**CAPE TOWN'S DOMESTIC CATS: PREY AND MOVEMENT PATTERNS IN DEEP-URBAN AND URBAN-EDGE AREAS**

***Sharon George***

**Project Supervisors: Dr. Robert E. Simmons & Dr. Justin O'Riain**

A thesis submitted to the University of Cape Town in partial fulfillment of the requirements for the Masters degree in Conservation Biology

Percy FitzPatrick Institute of African Ornithology
University of Cape Town
Rondebosch 7701
Cape Town

**September 2010**

Cover Photo: Sam Javanrouh

**DEDICATION**

***To my family, the one true constant in my life***

**ACKNOWLEDGEMENTS**

This study would not have been possible without the essential and gracious support of many people. With deepest gratitude, I wish to thank each and everyone who made an invaluable contribution to this project in their own unique way.

First and foremost, I would like to thank the National Research Foundation (NRF) who funded this project through Dr. Rob E. Simmons.

The person I am most grateful to is my principle supervisor, Dr. Rob Simmons, who devoted an immense amount of time and took great effort in seeing the project through to completion. I would like to thank him for his guidance, patience, encouragement and understanding especially during the more trying and challenging times of the project. I cannot thank you enough for being the supervisor who was always there.

I would like to thank my co-supervisor, Dr. Justin O'Rian, for finding the time to supervise me in the midst of a very busy schedule. I am extremely grateful for the critical, timely and spot-on guidance he provided during the project.

A really big thank you to the following people who volunteered their cats for the cat tracking exercise: Andrea Pulfrich, Howard and Dawn Ball, George and Mel Bing, Jan Cashel, Theresa Mann, Luci Smith, Susan Fitchat, Sharon Bosma and Dick Churley, Peter Johnston, Ruth Hobbs, Mellissa Hanley, Peter and Binny Ridgeway, Heidi Hawkins and Catherine Ward. Not only did they participate but did so with great enthusiasm and genuine interest. I would like to thank them for their effort, patience, kindness and most of all for being objective cat owners. This project would not have been completed without their help and for this I am most grateful. It was a great pleasure getting to know each one of them and working with them.

Though I am unable to list everyone who participated in the survey/prey-recording exercise, I would like to express my heartfelt gratitude to them for their invaluable contribution to the study. Finding objective cat-owners willing to dedicate their time and effort to filling out the questionnaire and recording prey returned by their cats over a 10-week period was probably one of the most challenging aspects of this project.

I am very grateful for the assistance provided to me by a number of people who helped distribute the questionnaires in different parts of Cape Town: Dr. John Oakley and Jan (Sunray Vet Clinic), Dr. Roy Aronson and Moira (CitiVet), Dr. Steve Kitley (Riverside Vet Clinic), Dr. Dylan Dukaas (Glencairn Vet Clinic), Dr. George Koury (CitiVet), the staff at Penzance Vet Clinic, Cilla Bromley and Heather Malan. Special thanks goes to John Yeld (Cape Argus), Karen Watkins (Constantiaberg Bulletin) and Anton Ferreira (Sunday Times) for their help in publicizing the project and requesting members of the public who own cats to participate in the study.

There are a number of people who were a great help during various stages of the project: I would like to thank Richard Bevan – 'The shoemaker from Fishoek' and George Du Plessis, for their help in designing and making the collars/harnesses used for the cat tracking exercise. A big thank you goes to Esme Beamish and Andrea Pulfrich for allowing us to test the collars/harnesses on their cats. Special thanks goes to Talli Hoffman (Department of

Zoology, UCT), Nicholas Lindenberg and Thomas Slingsby (GIS Unit, UCT) who took the time to teach me and guide me during data analysis (GIS). I am very grateful for the knowledge they imparted and for always being willing to help. I would also like to thank the following people who contributed to the study in various ways: Cornelia Krug, Yvonne Robson, Rita Brock and Tim Hicks.

Heartfelt gratitude goes to the staff members (academic, research and support staff) under the Department of Zoology at UCT for all their help not only during the project but during the entire Conservation Biology course. I would especially like to thank the following people: Prof. Peter Ryan, the CB course coordinator, who we always ran to for advice; Hilary Buchanan, who was always so warm, kind, reassuring, encouraging and took a genuine interest in the welfare of the CB students; Chris Tobler, for dealing with my computer/internet problems on many occasions and for the many jokes regarding my project; Lionel Mansfield, for always being so pleasant and providing timely help when required; Margaret Koopman, who willingly and efficiently helped Rob and I acquire articles and other literature for this project; and Tania Jansen, for being very supportive and helpful during the CB course.

A very special thank you to Yvonne Githiora, Christina Moseley, Ian Kissoon, Deo Kujirakwinja, Nathan Gichohi, Allison Skidmore, Gwyneth Wilson, Ben Heermans, Michael Marias and Deo Tuyisingize for their friendship and support during the CB course. Thank you all for being there to encourage me during the tough times, and for listening to my ‘exciting’ and frustrating stories about people and their cats! Thanks for being so patient and taking calls from the public on my behalf. Meeting you and getting to know each one of you has been a great experience. I would especially like to thank Christina, Ian, Yvonne, Deo K. and Nathan for being amazing friends and for always going out of their way to help me especially when I needed friends the most. Thanks for always being so willing to help both academically and personally.

There is a very special person I would like to thank for being one of the loveliest people I have ever met and for being such a great help and great company during the door-to-door surveys in Glencairn Heights and Hout Bay. Catherine Simmons, thank you for being such a sweet-natured, kind, fun and encouraging person. I will never forget eating potato salad with you as we rested on the roadside in Hout Bay.

I would like to thank Rob Simmons and Phoebe Barnard for being nothing short of amazing during my stay in Cape Town. Thank you so much for opening your home to me and making me feel part of the family. I have no words to express how thankful I am for the love, kindness and encouragement you were both always so ready to provide especially during the more trying times of my stay in Cape Town. Meeting people like you always reminds me that the world is in fact a beautiful place.

Special thanks to my loving family: My wonderful parents, Thomas and Vitha, who have sacrificed so much for me and supported me in every way just to make sure that my dreams are realized. Thank you for loving me with a love that knows no limits; my beloved sister and brother-in-law, Shalin and Manoj, for being my second parents and for all the support, love and laughter: my big brother and sister-in-law, Shaji and Yumiko, for their support, love and encouragement: and my nephews and niece, Vincent Daigo, Ethan Rohan and Michelle

Maya, for making the world so much more beautiful and inspiring me to make it even more so.

I would like to thank all my precious friends for their love and support and most especially for believing in me. I would like to specially thank the following people who made my stay in Cape Town a happy and memorable one:  Saranne, Jess, Angie, Chantal, Laura, Rein, Pat, Stewart, Gina, Angeline, Jim, Aldona, Nisha and Jithan. A big thank you to my friends in Zambia and other parts of the world who made sure I didn't get too homesick and kept cheering me on: Steven, Griffin, Twaambo, Manish, Sam, Prineeti, Ushma, Ranie, Masuwa, Busi, Isaac, Shepherd, Rhutt, Bejoy, Ashby, Pearl, Gloria and Chris. And finally, a special thank you to someone very close to my heart – Olivia, thank you for being not only one of my best friends but my big sister. Thank you all for adding so much value to my life.

## TABLE OF CONTENTS

## List of Figures

## List of Tables





## List of Appendices

## List of Abbreviations

| | |
|---|---|
| CFR | Cape Floristic Region |
| GPS | Global Positioning System |
| IUCN | International Union for the Conservation of Nature |
| MCP | Minimum Convex Polygon |
| SASHA | Sunnydale Animal Sterilisation & Health Association |
| SPCA | Society for the Prevention of Cruelty to Animals |
| TEARS | The Emma Animal Rescue Society |
| TNR | Trap-Neuter-Return |

**ABSTRACT**

Domestic and feral cats (*Felis catus*) have impacted negatively on native wildlife on both islands and on the mainland. Impacts range from a reduction in numbers of prey species to local extinctions, especially of birds on islands. This study provides the first data on the impacts of domestic cats on wildlife on the African mainland continent by comparing the diet and movement patterns of cats that live within urban areas with those of cats that live on the urban-edge adjacent to natural areas of Cape Town, South Africa.

The diets of 78 domestic cats (30 deep-urban and 48 urban-edge) were assessed over a 10-week period by questionnaire survey. Cat owners recorded information on prey items returned by their cats, with additional data on feeding frequency, sterilization status, age and periods of confinement. Urban-edge cats had a significantly higher predation rate (0. 11 prey/day) than deep-urban cats (0.06 prey/day), and the number of prey returned/day was significantly negatively correlated with age ($R_s = -0.41$, $p = 0.0002$). Cats above the age of 13 did not hunt at all. The estimated number of prey items killed within the Cape Town area was 3.6 million prey items (range: 2.9 – 4.3) per annum with the majority of these being small mammals.

The movement patterns of 14 domestic cats (7 deep-urban and 7 urban-edge) were monitored over a 5-10 day period using miniature GPS loggers. The mean home range size did not differ significantly (Mann-Whitney U-test: $U = 17$, $p = 0.37$) between deep-urban (27.2 ± 6.7 ha) and urban-edge (36.1 ± 3.7 ha). The maximum displacement/furthest point (straight distance) from home over 10 days was 848.8 m by an urban-edge cat. Both deep-urban and urban-edge cats travelled significantly more during the day than at night. The difference between use (time spent) and availability (area) of natural habitat by deep-urban and urban-edge cats was highly significant - both sets of cats used natural habitat less than expected. Both types of cats spent more time than expected in the urban habitat.

