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Worldwide domestic and feral cat (*Felis catus*) numbers have increased. Concerns regarding high populations of feral cats in urban areas include wildlife predation, public nuisance, and disease. This study aimed to estimate the size of the feral cat population on 5 campuses of the University of KwaZulu-Natal, South Africa, to determine whether sterilization has an effect and to make management recommendations. The study used both the total count and mark-recapture methods to estimate the feral cat population on each campus. The study chose a noninvasive method of taking photographs to "mark" individuals and record those who were sterilized. The study estimated a total of 186 cats on all campuses and density at 161 cats km^{-2}. There was a negative relationship between sterilization and numbers. Sites with higher sterilization showed a lower proportion of younger cats. At the average sterilization of 55%, the population, according to predictions, would remain stable at fecundity, survival, and immigration rates reported by cat caretakers. However, caretakers underestimated cat abundance by 7 $\pm$ 37 *SD*%. Caretakers' feral cat sterilization and feeding programs appear to provide a service to the university community. Key management recommendations were to increase sterilization to 90% to reduce the population over the long term and to raise funds to support the costs incurred by voluntary cat caretakers.

The number of domestic cats (*Felis catus*) has increased worldwide (Jarvis, 1990). Free-roaming cats who have no caregivers (owners) and who are acciden-

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tally or deliberately provided food are commonly known as feral cats and further distinguished as semiferal or—if socialized toward humans—strays (Bradshaw, Horsfield, Allen, & Robinson, 1999).

Feral cat populations originate from owned cats who are lost or abandoned; numbers grow from breeding and with immigration of new stray cats (Robertson, 2008). Domestic cats have retained their hunting instincts and, even if adequately fed, prey on birds, small mammals, or reptiles (Fitzgerald & Turner, 2000). Feral cats are generalists and adapt to prey-source availability, including human food waste (Coman & Brunner, 1972). Cats reproduce at a high rate and populations increase rapidly in favorable conditions (Mahlow & Slater, 1996).

Densities of feral cats in urban areas may be high (Liberg, Sandell, Pontier, & Natoli, 2000); this raises concerns about wildlife predation, public nuisance, and disease (Slater, 2002). Methods used to reduce feral cats range from euthanasia, trap-neuter-return (TNR), relocation, homing of kittens, and oral contraception to decreasing the source of cats (Mahlow & Slater, 1996; Robertson, 2008). Implementing these methods relies on the participation of animal welfare organizations; voluntary cat caretakers, who often start feeding programs at feral cat colonies (Slater, 2002); or on land managers, property owners, and public health officials.

There is debate about the benefits of feral cat-feeding programs in urban areas (Longcore, Rich, & Sullivan, 2009). Those against these programs say they increase cat numbers (Schmidt, Lopez, & Collier, 2007); advocates say they reduce predation on wildlife (Calhoon & Haspel, 1989) and public nuisance. In addition, advocates contend that cats are monitored, are generally healthier (Fitzgerald & Turner, 2000; Slater, 2002), and that illnesses are treated and new cats sterilized punctually. Some argue that a core population of healthy cats prevents immigration of new cats (Mahlow & Slater, 1996); yet, others argue there is less competition for resources with a feeding program so less barrier to immigration (Schmidt, Swannack, Lopez, & Slater, 2009). A number of studies have shown that TNR colonies do not resist invasion (Castillo & Clarke, 2003; Levy, Gale, & Gale, 2003; Zaunbrecher & Smith, 1993).

There is also debate as to whether sterilization programs of feral cats have an effect over the long term (Longcore et al., 2009) or whether euthanasia is needed to effectively decrease populations (Mahlow & Slater, 1996). High rates of immigration can negate sterilization efforts (Natoli et al., 2006). Increased public education to sterilize companion animals, as well as subsidized sterilization clinics (Mahlow & Slater, 1996; Natoli et al., 2006; Schmidt et al., 2009) to reduce domestic cat populations, would reduce immigration. In each community, there are often extreme views on feral cat management, and it is difficult to achieve consensus (Slater, 2002).

Feral cats are often prevalent at public places such as hospitals, hotels, and universities where there is access to food waste (Hughes & Slater, 2002;

Levy et al., 2003). The University of KwaZulu-Natal (UKZN) in South Africa comprises five campuses, three of which have urban conservancy status (UKZN Conservancy Website, 2006, http://conservancy.ukzn.ac.za/). In 2005, a study at the Howard College campus reported 55 resident cats and little evidence of the cats entering the surrounding natural bush and home ranges centered at feeding stations (Tennent & Downs, 2008). Management recommendations included an ongoing sterilization program; suitably located, funded, and maintained feeding stations; and long-term monitoring (Tennent, Downs, & Bodasing, 2009).

