minimum capacity (Chapter 6). This would ensure a minimal rate of both immigration and predation pressures. The management policy should include the establishment of a sterilising and feeding programme. This would require the involvement of the local SPCA or veterinarian and the cat care-givers, as well as the budgeting of personnel and finances from the University management, not only on a once-off basis but as a long-term management policy. A big concern regarding the feeding programme is that some local wildlife, and not just feral cats, may come dependent on these human handouts. Left unattended, overnight, a feeding programme has the potential to increase the rate in which other problems animals may occur. This would further compound the problem for the University management and have implications for the conservancy. Thus, the feeding programme should be low-key and only enough food supplied, for a limited time every day, to maintain the resident feral cat population.

An aspect not investigated in this study due to constraints from the feral cat caregivers was the level of disease in the cats on the HCC. Zoonotic diseases are a serious threat and further studies are needed because cats can be a reservoir of many diseases that can be transmitted to both people and other fauna. The main areas where the cats congregate on campus are concentrated in the vicinity where there are high levels of both student and staff activity. The ease with which diseases may be spread from cats needs to be investigates as it has implications for the University management.

The feral cat population on the HCC can not be left to fend for itself. To do so would have serious consequences for both the welfare of the indigenous fauna and the cats themselves. We have not absolutely quantified the effects the cats have on the local wildlife, however, prevention is better than a cure. It would be more beneficial (and cost effective) to control feral cat numbers now than wait to see what damaging effects they may have in the future.

This study has raised awareness of feral cats in urban situations in South Africa. Various hospitals and some members of the public contacted the authors during this study and identified feral cat problems. Also of serious concern to biologists is the number and impact of feral cats in rural areas in South Africa. Many countries worldwide have already introduced stringent control methods for both domestic house cats and feral cats, despite the emotional views of many cat enthusiasts. Further studies are required in South Africa and the biology and population demographics of the feral cat colonies in this country needs to be investigated in both an urban and a rural context to determine their status as a potential threat to both humans and wildlife.

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