Together these findings suggest that domestic cats in urban areas of Cape Town pose a significant threat to wildlife, with indigenous small mammals most at risk. This agrees with many other studies carried out in New Zealand, Australia and the United Kingdom.

**Key words**: domestic cat, *Felis catus,* predation, home range, diet

# CHAPTER ONE

# INTRODUCTION

## 1.1 Background

Alien plant and animal species that have been introduced by humans to new ecosystems pose a great threat to native species (Atkinson, 1996; Wilcove *et al.,* 1998; Crooks & Soule, 1999; Mack *et al.,* 2000; Baker *et al.,* 2008; Longcore *et al.,* 2009). Invasive alien species rank high on the list of threats to biodiversity alongside other major factors, such as habitat destruction, climate change, over-exploitation and pollution (Butchart *et al.,* 2006; IUCN, 2009). Alien species introductions have led to the extinction of approximately 77 species of native vertebrates in modern times (Butchart *et al.,* 2006) with introduced carnivorous mammals causing the decline and extinction of vertebrates animals across multiple taxa worldwide (Iverson, 1978; Moors, 1985; Kirkpatrick & Rauzon, 1986; Fitzgerald, 1988; Towns *et al.,* 1990; Lowe *et al.,* 2000; Veitch, 2001; Kawakami & Higuchi, 2002; Nogales *et al.,* 2004; Butchart *et al.,* 2006; Davey *et al.,* 2006; Baker *et al.,* 2008, Morgan *et al.,* 2009). Amongst these the domestic cat (*Felis catus*) is currently on the list of the 100 worst invasive alien species worldwide (Lowe *et al.,* 2000). On islands the effect of cats, themselves introduced to combat introduced rats or mice, is particularly striking with an estimated 33% of all known extinctions of the indigenous island-breeding birds arising from the depredation of cats (Lever, 1994). Moreover, a recent assessment of all mortality factors on birds in the USA put collisions with windows as the chief source, accounting for 97-976 million deaths per year, and secondly predation by domestic and feral cats accounting for 110 million deaths per year (Sovacool, 2009).

### 1.1.1 The domestic cat (*Felis catus*)

The domestic cat has its origins in the interbreeding of the European (*Felis sylvestris silvestris*) and African Wild Cat (*Felis silvestris lybica*) (Coleman *et al.,* 1997). According to Serpell (1988) and Randi & Ragni (1991), cats were first domesticated approximately 4000 years ago in Egypt. Since then, they have travelled alongside humans to many parts of the world either as pets, and are valued for their ability to control pests such as rodents and rabbits or as a source of food (Dickman, 1996). Cats are known to be extremely adaptable to local conditions (Coman & Brunner, 1972; van Aarde, 1986; Konecny, 1987; Nogales *et al.,* 2004; Tennent & Downs, 2008) and have penetrated and thrived in a wide range of different ecosystems from inhospitable sub-Antarctic islands (Tabor, 1983; Atkinson, 1989; Say *et al.,* 2002) to semi-arid deserts (Apps, 1986; Denny *et al.,* 2002). For this reason, they have become established in many parts of the world (Konecny, 1987; Edwards *et al.,* 2001) and in several places have become the top predator.



Depending on where and how they live, cats can be grouped into three main categories:

- **Domestic cat:** a cat that is kept as a pet and lives in close association with a household. All its needs, including shelter and food, are provided by its owner (Moodie, 1995; Dickman, 1996; Brickner 2003).
- **Stray cat:** a cat that isn't owned but relies partially on human provisioning for its needs (Moodie, 1995). Stray cats include abandoned pet cats and those found on farms and in urban areas such as garbage dumps (Moodie, 1995; Dickman, 1996; Brickner 2003).
- **Feral cat:** free-roaming cats that do not rely on humans for provisioning of their food and 'survive and reproduce in self-perpetuating populations' (Moodie, 1995).

However, as noted by Moodie (1995), most literature refers to stray cats that are fed by humans in urban areas as feral cats. For this reason, I will use the term 'feral cats' to refer to both the stray and feral cats defined above.

### 1.1.2 The impact of cats on native wildlife

The impacts of both domestic and feral cats on wildlife populations around the world have been of the subject of great controversy. Free-roaming domestic cats and feral cats affect wildlife populations both directly (i.e. through predation) and indirectly (i.e. through risk-aversion effects). Risk effects arise when predators negatively-affect prey behaviors such as foraging and habitat use (Lima, 1987; Beckerman *et al.,* 2007). Changes in prey behavior as a response to predation risk are known to have had significant effects on bird populations by altering traits such as clutch size and survival (Lima, 1987). While most studies focus on the direct impacts resulting from predation mortality, it has been suggested that risk effects may have greater consequences on prey populations than direct predation (Preisser *et al.,* 2005). Other indirect impacts of cats include competition with native predators, and disease transmission (Paton, 1993; Tidemann, 1994; Dickman, 1996; McCarthy, 2005).



Most studies, however, focus on the direct impacts of cat predation on prey populations and over the past few decades there has been a growing concern regarding the impact of predation by both feral and domestic cats on native fauna (Gibson *et al.,* 1994; Dickman, 1996; Edwards *et al.,* 2001; McCarthy, 2005; Tennent & Downs, 2008; Morgan *et al.,* 2009). Cats are known to have contributed to the extinction and endangerment (mostly on islands) of a number of indigenous species, including birds (Lever, 1994; Veitch, 2001), small mammals (Tershy *et al.,* 2002), reptiles and amphibians (Iverson 1978; Moors, 1985;

Kirkpatrick & Rauzon, 1986; Konecny 1987; Fitzgerald, 1988; Towns *et al.,* 1990; Dickman *et al.,* 1993; Dickman, 1996; Fitzgerald & Turner, 2000; Lowe *et al.,* 2000; Hutchings, 2003; Nogales *et al.,* 2004; McCarthy, 2005; Baker, *et al.,* 2008; Sims *et al.,* 2008). Most studies however, have shown that the greatest impact has been on avian assemblages (Lowe *et al.,* 2000; Kawakami & Higuchi, 2002; Nogales *et al.,* 2004; Baker *et al.,* 2008; Sims *et al.,* 2008) with Lever (1994) suggesting that cats are responsible for the extinction of approximately 33 bird species worldwide. The most infamous example of an extinction caused by cats is that of the Stephen's Island Wren (*Traversia lyalli*) in New Zealand that was driven to extinction by a group of feral cats (and not by a single cat as is often reported) in 1894 (Dickman, 1996; Galbreath & Brown, 2004). Another example is from the sub-Antarctic Marion Island, where feral cat predation resulted in the local extinction of the Common Diving Petrel (*Pelecanoides urinatrix*) and adversely affected a few species of hole-nesting petrels (Nogales *et al.,* 2004). According to Van Aarde (1980), feral cats on Marion Island were responsible for killing approximately 455 119 seabirds per year. Other examples of species affected by feral cat predation include iguanas and skinks in the Fiji Islands (Gibbons, 1984); and the endemic giant lizard (*G. gomerana*) from La Gomera Island, which is currently on the verge of extinction with cats suspected to be the main culprits (Nogales *et al.,* 2001; Nogales *et al.,* 2004).



Cat predation may not always lead to extinction but may lead to a heavy toll on native populations. A survey of domestic cats in the United Kingdom for example, showed that the estimated population of about 9 million domestic cats was responsible for killing approximately 92 million vertebrate prey items during a five month period (Woods *et al.,* 2003). These well known negative impacts and the cats' widespread distribution have led to the domestic cat being looked upon as a 'potentially damaging predator for local ecosystems' (Morgan *et al.,* 2009).

### 1.1.3 The controversy regarding the impact of cats

Perhaps because of the controversy surrounding cats and their impact on biodiversity, there are now numerous studies on the negative impacts of cats carried out worldwide including New Zealand (Gillies & Clout, 2003; Harper, 2007; Morgan *et al.,* 2009, Van Heezik *et al.,* 2010), Australia (Jones & Coman, 1982; Paton, 1991; Dickman, 1996; Molsher & Dickman, 1999; Molsher, 2001; Denny *et al.*, 2002; Meek, 2003; Molsher *et al.,* 2005), Europe (Liberg, 1984; Churcher & Lawton, 1987; May, 1988; Mirmovitch, 1995; Woods *et al.,* 2003; Baker *et al.,* 2005; Baker *et al.,* 2008; Sims *et al.,* 2008), the U.S.A (Bradt, 1949; George, 1974; Coleman & Temple, 1996; Levy *et al.*, 2003; Schmidt, 2007) and on oceanic islands (Iverson, 1978; Gibbons, 1984; Kirkpatrick & Rauzon, 1986; Konecny; 1987; Lever, 1994; Fitzgerald & Turner, 2000; Kawakami & Higuchi, 2002; Nogales *et al.*, 2004). Few studies have been carried out on cats on the African (mainland) continent, despite the generally higher levels of biodiversity here. The only known studies on cats in mainland Africa have been on ferals, and researchers assessed the abundance and home ranges of feral cats in an urban conservancy in KwaZulu-Natal (Tennent and Downs, 2008); followed by management recommendations for the same feral cat population (Tennent *et al.,* 2009); and a subsequent poll of attitudes of the public towards a feral cat population on the university campus (Tennent *et al.,* 2010). There are no published studies on the impact of domestic cats on native prey on mainland Africa, and this study seeks to redress that imbalance.