The present study estimated the feral cat population at UKZN campuses and analyzed whether sterilization was having an effect. Expectations were that the density would be similar to the previous study (Tennent & Downs, 2008) or with fewer cats at sites with higher sterilization. It was also expected that sterilization would affect the age structure of the population with a lower proportion of younger cats at sites with higher sterilization.

METHODS

The study was conducted on five UKZN campuses: Pietermaritzburg (29°36′50″S 30°23′59″E), Westville, Howard College, Edgewood, and Medical School—with the latter four situated around Durban (29°48′28″S 30°59′27″E; Figure 1).

FIGURE 1 Locations of the five campuses at the University of KwaZulu-Natal in the province of KwaZulu-Natal, South Africa: 1. Pietermaritzburg, 2. Edgewood, 3. Westville, 4. Howard College, and 5. Medical School. Distance from Durban to Pietermaritzburg is approximately 90 km.

Westville, Howard College, and Edgewood are registered as urban conservancies; the former two are adjacent to indigenous nature reserves.

Although not a conservancy, Pietermaritzburg has extensive natural areas on its grounds. Medical School is located in a built-up industrial area with very little vegetation in the grounds. Each campus consists of academic and staff office buildings, sports fields (excluding Medical School), student residences, and canteens. There are also external student residences located off campus, three of which were included in the study: Albert Luthuli at Howard College and Denison and Malherbe at the Pietermaritzburg. In total, eight sites were surveyed, six of which had both sterilization and feeding programs carried out by voluntary cat caretakers. At Edgewood, there was a sterilization program but no feeding; at Medical School, there was feeding but no sterilization (Table 1).

Each site's area was calculated in ArcGIS 9.3 (ESRI GIS and Mapping Software, Redlands, CA). The entire property was used to calculate the area at Pietermaritzburg, Edgewood, Medical School, and the three residences—except for outlying sports fields at Edgewood. At Howard College and Westville, the outlying sports fields and natural areas were not surveyed and were excluded from the area calculation as there were no feeding stations or sources of waste food there. Positions of all feeding locations or locations of cats at the non-feeding sites were recorded with a handheld, global-positioning-system device (Garmin, KS).

Methods to count animals for estimating population size depend on the size, distribution, and habits of the animals (Buckland et al., 2005). For small populations where individual recognition is possible, a direct count that attempts to count all the individuals in the population can be successful (Greenwood, 1997). The mark-recapture method is also suitable where individuals can be marked and identified individually (Borchers, Buckland, & Zucchini, 2002; Greenwood, 1997). Both the total count and the mark-recapture methods were used to estimate the feral cat population in this study with a noninvasive method of taking photographs to mark individuals (Jackson, Roe, Wangchuk, & Hunter, 2006). Feeding programs occurred at six of the eight sites; it was thought that the best time to observe most cats was at feeding times. Feeding times were mostly scheduled during the day, which also provided better conditions to take photographs to mark the cats for the mark-recapture analysis and for the identification database.

Three weeks each month, from April to June 2009, sites were visited weekly. The day each site was visited was changed each week to cover weekdays, weekends, semester days, and holidays. At the larger campuses, cats were counted by walking along the route that passed all the feeding stations at feeding times. For the nonfeeding campus, the survey route followed food sources such as canteens and on-campus residences. Walks varied from 1 to 2 hr, depending on the size of the campus; the direction of the routes was changed at random. At

TABLE 1
Feral Cat Maintenance Details at the University of KwaZulu-Natal Campuses as at 2009; Comparison of Feral Cat Counts per Site and the Density of Feral Cats per Site

	Details per Campus			*Number of Cats*					*Density*	
Campus/Residence	*Feeding Program*	*Sterilization (%)*	*Maintenance*	*Total Count*[a]	*Jolly-Seber*	*−95%*	*+ 95%*	*Caretakers' Estimate*	*Area (ha)*	*Density (Cats ha^{-1})*
Pietermaritzburg	Yes	42	High	43	34	33	35	42	19.66	2.19
Westville	Some	34	Medium	29	24	17	35	17	40.23	0.72
Albert Luthuli Residence	Yes	62	Medium	26	22	19	27	20	10.76	2.42
Edgewood	No	48	Low	21	17	11	25	19	23.40	0.90
Howard College	Yes	62[b]	High	20	17	10	21	34	36.79	0.92[b]
Medical School	Yes	0	Low	13	10	7	11	15	4.54	2.86
Denison Residence	Yes	92	High	12	12	n/a		11	5.54	2.17
Malherbe Residence	Yes	100	High	8	8	n/a		7	1.98	4.05
	Total			172	144			165	142.90	
	Average	55%		23	[b]					1.61
		Adjusted count		186	[b]					

[a]Table ordered from highest to lowest Total Count. [b]Howard College Campus Caretakers' Estimate of 34 was used.