Despite of the vast literature and evidence on the adverse impacts of cats, the impact of both domestic and feral cats on native wildlife remains a highly contentious and emotive issue (Fitzgerald & Turner, 2000; Beckerman *et al.,* 2007, Tennent & Downs, 2008; Morgan *et al.,* 2009). While most authors agree that cats (both domestic and feral) do prey upon native species, cat advocates argue that the degree to which cat predation negatively impacts wildlife populations has been exaggerated (Fitzgerald*,* 1988).

One of the major problems in evaluating the impact of cats on prey populations is in determining whether cats predominantly hunt individuals that would not have survived ('doomed surplus' or *compensatory* mortality) or if predation is adding to, rather than replacing, other forms of mortality (*additive* mortality) (Van Heezik *et al.,* 2010). Evidence from some studies has supported the claim that prey populations are not greatly affected by cat predation and that most mortality is compensatory rather than additive (Jarvis, 1990; Barratt, 1998; Kays and DeWan, 2004; Flux, 2007; Lilith, 2007). Another argument suggesting exaggeration of the impact of cat predation (on prey populations) by published studies is that extrapolation is made from local to nation-wide figures of prey mortality, which is unreasonable because the proportion of cats that actively hunt, and the number and the diversity of prey returned, is highly variable and dependent on prey availability that varies in different habitats (Fitzgerald, 1990; Jarvis, 1990, Van Heezik *et al.,* 2010). Species abundance is highly variable between rural and urban areas, and across urban gradients and therefore cats living in different habitats experience different hunting opportunities (Mills *et al.,* 1989, Van Heezik *et al.,* 2010). Furthermore, most studies rely on measuring predation in already altered and densely (cat) populated habitats. I know of no studies that have experimentally assessed a before-and-after situation with and without cats to determine the impacts involved. This remains to be done.

Some cat advocates also argue that cats greatly aid pest control and therefore might indirectly benefit native species by controlling rodent pest populations (Fitzgerald, 1988). It has been predicted that where native species (e.g. an endemic bird) are the shared prey of several introduced predators (e.g cats and rats), the ecological release of an introduced mesopredator (rats), after the eradication of an introduced top predator (cats), would result in greater negative impacts on the native prey (endemic birds) through higher predation rates by the increased mesopredator population (Courchamp *et al*., 1999). This type of trophic cascade is termed 'mesopredator release.' A study carried out by Rayner *et al*. (2007), investigated the impacts of the feral cat (*Felis cattus*) - an introduced top predator, and the Pacific rat (*Rattus exulans*) - an introduced mesopredator, on the breeding success of a small burrowing seabird, the Cook's petrel (*Pterodroma cookii*), on Little Barrier Island in New Zealand. The study showed that the initial eradication of cats on the island (in 1980) led to reduced breeding success (decline in the nesting success) of Cook's petrels and that the eradication of rats that followed (in 2004) led to an increase of petrel breeding success (Rayner *et al.*, 2007). The counter-argument (Lilith *et al.,* 2006) is that a cat's ability to control pests is only a small compensation for the damage they cause to native prey populations. Cat advocates also imply that cats are not responsible for the reported declines in prey populations as they are rarely singled out in reviews as causes of declines in numbers of various prey species (Alley Cat Allies, 2005). They usually argue that cats are used as a scapegoat and blamed unnecessarily when the real cause of species declines should be attributed to other factors such as habitat destruction, impact of other wild predators and climate change (Longcore *et al.,* 2009).

The conclusion from these arguments and counter-arguments is that we must be as rigorous as possible in our assessments of cat predation and be aware of the political back-lash that may accompany the publication of our assessments. I will show later that a short survey of attitudes even towards this pilot study of cats in Cape Town produced widely divergent and opposite views.



### 1.2 Cats in an urban context

Few studies have provided evidence that cats have had significant adverse effects on prey populations in areas other than isolated oceanic islands (Fitzgerald, 1988; Jarvis, 1990; Barratt, 1998; Woods *et al.,* 2003). Literature on the impact of cats, and more specifically domestic cats on mainland habitats, is scant. One of the problems is that prey populations may already be depressed by factors such as urbanization and climate change so comparing predation impact lacks an appropriate "before" control. Nevertheless, what is known is that cats are usually allowed to roam freely within their neighbourhood and are known to kill appreciable numbers of prey (Mead, 1982; Churcher & Lawton, 1987; Barratt, 1998; Gillies & Clout, 2003; Lepczyk *et al.,* 2003; Woods *et al.,* 2003, Baker *et al.,* 2005; Baker *et al.,* 2008; Van Heezik *et al.,* 2010). Most studies of cat predation activity and movement patterns have revealed that domestic cats exist at very high densities in urban areas where human populations are dense (Paton, 1991; Baker *et al.,* 2005; Gaston *et al.,* 2005; Sims *et al.,* 2008, Baker *et al.,* 2008, Van Heezik *et al.,* 2010). That fact that most domestic cats are fed by their owners makes their densities largely independent of natural prey abundance (Baker *et* *al.,* 2005; Baker *et al.,* 2008), unlike natural predator populations whose sizes are largely limited by food availability. Cats are highly efficient predators and in spite of having access to supplemental food provisioned by their owner, continue to hunt (Hutchings, 2003). Even though food provisioning may reduce individual predation rates (May, 1988), supplemented cats still kill large numbers of prey (Woods *et al.,* 2003; Baker *et al.,* 2005). Moreover, in urban environments, cats rarely have predators that may limit their numbers (e.g. caracal (*Caracal caracal*), leopards (*Panthera pardus*)), and are therefore likely to proliferate to unusually high densities.



Natural habitats in urban and peri-urban areas are very similar to islands in that they consist of 'fragments that are surrounded by an inhospitable matrix, but unlike on islands the inhospitable areas serve as an ongoing source of subsidized predators' (Longcore *et al.,* 2009). The same applies to protected areas such as nature reserves and national parks that lie adjacent to or within urban areas. It has been reported that native vegetation found in and around urban edges often support more resources for native fauna and is therefore likely to host higher densities of native species (Crooks *et al.,* 2004; van Heezik *et al.,* 2008; Sewell and Catterall, 1998). Domestic cats living on the urban edge may expand their ranges into wild areas (which in some cases may be protected areas), and this exposure of native areas to urban predators such as domestic cats can lead to significant ecological impacts (Barratt, 1997a; Morgan, 2002; Gillies, 2007; van Heezik *et al.,* 2010). Urban habitats such as gardens as well as peri-urban protected areas, serve as important habitats for birds (both migratory and resident) and support a wide range of local and regional biodiversity (Longcore *et al.,* 2009). For these reasons, it is essential to investigate and understand the degree of penetration by domestic cats into natural areas and the impact of domestic cat in such environments. Data on predation activity and movement patterns of both feral (though this is not investigated in this study) and domestic cats can be used to help implement and inform cat control strategies.

### 1.3 Cats in Cape Town- South Africa

This study focused on the city of Cape Town. This area was chosen due to its proximity to a large central national park (Table Mountain National Park). The larger region of the Western Cape is estimated to hold 320 000 food-supplemented cats according to the pet food manufacturers (T. Hicks[1], pers. comm.). Missing from that estimate are the un-fed feral cats, which constitute a large but unknown number (Y. Robson[2], pers. comm.). The size of Cape Town's domestic cat population is unknown.

The effects of cats on indigenous faunal biodiversity in southern Africa have long been a source of concern to conservation biologists (van Aarde, 1980; Bester *et al.,* 2002; Simmons and Komen, 2003), especially within protected areas where cats occur. Cape Town and its suburbs almost completely surround the Table Mountain National Park (TMNP) and therefore both domestic and feral cats in the area may impact the local fauna. TMNP is home to a number of wildlife species (likely to be impacted by cat predation) that are either endemic to the CFR region or are red-listed globally or in South Africa or both (see Table 1 under Study Area). While the Cape Peninsula does not host any endemic or red-listed small mammals, it is home to three of the six bird species endemic to the Cape Floristic Region (CFR). It also hosts a number of amphibians and reptiles that are either endemic to the

[1] MARS Africa, Rosslyn, South Africa. Email Id: Tim.Hicks@eu.effem.com
[2] Sunnydale Animal Sterilisation and Health Association, Cape Town. Email Id: sashapets@gmail.com

region or threatened or both. It also hosts 111 invertebrates that are endemic to the Cape Peninsula (Piker and Samways, 1996). All are small enough to be potential prey to domestic cats in my study.

## 1.4 Aims of the study

The aim of this study was to investigate the movement patterns and diets of domestic cats that live within urban areas removed from TMNP, (hereafter 'deep-urban' cats) and to compare them to cats that live adjacent the TMNP (hereafter 'urban-edge' cats).

Specific study objectives were to:

1) Determine domestic cat densities in Cape Town.
2) Determine the main target prey species of both deep-urban and urban-edge cats.
3) Compare dietary diversity of deep-urban and urban-edge cats.
4) Determine if there is a correlation between supplemental feeding and prey return rate.
5) Determine if cat movement patterns and prey consumed are dependent on the sex and/or age of cats.
6) Determine if fertile cats had higher predation rates than sterilized cats for both deep-urban and urban-edge cats.
7) Determine if free-roaming cats have greater prey returns than partially confined cats for both deep-urban and urban-edge cats.
8) Determine if cats with bells on their collars exhibit lower prey returns than those without bells on their collars for both deep-urban and urban-edge cats.
9) Estimate the total number of prey caught by Cape Town's cats annually.