Westville, part of the route was by car. At the smaller residences and at Medical School, all the cats came to one feeding location.

Routes were walked alone or with either cat caretakers or students. Westville, Howard College, and Edgewood were surveyed nine times, the last three at dusk; Pietermaritzburg and Medical School were surveyed six times when cumulative numbers of cats had reached an asymptote (Figure 2).

External residences were visited only three times because, by this time, all the cats had been seen. Because of a security concern, no site was visited at night. Even though small felines are typically crepuscular to nocturnal (Alderton, 1993; Sunquist & Sunquist, 2002), domestic and feral cats have adapted their activity periods to match when food sources are available (personal observation). Thus, diurnal counts were deemed satisfactory for a reliable population estimate (UKZN Conservatory Website, 2006).

Cats were photographed using a digital camera (Sony DSC-600 Cybershot, Tokyo, Japan). Attempts were made to photograph each cat from both sides and to take a close-up of the head to show ear clips, which is the international method to indicate a feral cat has been sterilized. On rare occasions, when a cat was at a fair distance or moved quickly out of sight only, a photograph was not taken and the observation was recorded as "sight only."

Electronic questionnaires were sent to the known cat caretakers (n = 11) on the various campuses in September 2009 to provide information on population dynamics and to contribute to management recommendations; all were completed and returned. Questions (n = 52) covered the history of each colony,

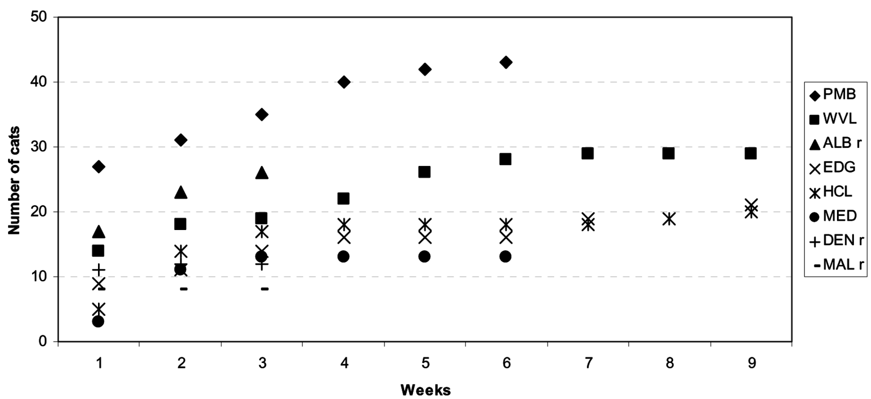

FIGURE 2 Cumulative counts of feral cats per week per site at the University of KwaZulu-Natal, from April to June 2009. ALB r = Albert Luthuli residence, DEN r = Denison residence, EDG = Edgewood, HCL = Howard College, PMB = Pietermaritzburg, WVL = Westville, MAL r = Malherbe residence, MED = Medical School.

immigration, and emigration; sterilization, feeding, health, and challenges—with the past 3 years as a time frame. Results were summarized and used to forecast population growth, identify other factors that may influence the population numbers (other than sterilization), and to estimate costs of feeding and sterilization.

Statistica 7.1 (StatSoft, Tulsa, OK) was used for the statistical analyses, which included General Regression Models. Microsoft Excel 2003 (Microsoft Corporation, WA) was used for the mark-recapture models and population dynamics. Means are reported as mean ± standard error.

It was difficult to determine how many colonies of cats there were on each campus, so all cats on each campus were considered a colony. However, each of these may have comprised subcolonies. Each cat was assigned a unique identification number consisting of a site, sublocation, and coat-color code. The 1,556 digital photographs were grouped per site and week and named with the week of count and unique number. These were used as evidence of the count, for the mark-recapture calculations, and to build an identification database. Cat caretakers assisted with identification details such as sex, estimated age, sterilization date, and sterilization mark. Estimates of gender and age were made for cats not monitored by cat caretakers; if there were no ear clips, it was assumed the cat was not sterilized. Cats were assigned to four age categories: kittens (less than 6 months), juveniles (6 months to 2 years), adults (2 to 6 years), and seniors (older than 6 years).

The total count was simply an accumulation of all the new cats observed per week per site, added to the previous respective tallies. Data were then recaptured into a Jolly-Seber open-population, mark-recapture model (Greenwood, 1997) per site and used as a second estimate of population size.

Typically, density of animals is calculated from the number of animals observed in sample areas of the study site and then extrapolated to the entire area of the study site (Buckland et al., 2005). This is appropriate for animals at low distributions over a large area (Buckland et al., 2005), which was not the case in this study. Feral cats were expected to be distributed at a high density over a small area; a total count of cats was conducted, covering the full area of each site. Density of cats was calculated from the estimates of total number of cats and total area of each site.

RESULTS

Population Size

From April to June 2009, we made 573 observations of cats at UKZN. The total feral cat population was estimated at 172 cats across all the eight sites, using the total-count method (Table 1). The highest number of cats (43) was at Pietermaritzburg and the lowest (8) at Malherbe residence. The number of cats at other sites ranged from 12 to 29, with an average of 23 cats. A total of 90% of cats were observed in the first four counts across all sites when the cumulative number of cats at each site reached an asymptote (Figure 2).

The Jolly-Seber population estimate using the mark-recapture data was lower at 144 cats and showed consistently lower numbers for all the sites compared with the total-count method (Table 1). Because the three counts were the same cats each time, the Jolly-Seber calculations were not run for the two Pietermaritzburg residences. Although the Jolly-Seber estimates were approximately 13% less than the total count estimates, there was no significant difference between these two estimates (t test, $t = 0.701$, $df = 14$, $p = .495$). A comparison of the total count estimate was also made against the caretakers' estimates as at July 2009 (Table 1). Caretaker estimates included any cats who were gained or lost from April to June 2009; however, any losses were not reflected in the study's total counts. There was more than a 20% difference in three cases; for Westville, Albert Luthuli caretaker's estimates were less than the study's total count and at Howard College, the caretaker's estimate was greater. At Westville, the three caretakers fed only in certain areas of the campus; however, additional cats were seen in other areas, resulting in the study's estimating a higher total count. At Albert Luthuli, the study photographs revealed more gray tabbies than the caretaker reported. Total caretaker estimate for all sites was lower at 165 compared with the study estimate of 172, with no significant difference between these two estimates (t test, $t = 0.175$, $df = 14$, $p = .863$). In the remaining analyses, the total count estimates were used, with one adjustment for Howard College to use the caretaker's estimate of 34 instead of the total count estimate of 20 cats, giving an overall total of 186 cats.

Overall average density of cats for all sites was 1.61 ± 0.42 cats ha^{-1} ($n = 5$), combining the residences with their main campus. Highest densities were at Pietermaritzburg, which had the most number of cats, and Medical School, which had no sterilization but was also the smallest campus (Figure 3).

Three counts at three Durban sites were at dusk, later than the normal feeding schedule, to verify that most cats were observed diurnally at feeding times. Only one additional cat at Westville and two at Howard College were observed; however, at Edgewood, where there was no feeding, 5 new cats were observed (23% of the total). At Howard College, there were reportedly another 14 nocturnal cats who were not observed at the lunchtime feedings. The initial estimate of 172 cats (excluding the 14 nocturnal Howard College cats) should thus be considered the minimum number of UKZN cats. There were also external campus grounds and residences off the main campuses that were not included in the study, which could be surveyed in future censuses.