10) Determine the extent to which deep-urban cats and urban edge-cats venture into TMNP and other natural habitats.

11) Determine the proportion of time that deep-urban cats and urban-edge cats spend in natural areas versus urban (built-up) areas.

12) Survey the attitude of cat-owners to the project and make recommendations based on results to mitigate any adverse effects cats are having on faunal diversity within protected areas.

This study does not set out to determine the *impact* of cats per se on prey populations (given the lack of experimental and control areas for comparison), but should be seen as a pilot study of the feasibility of studying predation rates and short-term home range for the first time on mainland Africa.

# CHAPTER TWO

# STUDY AREA AND METHODS

## 2. 1 Study Area

The study was conducted over a four-month period in Cape Town, located in the south-western corner of South Africa (33˚55΄S, 18˚25΄E) (Figure 1A). It is the second most populous city in South Africa and has a human population of approximately 3.5 million (City of Cape Town, 2010). It is also home to Table Mountain National Park that extends from Signal Hill (S 33 55 00, E18$^{o}$ 24' 16") in the north to Cape Point (S34$^{o}$ 20' 45" E18$^{o}$ 29' 14") in the south, along the mountain range that covers most of the Cape Peninsula. The park covers a total area of 265 $km^2$ (Forsyth and van Wilgen, 2008) and is almost completely surrounded by suburbs (Hout Bay and the Atlantic seaboard in the north-west, Cape Town CBD in the north, Southern Suburbs in the east, and the South Peninsula in the south-east). The park is part of the Cape Floristic Region, a biodiversity hotspot (Myers, 1990) that supports a wide range of both flora and fauna endemic to the region (Table 1). Biodiversity in the region is currently threatened by factors such as urbanization and fragmentation, spread of invasive alien species, climate change and pollution (Barnes, 2000; Conservation International, 2008). The threats from domestic cats are presently unstudied.

Table 1. Potential prey of domestic cats (including birds, amphibians and reptiles) that occur in TMNP and the Cape Peninsula that are either endemic or threatened or both. Other species may be threatened but this list includes only the presently published sources of threatened or endemic vertebrates found in the Cape Peninsula (Branch, 1988; Picker and Samways, 1996; Barnes, 2000).

| **Category** | **Common Name** | **Scientific Name** | **Distribution** | **Conservation Status** |
|---|---|---|---|---|
| Birds | Cape Sugarbird | *Promerops cafer* | Endemic to the Cape Floristic Region | Least Concern |
| | Orange-breasted Sunbird | *Nectarinia violacea* | Endemic to the Cape Floristic Region | Least Concern |
| | Cape Siskin | *Crithagra totta* | Endemic to the Cape Floristic Region | Least Concern |
| Amphibians | Table Mountain Ghost Frog | *Heleophryne rosei* | Endemic to TMNP | Critically endangered(Globally) |
| | Micro Frog | *Microbatrachella capensis* | Endemic to south-western W. Cape | Critically endangered (Globally) |
| | Western Leopard Toad | *Amietophrynus pantherinus* | Endemic to south-western W. Cape | Endangered (Globally) |
| | Cape Platanna | *Xenopus gilli* | Endemic to the W. Cape | Endangered (Globally) |
| | Cape Rain Frog | *Breviceps gibbosus* | Endemic to south-western W. Cape | Vulnerable (Globally) |
| | Cape Mountain Toad | *Capensibufo rosei* | Endemic to south-western W. Cape | Vulnerable (Globally) |
| | Cape Caco | *Cacosternum capense* | Endemic to the W. Cape | Vulnerable (Globally) |
| | Sand Rain Frog | *Breviceps rosei* | Endemic to coastal areas of the W. Cape | Least Concern |
| | Cape Mountain Rain Frog | *Breviceps montanus* | Endemic to the W. Cape | Least Concern |
| | Tradouw Mountain Toad | *Capensibufo tradouwi* | Endemic to the W. Cape | Least Concern |
| Reptiles | Kasner's Dwarf Burrowing Skink | *Scelotes kasneri* | Endemic to S. Africa | Vulnerable (Globally) |
| | Cape Sand Snake | *Psammophis leightoni leightoni* | Endemic to southern part of the W. Cape | Vulnerable (Locally) |
| | Yellow-bellied House Snake | *Lamprophis fuscus* | Endemic to S. Africa | Near-threatened (Globally) |
| | Namaqua Plated Lizard | *Gerrhosaurus typicus* | Endemic to S. Africa | Near-threatened (Globally) |
| | Hawequa Flat Gecko | *Afroedura hawequensis* | Endemic to S. Africa | Near-threatened (Globally) |
| | Gronovi's Dwarf Burrowing Skink | *Scelotes gronovi* | Endemic to S. Africa | Near-threatened (Globally) |

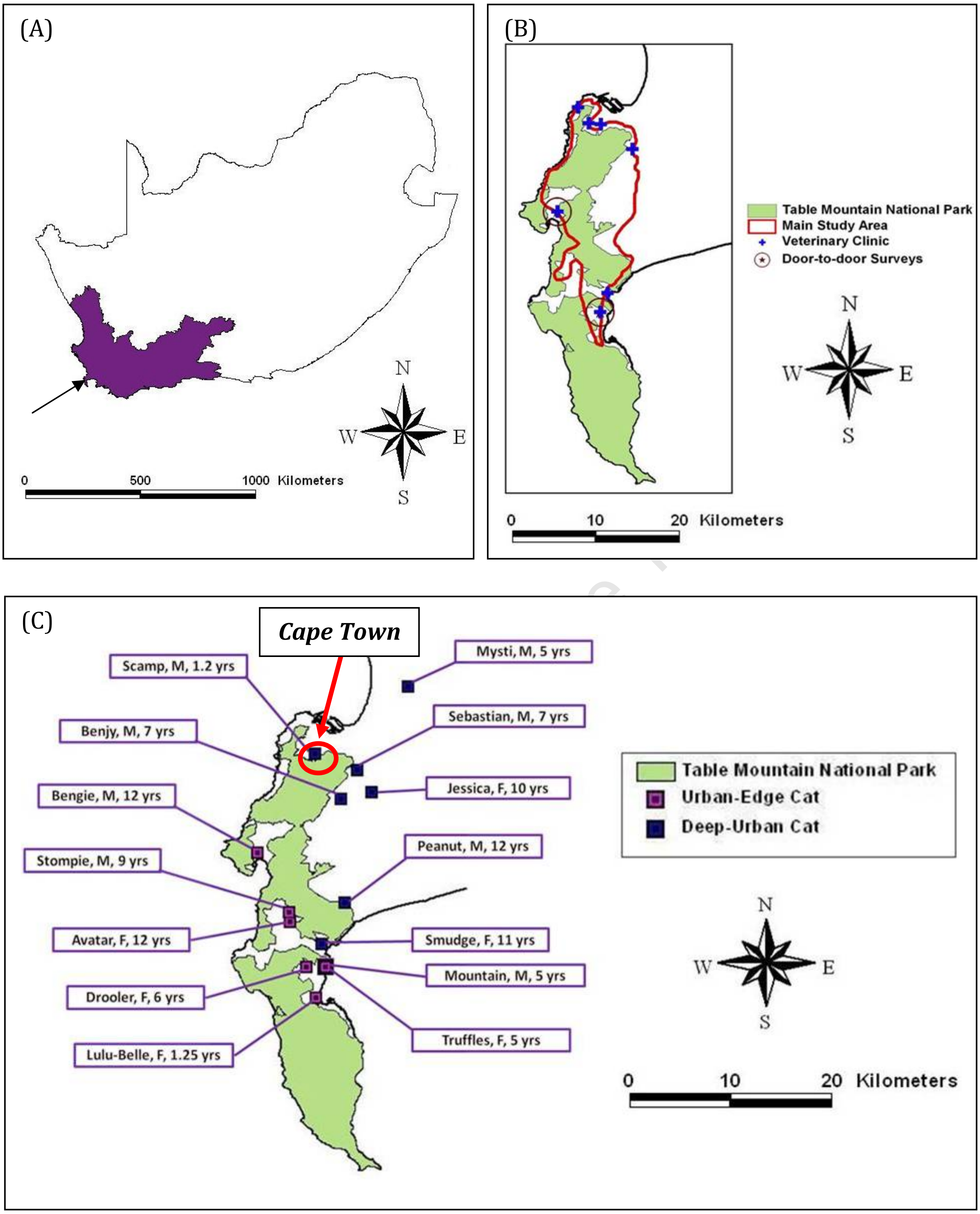



Figure. 1. Map of study area: A) Location of Cape Town in Western Cape, South Africa, B) Main study area and locations where questionnaires were distributed, C) Locations of the 14 cats that were GPS tracked.

## 2.2 Population of cats in Cape Town

I estimated the number of cats in Cape Town in two ways. According to the pet food industry, the Western Cape hosts 16% of the estimated 2 million domestic cats in South Africa (T. Hicks[3], pers. comm.). These figures do not include domestic cats found in townships, nor unfed feral colonies, and are therefore conservative figures obtained by the MARS Africa Pet Food industries. I therefore undertook door-to door surveys and determined (i) the number of cats per hundred households in Glencairn Heights and Hout Bay (Figure 1B). Ideally, more suburbs should have sampled but this was not possible due to time limitations, logistical problems and safety concerns. The average number of cats per 100 households was then combined with (ii) the national census data of the number of households in Cape Town (City of Cape Town, 2010) and (iii) the average number of cats per cat-owning households obtained from the same door-to-door surveys and the questionnaires distributed. The domestic cat population was estimated from the product of (i) to (iii). Cape Town is also known to host a large feral cat population (Y. Robson[4], pers. communications).