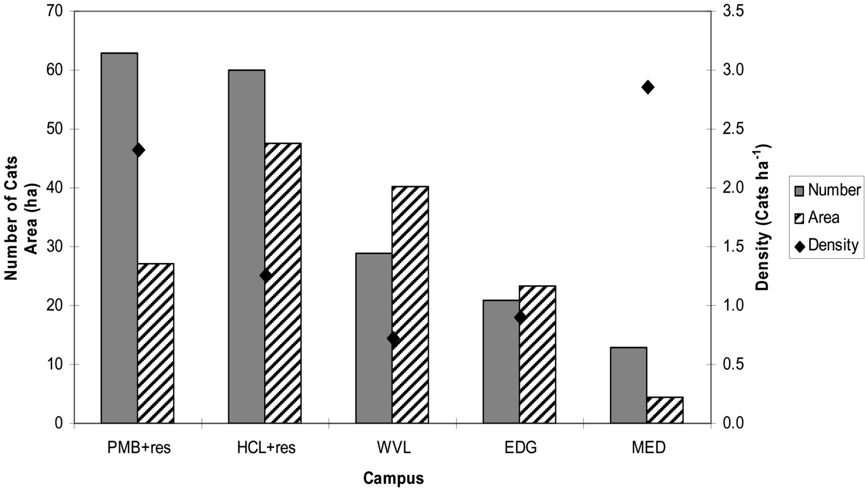

FIGURE 3 Comparison of the density of feral cats at each University of KwaZulu-Natal campus to the mean density of 1.61 feral cats ha^{-1} overall at UKZN, as estimated in 2009. (Abbreviations as for Figure 2.)

Sterilization Effect

Average sterilization across all sites was 55 ± 11% (Table 1, range 0–100%). As expected, there was a significant negative linear relationship between number of cats and sterilization percentages ($r = -0.795$, $df = 6$; $p = .032$; Figure 4). Although not significant, there was a linear increase in density with an increase in sterilization percentages ($r = 0.741$, $df = 6$, $p = .056$; Figure 5). Linear equations showed that for every 16% increase in sterilization, numbers decreased by 10 cats; yet, density increased by 1 cat ha^{-1}. Medical School at nil sterilization was excluded from these regression analyses. There was a significant effect of sterilization across the four age categories ($Wilks = 0.035$, $F_{(4,3)} = 20.819$, $p = .016$). The percentage of younger cats decreased as sterilization increased (Figure 6).

Management

Of the 11 cat caretakers at UKZN, 1 began feral cat maintenance in 1998; 5 began maintenance from 2002 to 2005; and 5 began from 2007 to 2009. Two caretakers were at Pietermaritzburg, 3 at Westville, and 1 each at the other sites. Across all the sites there were feeding programs for 78% of cats; where there was a sterilization program, 62.8% of the cats were sterilized. Sites were categorized as low, medium, and high maintenance according to presence of

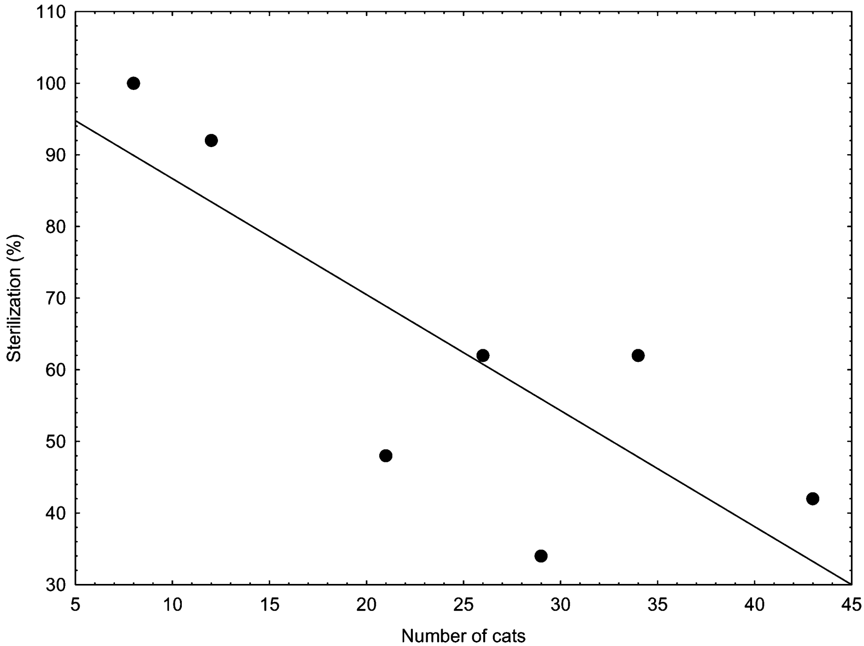

FIGURE 4 Scatterplot showing a significant negative relationship between sterilization and number of feral cats at the University of KwaZulu-Natal in 2009.

feeding and sterilization programs, health care given, and quality of food (Table 1). Where monitoring began recently, respondents gave no averages over 3 years. Some questionnaires were unanswered for low-maintenance sites. Results reported here rely on the accuracy of the caretakers' answers. The sterilization rate results in the study were based on the number of cats sterilized versus the total cats at each site. We then used population models to show the effects of sterilization rate where the sterilization rate was based on females. For the population-dynamics section, data were grouped into the eight sites and averaged. It was assumed that cats reproduce from their 1st year for every year of their lives. Average fecundity was 0.7 kittens per annum per female (accounting for kitten mortality and homing, both of which affected overall survival); average adult survival rate (including emigration) was 82% per annum and average immigration rate was 6% (1.4 cats) per annum. Ratio of males to females was deemed to be equal (Andersen, Martin, & Roemer, 2004). Average colony size of 23 cats was used to illustrate population growth at different levels of sterilization over the next 5 years (Figure 7). At the UKZN average fecundity, survival, and immigration rates, a stable population would be achieved at 57%

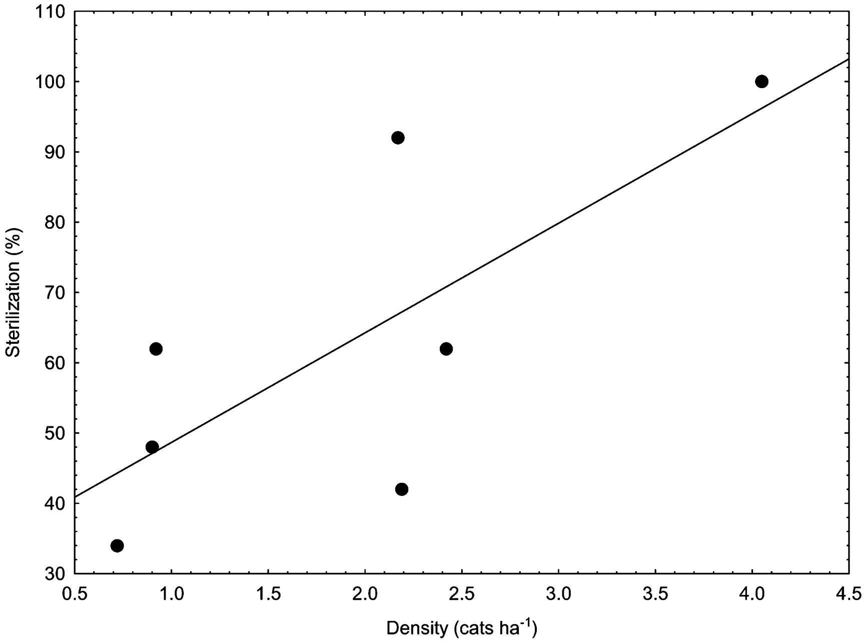

FIGURE 5 Scatterplot showing a positive relationship between sterilization and density of feral cats at the University of KwaZulu-Natal in 2009.

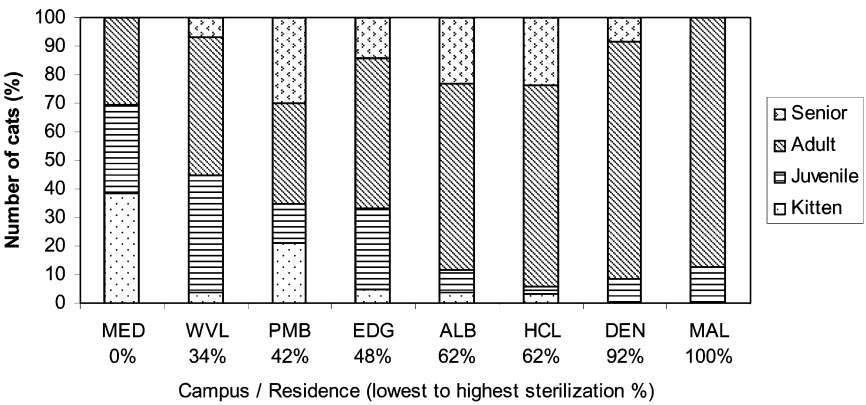

FIGURE 6 Percentage of feral cats in youngest to oldest categories per site at the University of KwaZulu-Natal in 2009. Sites are ordered from lowest to highest sterilization. (Abbreviations as for Figure 2.)