Both domestic and feral cats are reported to venture into protected areas and other natural habitats such as wetlands (Morgan *et al.*, 2009; D. Gibbs[5], pers. comm.), and GPS loggers (below) were used to determine how often and how far cats venture into such areas.



[3] MARS Africa, Rosslyn, South Africa. Email Id: Tim.Hicks@eu.effem.co
[4] Sunnydale Animal Sterilisation and Health Association, Cape Town. Email Id: sashapets@gmail.com
[5] City of Cape Town, Cape Town. Email Id: Dalton.Gibbs@capetown.gov.za

### 2.3 Recording prey brought back by cats

The methods used for recording prey in this study followed those employed by Churcher & Lawton (1987), Paton, 1991, Barrat (1998), Gillies and Clout (2003), Woods et al. (2003), Baker et al. (2005), Morgan et al. (2009) and van Heezik et al. (2010). A total of 600 questionnaires were distributed to cat owners in most suburbs in Cape Town. Of these, 350 questionnaires were distributed with the help of seven veterinary clinics, and 200 questionnaires were delivered to households through door-to-door surveys in two suburbs - Glencairn Heights and Hout Bay (Figure 1B). The remaining 50 questionnaires were distributed electronically to cat owners who responded to appeals made around Cape Town through the media including newspapers, magazines and radio; emails sent out to staff and students in various departments at the University of Cape Town; and an email sent through the Glencairn Heights Neighbourhood Watch Chairperson. Cat owners were given a brief summary of the study and asked if they were willing to volunteer their cats for the study. It was observed during door-to-door surveys that large numbers of cat owners were hesitant to commit to the project as they felt that the study would be used to criticize their ownership of cats. The questionnaire (Appendix 1) requested the following information:



- the type of housing
- location (deep-urban or urban-edge)
- the number of cats owned
- the ages and sex of each cat
- whether they had been neutered
- whether they wore bells on their collars
- the number of times the cats were fed per day

- whether the cats were confined at all times, were semi-restricted unrestricted at all times
- whether other forms of wildlife were present in their gardens and whether they fed these animals.

The main body of the questionnaire requested cat owners to record prey items brought home by their cats in as much detail as possible for a period of 10-12 weeks. Information requested included:

- the exact date prey was returned
- type of prey
- the number of prey items
- the status of prey (e.g. released, eaten, partially eaten or killed and left intact).



Cat owners were requested to freeze prey items for collection to ensure accurate identification of the prey. In cases where cat owners were not willing to do so (or in cases where prey were still alive), they were requested to photograph the prey item. If both were not possible, cat owners were asked to identify the prey item as accurately as possible (this was only possible for those cat owners with some conservation/zoology background) or simply to record it as a bird, mouse, shrew, frog, lizard, snake or insect (Appendix 1) and provide as much description of the dead prey as possible (e.g. approximate size, colour, distinct features e.g. three white stripes on back etc.). In households that had more than one cat, cat owners were asked to assign individual prey items returned to individual cats.

Where this was not possible, the total number or prey items returned was divided by the total number of cats within the household.

The main assumptions made were that: the sample of cats was representative of those throughout Cape Town; election of cats was done randomly based mainly on the willingness of cat owners to participate; and cats were healthy. As is the case with all such similar studies, the main assumption is that the number of prey items returned is a reflection of the prey captured by the cat (George, 1974; Churcher and Lawton, 1987). According to Kays and DeWan (2004), this almost certainly under-estimates the actual number of prey captured by a cat by at least 3 fold. It was also assumed that cat owners were competent and honest when recording prey returns and didn't under-record prey to prove how little their cat killed. Emails and phone calls were made to cat owners to encourage them during the record keeping period and veterinary services were visited regularly to encourage the return of questionnaires.



During phone calls as well as door-to-door surveys, I determined the attitude of owners by asking them if they supported the project and how they felt about cats and their impact on wildlife.

**2.4 Movement patterns and GPS Tracking**

I tracked a selection of cats from different environments to determine how they used their environment and how far and fast they ventured through it. A total of 14 cats were tracked using miniature GPS loggers: seven cats were 'deep-urban' cats defined as coming from households located in residential areas far from large native fragments, located well within suburbia, and seven cats were 'urban-edge' cats defined as those that live on the edge of large natural fragments (Figure 1C). The GPS loggers (CatTrack™) weighed 22g and were purchased from 'Mr. Lee – Projects for cats and pets' (http://www.mr-lee-catcam.de/index.htm). The loggers were relatively small in size (4.4 x 2.7 x 1.3 cm) (Figure 2), were imported from the USA and proved acceptable to all cat owners. The Science Faculty Animal Ethics Committee at the University of Cape Town approved the use of the loggers and collars/harnesses on cats (Clearance No.: **2010/V1/RS**).


Figure 2: The GPS logger.
(Photo: Juergen Perthold)



The loggers were affixed to the cat either with collars or a harness for cats known to remove their collars. The first trials were with harnesses, as recommended by the designer of the logger to keep the GPS logger facing upwards. A pouch made of soft-leather was designed and made by local artisan (R. Bevan, Fishoek) and sewn onto the strap that runs along the back of the cat; the GPS logger was then slipped into the pouch (Figure 3).

Figure 3. Design of the harness and its fixture to the cat (Sebastian).
(Photo: Sharon George)

However, these were only used for a few cats that readily accepted it and that were known to remove or lose simple neck collars. Most cat owners (and cats) preferred collars to harnesses so the GPS holder was re-designed. The soft-leather pouch was sewn to commercially–available collars and the GPS logger again slipped into the pouch. To prevent the 22g logger slipping under the cat's neck, a shifting counter-weight (a 28.4g sinker) was attached to the bottom of the collar to ensure that the logger remained facing upwards when fitted onto the cat (Figure 4). It was essential that the counter-weight was one that could shift when the collar was resized for different cats. To maximize the GPS satellite link a hole was cut in the pouch (Figure 4) to provide unimpeded linkage.




Figure 4. Design of the final collar with the pouch, counter-weight and the GPS logger.
(Photo: Sharon George and Rob Simmons)

Cats were selected from around Cape Town (Figure 1C) based on the willingness of cat owners to have their cats wear collars or harnesses. Finding cat owners willing to do so was difficult as the majority of cat owners perceived it as cruel or risky (i.e. the collar becoming hooked) for their cat to wear a collar or a harness. Among those willing to participate, some later withdrew after their cats rejected the collar/harness or removed it. Other cat owners were only willing to participate if the collar came with a release mechanism (to enable the cat to break free in the event that it gets hooked). This was tried once only as the cat lost both the collar and GPS logger within the first few days of being tracked. Given the limited number of loggers used (eight were ordered, four of the correct sort were received, and one was lost), and their cost, release collars were not tried again. This further reduced the number of cat owners willing to volunteer their cats. The 14 cats that were tracked wore the collars/harnesses for 2 days prior to switching the loggers on. This was done to habituate the cat to wearing the device to help record normal ranging behaviours. The GPS loggers were set to acquire a signal every 1 min giving an estimated battery life of 60-70 h. Most cat owners preferred to remove the collar when their cats were at home thereby reducing the time worn to a minimum. This was taken into consideration during data analysis. During this time the loggers were re-charged before being re-fitted. Owners were asked to monitor any changes in behavior while cats were wearing the collars/harnesses. No abnormal behavior or restlessness was reported for the cats. Seven of the 14 cats logged caught prey while wearing the collar/harness (Figure 5) further suggesting that GPS tracking did not affect the cats normal activities. This has also been reported by other authors who recently carried out similar studies (van Heezik *et al.,* 2010).

Figure 5. One of the collared cats (Avatar) with a freshly killed Striped Mouse.
(Photo: Susan Fitchat)

The loggers were designed to track each cats for an equal period of time (i.e. 7 days). However, two cats were tracked for 120 hours (5 days), nine cats were tracked for 168 hours (7 days) and three cats were tracked for 240 hours (10 days). This variation was taken into consideration when analyzing the total area covered and the total distance travelled by each cat. Assumptions made were that the cat owners were competent and honest regarding the maintenance and charging of the loggers. The number of resultant waypoints varied greatly between cats (2,380 – 12,058) because signal acquisition was influenced by the location of the cat at any given point. Fewer signals are received when cats are indoors or close to tall buildings, under dense foliage, under cars or any other form of cover. This affects the accuracy of locations and results in the under-estimation of the specific habitat under investigation (D'Eon *et al.,* 2002; Van Heezik *et al.,* 2010). As with all GPSs the accuracy of locations is also affected by the number of satellites acquired and their position in the sky (Van Heezik *et al.,* 2010).