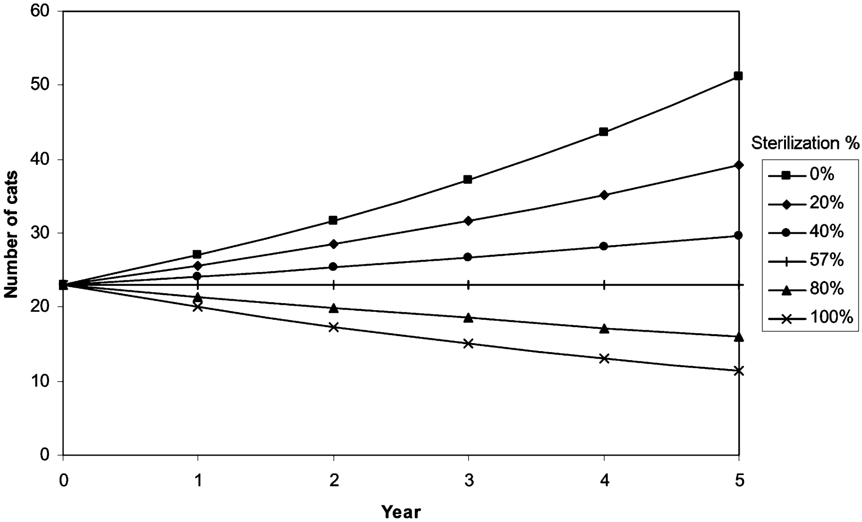

FIGURE 7 Feral cat population forecast at different sterilization rates for the University of KwaZulu-Natal over 5 years. Population parameters estimated in 2009 were fecundity 0.7 kittens per female per annum (p.a.), 85% survival p.a., and 6% immigration p.a.

sterilization; thus, a sterilization rate higher than 57% is required to reduce the population. At zero sterilization, the population would double in 5 years; at 100% sterilization, the population would halve in 5 years. At UKZN, for the total population of 186 cats, at a constant sterilization rate of 55%, population was predicted to remain stable at a ratio of 1.03 and increase only by 6 cats in 5 years. However, for an average fecundity rate of 3 kittens per annum per female (Schmidt et al., 2007), which included kitten survival but not homing, the population could increase by a ratio of 6.54 to 1,217 cats in 5 years. Carrying capacity factors, however, may limit the population. A constant sterilization rate of 90% is required to keep the population stable at this increased fecundity rate.

For the questionnaire sections on management and challenges, the 11 respondents were not grouped into their respective sites. Average feeding and sterilization costs incurred by the voluntary cat caretakers were approximately ZAR12,570 (about US$1,612) per month across all sites. Approximately 25% of this was funded by donations from various university staff; the remainder was self-funded by the cat caretakers. At the high-maintenance sites, there were additional costs for veterinary care (ranging from ZAR100 to ZAR1,500 per annum or about US$13–US$192 per annum) and preventative medication (ranging from ZAR20 to ZAR500 per annum or about US$3–US$64).

At high-maintenance sites, cats received rabies vaccines and parasite control when sterilized and care for illnesses and injuries, whereas this decreased at medium maintenance to minimal of these at the low-maintenance sites. Main challenges listed were help with feeding (91%) and help with feeding costs (64%). Help with trapping and sterilization was a concern for the low-maintenance sites and at Pietermaritzburg, which had only one caretaker for 40+ cats. There were few reports of cats showing predation (72% reported once a year, rarely, or never); however, this merely confirms that predation occurs. A few nuisance complaints (18%) and highest frequency of sick cats (monthly) came from the low-maintenance sites that had no feeding programs. Sick cats were seen mostly once a quarter (45%), with mouth and upper respiratory infections being the most common illnesses. Interestingly, caretakers underestimated cat abundance by 7 $\pm$ 37 *SD*%.

DISCUSSION

Population Size

Total number of UKZN feral cats was estimated at 186; although higher than the caretakers' estimate and the Jolly-Seber method, there were no significant differences—indicating that the estimates were reliable. The Jolly-Seber mark-recapture estimate was expected to be lower because the assumption of equal ability to detect was not met. In the future, caretakers could give a reliable estimate of numbers, or a minimum of four surveys could provide a 90% estimate. It appears that cats adapt readily to a feeding program scheduled during the day; however, counts at nonfeeding sites should include nocturnal surveys.