## 2.5 Data Analysis

### 2.5.1 Prey records

Prey items recorded were grouped by taxonomic class and major prey items were identified down to species level. All cat owners were able to identify prey down to class level or at least were able to state whether it was a mouse, shrew, frog, lizard, snake, bird or insect. Only a select few cat owners identified prey items to species level. There were no unidentified prey items. Occasional misidentifications of "rats" could be corrected as indigenous *Otomys* rats through photographs and prey remains. Predation rates were based only on prey returned home. Daily predation rates were calculated for both deep-urban and urban-edge cats by dividing the total number of prey items returned by the total number of record-keeping days. The proportion of prey items of each category (i.e. mammals, birds, reptiles, amphibians and invertebrates) was determined for both deep-urban and urban-edge cats. Prey species diversity was calculated for both deep-urban and urban-edge cats using Shannon-Wiener and Simpsons indices.

### Statistics

Non-parametric tests were conducted on the data obtained from the questionnaires. Mann-Whitney U-tests were used to test for predation rates differences between deep-urban and urban-edge cats. This was undertaken initially only for cats that actively hunted during the study period and later for all cats (irrespective of whether they hunted or not). Mann-Whitney U-tests were also used to test for differences in predation rates between male and female cats. The Kruskal-Wallis test was used to test for differences in predation rates of cats that were fed at least once per day, twice a day or more than twice a day. Spearman's Rank correlation analysis was used to assess whether age had any influence on the predation rates of the cats. I planned to test for differences in predation rates between (i) sterilized and non-sterilized cats, (ii) unrestricted free-roaming and semi-confined cats, (iii) cats with bells and those without bells, and (iv) cats that lived in a house with a garden and those that didn't. This was not possible because all but two of the 78 cats were sterilized, all except 11 cats were unrestricted free-roaming cats and all cats had access to a garden. Owners of 70 of the 78 cats were unwilling to fit collars with bells to their cats, and two cat owners whose cats wore collars with bells were unwilling to remove them for half the study period. This left only six cats for which bells were removed half way through the study period.

The overall predation impact of Cape Town's cats on prey populations was calculated based on the estimated cat population in Cape Town, multiplied by the mean maximum predation rate (i.e. predation rates obtained from urban-edge cats/yr) to give a maximum total prey take per year. The minimum total prey take was similarly calculated, from the mean minimum predation rate (i.e. predation rates obtained from deep-urban cats/yr) to give the minimum impact possible. The average impact of Cape Town's cats on their prey was calculated using the overall predation rate of all cats (deep-urban and urban-edge combined).

### 2.5.2 GPS Tracking

GPS data loggers were tested (by wearing them myself and comparing my known movements with records from the loggers) to determine for errors in accuracy and to determine the effect of the leather pouches on the accuracy of data collection. Data obtained using the GPS collars was first imported into @Trip (software specific for the GPS loggers). Outliers that appeared to be spurious (based on the distance travelled within a short time frame) were deleted manually. The resultant data was then imported into ArcView GIS 3.3 for analysis. These tracks are shown in Appendix 2. It is important to note that I was unable to measure the error associated with each of the locations because the loggers that were used did not provide an HDOP (Horizontal Dilution of Precision) value per location. These values would have given some indication of satellite configuration.

For each cat, mean daily distance travelled during the whole period was calculated. Mean distance travelled and mean speed during both day and night was calculated for each cat. Day was defined as the period between sunrise and sunset and night the remaining period. Maximum displacement from home was calculated for each cat.

The area used by each cat was calculated using the Animal Movement Extension in ArcView. Minimum Convex Polygon (MCP) and fixed kernel methods were used to calculate areas covered by each cat. The total area used was defined using MCP 100% confidence limits rather than 95% confidence limits. 95% MCP's exclude infrequently visited sites (Meek, 2003). Given that one aim of the study was to determine the movement of cats into protected areas and other natural habitats, these outliers were important. Removing them reduces the total area used significantly and would have defeated the purpose of this study (see also Meek, 2003).

Fixed kernels were generated to identify regions of differential space use (95%, 75%, 50%, 25% and 10% of points were used to generate kernels). The smoothing parameter or bandwidth (*h*) ranged from 0.22 to 0.29. The resultant utilization distribution density was converted into probability contours to produce visual displays of range size and shape. Total area used was defined by the smallest area under the utilization distribution that encompassed 95% of the points and core areas were defined as the smallest area encompassing 50% of points (Table 3).

For each cat the time spent at home was determined by calculating the proportion of points located within the cat owner's yard. Because most cat owners chose to remove the GPS collars when their cats were at home (cat owners recorded the times they did this), I estimated the number of 'home' points that were 'lost' (based on the total hours at home and the mean number of waypoints generated/hour) and added them to the home points calculated in ArcView. This was necessary to avoid underestimating the time spent at home.

Differences in habitat use versus habitat availability was evaluated for both deep-urban and urban-edge cats. Three main habitats were identified: Natural (i.e. protected areas and other large natural patches of green areas such as wetlands with indigenous vegetation), Urban (built-up areas, roads as well as the cat's house) and Green belts (referring to urban gardens/green spaces found within urban areas and includes trees, shrubs, hedges, lawns and flowerbeds mostly consisting of exotic species).  The distinction between 'natural habitat' and 'greenbelts' was made to see whether cats prefer natural habitat over greenbelts (when both are available to them) given that natural habitats are likely to support more resources for indigenous fauna (Crooks et al., 2004) when compared to greenbelts that are likely to support more exotic fauna such as rats and mice. Both habitat use (based on proportion of points found in each habitat) and habitat availability (based on proportion of area of each habitat) was measured within 100% MCPs (van Heezik *et al.,* 2010). The 'lost' home points were added to the urban points calculated in ArcView to avoid underestimating urban space usage.

**Statistics**

Non-parametric tests were used to test for significant differences in distance travelled and area covered between deep-urban and urban-edge cats and, differences between males and females irrespective of urban placement (Mann-Whitney U-test). Spearman rank correlation analysis was used to test for associations between age and distance travelled and areas covered. Wilcoxon signed rank test was used to test if the distances travelled (and the speed of travel) differed significantly between day and night. Differences in habitat use versus habitat availability were assessed using a chi-square test.

# CHAPTER THREE

# RESULTS

A total of 32 questionnaires (5.3%) of the 600 questionnaires distributed were returned. Of these, 12 questionnaires were from deep-urban households (*n* = 30 cats) and 20 were from urban-edge households (*n* = 48 cats). Twenty-nine (90.6%) of the 32 respondents lived in free-standing houses and the remaining three lived in a semi-detached house, a high-rise apartment and a security village respectively. Deep-urban households had a mean of 2.5 cats per household and urban-edge households had a mean of 2.4 cats per household (Table 2).

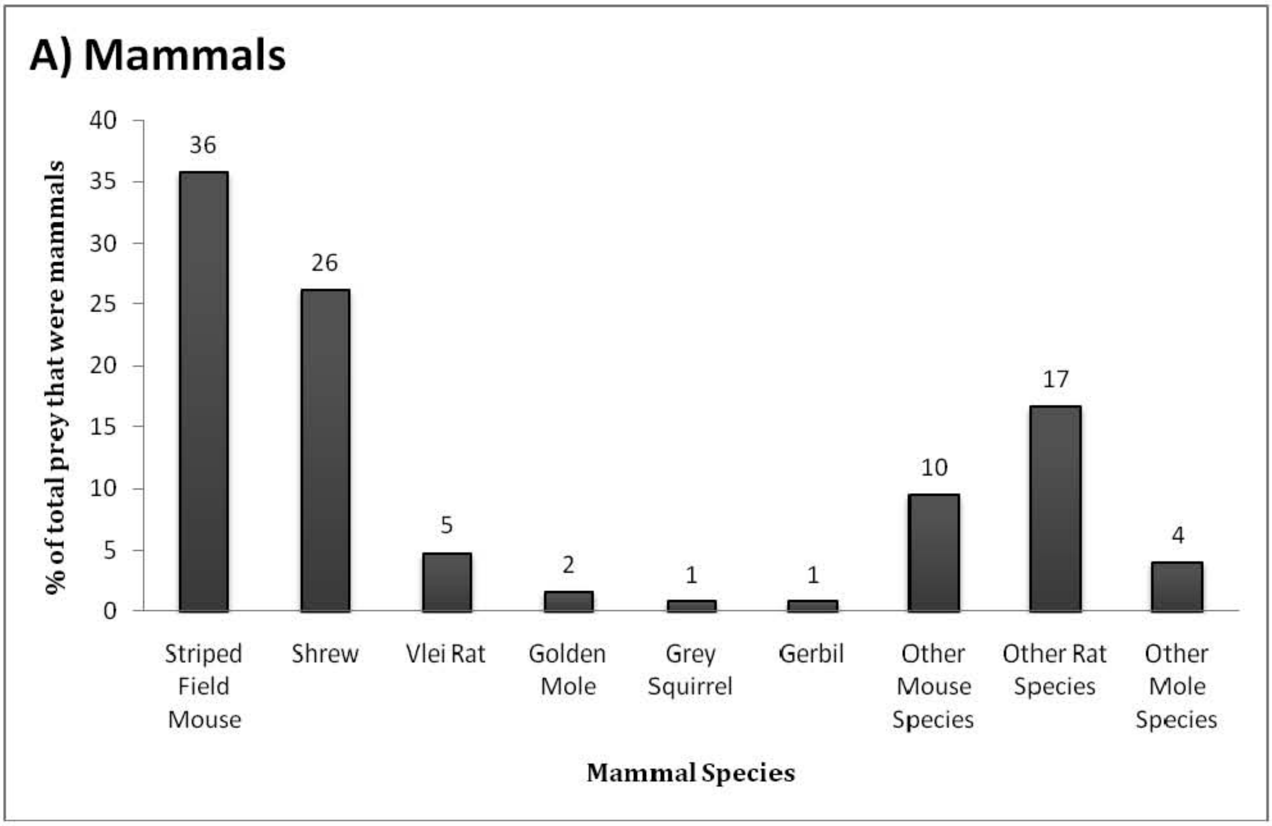
The samples of cats differed widely in age from 0.5 to 18 years old. The mean age (±SD) of deep-urban cats (7.18 ± 4.45 years) and was similar to that of the urban-edge cats (6.61 ± 4.21 years). Because I wished to determine the effect of ad-libidum vs. restricted food supplementation on predation rates, respondents were asked to provide data on cat feeding frequency: fifty (64.1%)of the total number of cats had access to food at all times (22 deep-urban and 28 urban-edge), twenty-five (32.1%) were fed twice a day (8 deep-urban and 17 urban-edge) and three urban-edge cats (3.8%) were fed only once a day. Of the 78 cats, 84% were unrestricted free-roaming cats (25 deep-urban and 41 urban-edge) and 16 % were semi-restricted (confined within the house from sunset to sunrise) cats (5 deep-urban and 7 urban-edge). All except two urban-edge cats were sterilized, precluding any further analysis of fertile vs. sterilized cats. There was only a small difference in the number of males and the number of females in the sample.

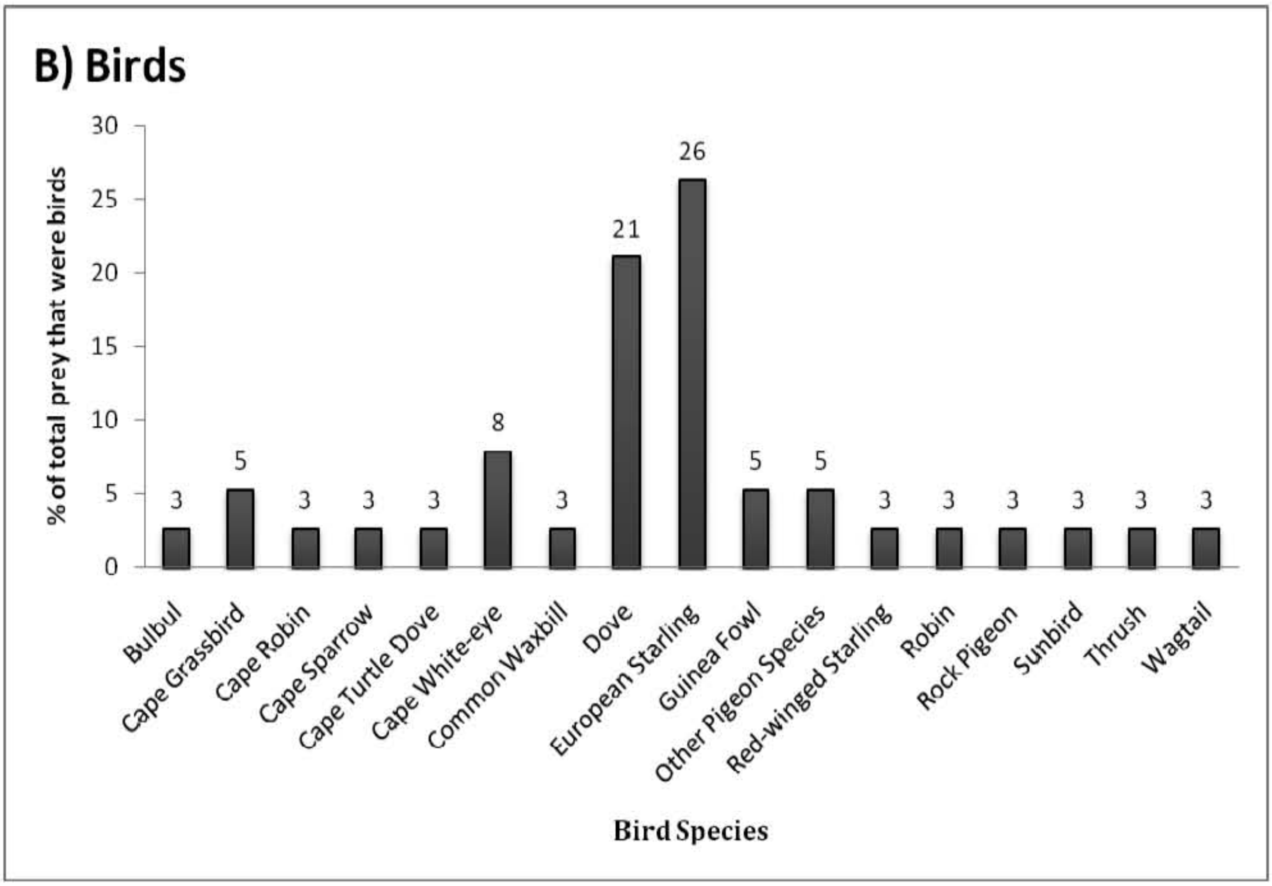
Table 2. Total number of households and cats, mean number of cats per household, proportion of cats that actively hunted during the study period, and sex of the study population in Cape Town from the questionnaires. Figures in parentheses represent ranges and proportions.

| | No. of households | Total no. of cats | Average no. of cats/household | No. of cats that actively hunted | Sex | |
|---|---|---|---|---|---|---|
| | | | | | Male | Female |
| **Deep-urban** | 12 | 30 | 2.5 (1-5) | 17 (57%) | 16 | 14 |
| **Urban-edge** | 20 | 48 | 2.4 (1-7) | 29 (60%) | 25 | 23 |
| **Total** | 32 | 78 | 2.4 (1-7) | 46 (59%) | 41 | 37 |

**3.1 Prey-recorded**

Of the 78 cats, 41% of the sample did not hunt at all (i.e. based on their owners reports that they never saw them catch anything). Of the remaining 46 cats (59%), all brought home at least one prey item during the study period (Table 2). These cats brought home a total of 286 prey items (Appendix 3), comprising 44% small mammals, 25% reptiles, 16% invertebrates, 13% birds and 1% amphibians (Figure 6). Of the prey identified, nine species of small mammals were apparent, in addition to 17 species of birds, five species of reptiles, two species of amphibian species and 10 invertebrate species. The most common species from each major category (that were identified down to species level) were the Striped Mouse (*Rhabdomys pumilio*), the European Starling (*Sturnus vulgaris*), the Rock Agama (*Agama agama*), and the Cape Rain Frog (*Breviceps gibbosus*). Of the four amphibians identified, three were Cape Rain Frogs and one was a Cape River Frog. Of the 46 invertebrates recorded, 30% of these were moths, 22% were stick Insects, 17% were cockroaches and the remainder comprised spiders, scorpions, grasshoppers, locusts, dragonflies, beetles and other unidentified insects.


A) Mammals
% of total prey that were mammals
40
35
30
25
20
15
10
5
0
36
26
5
2
1
1
10
17
4
Striped Field Mouse
Shrew
Vlei Rat
Golden Mole
Grey Squirrel
Gerbil
Other Mouse Species
Other Rat Species
Other Mole Species
Mammal Species


B) Birds
% of total prey that were birds
30
25
20
15
10
5
0
3
5
3
3
3
8
3
21
26
5
5
3
3
3
3
3
3
Bulbul
Cape Grassbird
Cape Robin
Cape Sparrow
Cape Turtle Dove
Cape White-eye
Common Waxbill
Dove
European Starling
Guinea Fowl
Other Pigeon Species
Red-winged Starling
Robin
Rock Pigeon
Sunbird
Thrush
Wagtail
Bird Species