The UKZN density was 161 cats km^{-2}. Density of feral cats can vary widely from 1 to more than 2,000 cats km^{-2}; however, densities of more than 100 (cats $km^{-2)}$ are typical of urban colonies that have access to food (Liberg et al., 2000). Because there are no barriers to prevent cats venturing from the sites, it is difficult to accurately determine the total area of a feral cat population. The small UKZN residences and campuses showed a higher density of cats than the larger campuses. However, cats may well range past the borders of the small sites to cover areas similar to the ranges of cats at larger sites. Densities tend to be overestimated at small sites (Denny, Yakovlevich, Eldridge, & Dickman, 2002) and underestimated at large sites, with averaging across sites further distorting the density estimate. In the 2005 study at Howard College, the density was reported as 23 to 40 cats km^{-2}; the area included all the grounds of the campus, the adjacent nature reserve, all external residences, and sports fields (Tennent & Downs, 2008). If this same area is used, the current study of Howard College showed 27 cats km^{-2}. Here, 55 cats were reported in 2005, compared with 60 in this study (including Albert Luthuli residence), with a 10% increase in 4 years. It was thus deemed more accurate to use the total count estimates instead of density estimates.

Caretakers reported evidence of wildlife predation by cats, although they thought it low. Cat caretakers also reported a low immigration rate at the monitored colonies. Feeding programs may reduce competitive behavior for resources (Levy et al., 2003), increase carrying capacity, and lead to increased immigration (Schmidt et al., 2009); perhaps there are other factors explaining the low immigration rate. Cat caretakers' food was mostly eaten directly at feeding times with the remainder very well hidden. Decreased evidence of feeding programs also deters the public from dumping unwanted kittens or cats (Levy et al., 2003).

Sterilization Effect

The overall sterilization level was 55% with (as expected) a negative relationship to numbers; however, it showed a positive relationship to density. It appears that smaller colonies are easier to manage and less costly to maintain, which enables sterilization to be kept at high levels. In a survey of 101 cat caretakers feeding 920 feral cats, trapping and sterilization at caretakers' expense resulted in 512 cats sterilized within 9 months (Centonze & Levy, 2002). At UKZN, sterilization (as expected) affected the colonies' age structure. As sterilization increased, the population included more cats who were older and fewer younger ones. A decrease in numbers of kittens is reported in most TNR programs (Hughes & Slater, 2002; Levy et al., 2003).

Other factors (homing of kittens, high emigration, and high mortality rates) may decrease numbers and result in fewer juveniles. Average kitten mortality rate at UKZN (60%, which includes homing) was high but similar to other studies (Nutter, Levine, & Stoskopf, 2004; Schmidt et al., 2007). Survival rate of UKZN adults of 82% was similar to Schmidt et al. (2007), where semiferal (fed) cat survival was 90% whereas feral (unfed) survival was 56%. High survival rate may indicate that feeding programs result in healthier and safer populations who are less at risk from trauma, disease, and starvation. Population models show that sterilization needs to exceed 50% (Schmidt et al., 2009) to 75% (Andersen et al., 2004) to effectively reduce cat populations, and even higher rates are needed to offset immigration.

Management

Both sterilization and feeding programs, implemented by voluntary caretakers at UKZN, may mitigate some public concerns of feral cat wildlife predation, nuisance, and disease. However, predation does occur, and cat caretakers may have reported less disease than actually present, as cats are vectors for a range of diseases and parasites (Taylor, Coop, Lloyd, & Jacobs, 2001). Sterilization reduces male nuisance behavior such as roaming, spraying, and fighting (Mahlow & Slater, 1996); fewer complaints were received after a sterilization and feeding program was implemented (Hughes & Slater, 2002). The benefit of the feeding program is to the cats only, not the reduction of the population. Continued monitoring is required to determine the longitudinal success of the sterilization and feeding programs and determine if the alternative, lethal control of cats, can be avoided.

However, sterilization and feeding programs are both labor- and cost-intensive. They require provision or raising of funds for these programs at UKZN. Efforts of cat caretakers to home kittens and sterilize adults may have stabilized the population; however, it is suggested that the sterilization be increased from 55% to 90% to reduce the population in the long term and to offset any increase in fecundity or immigration. In an intensive sterilization and adoption program with little immigration but a high rate of removal, a population declined by 66% within 6 years (Levy et al., 2003). However, in Rome, a coordinated sterilization effort of colonies, at approximately 60% over 10 years, resulted in only decreases of 16% to 32% because of high immigration rates of 21% (Natoli et al., 2006). Because some cats resist trapping, 100% sterilization is difficult; however, at 90%, an encounter between a male and female who have not been sterilized is relatively lower. These examples substantiate that intensive sterilization (80–90%) achieves the desired effect; if lower (60%), there is only a minimal effect.

CONCLUSION

An annual census is recommended to monitor the level of sterilization and numbers over the long term.

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