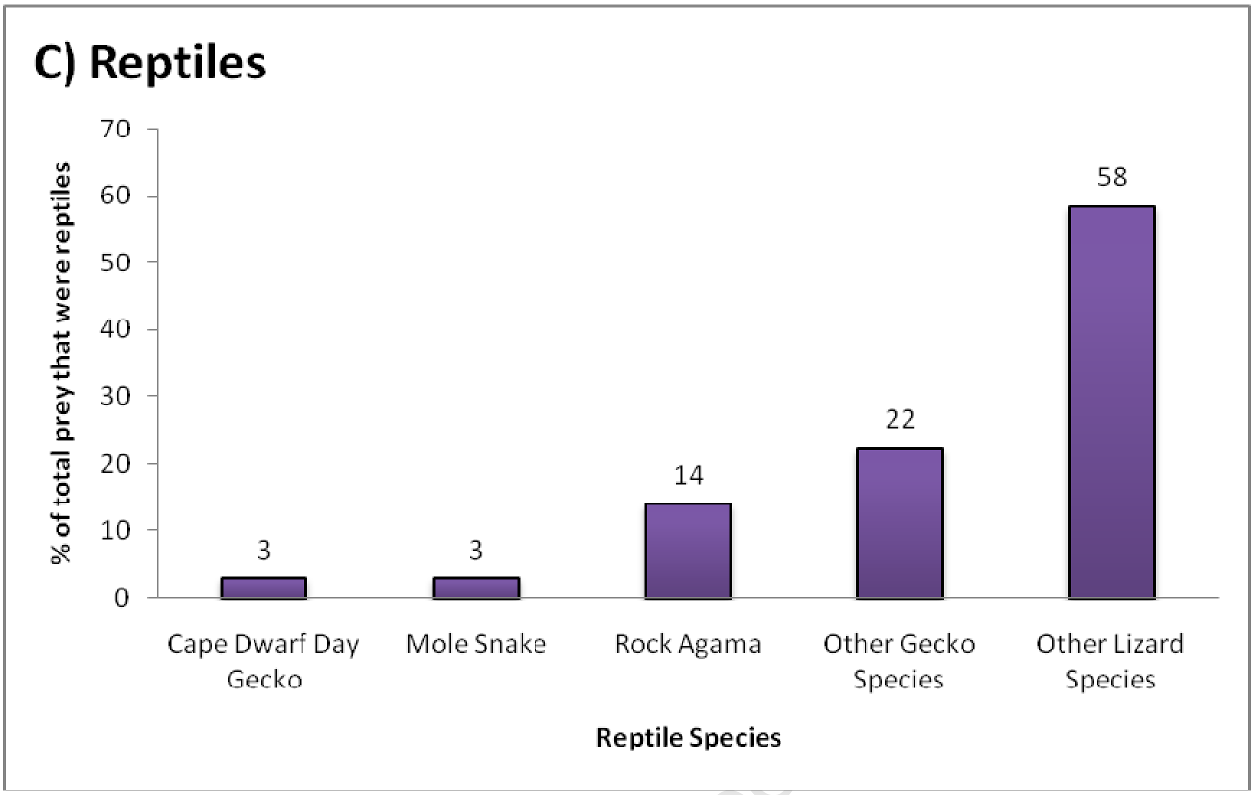



Figure 6. Proportions of identified prey species for each category Mammals (n=126 ); Birds (n=38 ); Reptiles (n=72).



**3.2 Prey hunted: Deep-urban vs Urban-edge cats**

Deep-urban cats (n=17) brought home a total of 72 prey items over a 10-week period. Of these 17% were small mammals, 21% were birds, 19% were reptiles and the remaining 43% were invertebrates (Species are listed in Appendix 3). The mean number of prey (±SD) brought back by these cats over the same period was 4.24 ± 3.38 prey/cat. Urban-edge cats (n=29) by contrast brought home almost three times more prey (214 prey items) over the same time period, comprising 53% small mammals, 11% birds, 27% reptiles, 2% amphibians and 7% invertebrates (Appendix 3). Furthermore, the mean prey brought home (±SD) by urban-edge cats (n= 29) was also higher at 7.36 ± 6.16 prey/cat. The number of prey, by category, brought home by only hunting cats between deep-urban and urban-edge differed (Figure 7). Shannon-Weiner prey diversity indices were slightly greater for urban-edge cats (H'=2.63) than for deep-urban cats (H'= 2.51). However, Simpsons Reciprocal prey diversity indices contradicted this and were greater for deep-urban cats (1/D = 10.19) than for urban-edge cats (1/D = 8.45).

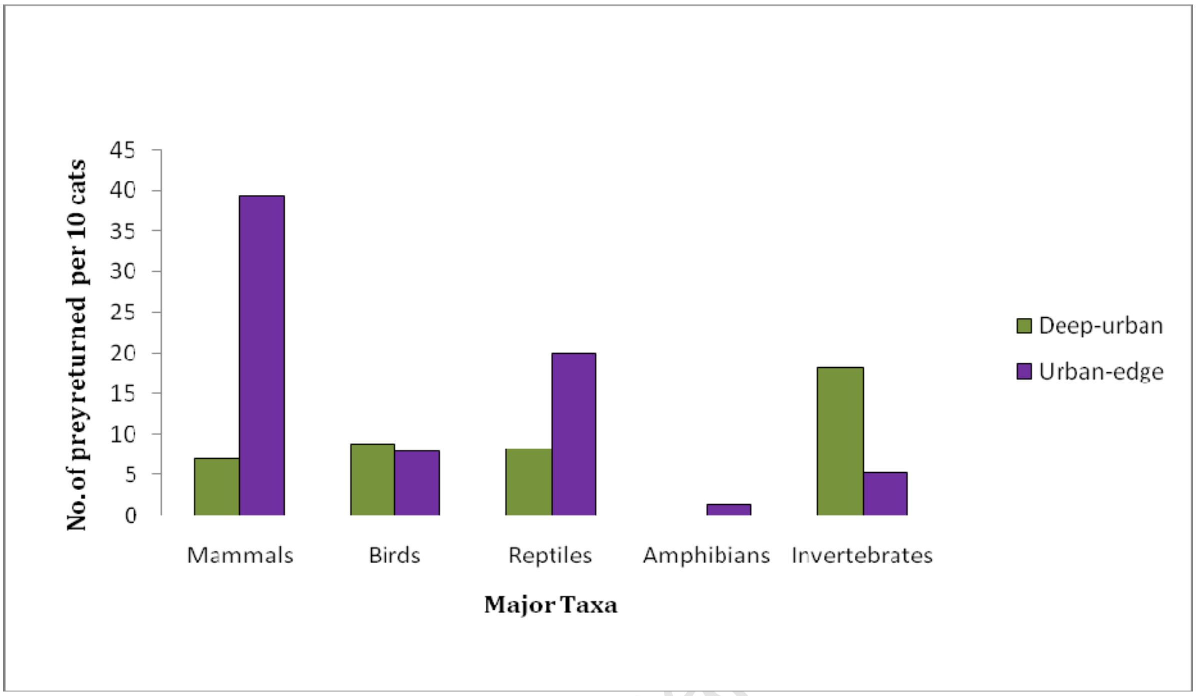



Figure 7. A comparison of the number of prey brought home/10 *hunting* cats over a 10-week period by Deep-urban and Urban-edge cats.

**Predation Rates**

**a) Hunting cats (n=46)**

The mean daily predation rate (±SE) for deep-urban cats (n=17) was 0.06 ± 0.02 prey/ day and was about half that of urban-edge cats (n=29) at 0.11 ± 0.02prey/day (Figure 8). The difference between daily predation rates of deep-urban and urban-edge cats was significant (Mann-Whitney U-test: U= 150.5, p= 0.03).

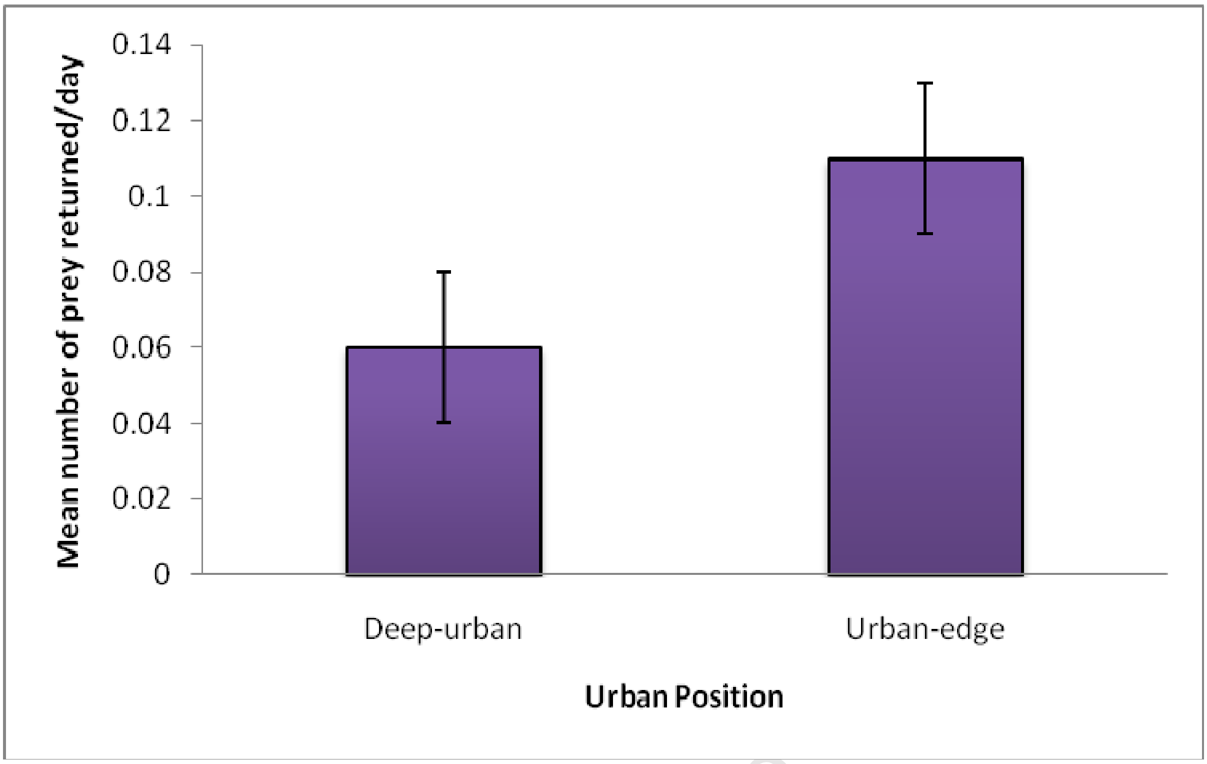


Figure 8. The significant difference in mean daily predation rate for hunting cats in deep-urban and urban-edge categories. *(Error bars = 1SE)*

**b) All cats (n=78)**

The mean daily predation rate (±SE) for all deep-urban cats, whether hunters or not, (0.04 ± 0.01 per day; n=30) and all urban-edge cats (0.06 ± 0.01 per day; n=48) (Figure 9) were not significant different (Mann-Whitney U-test: U = 597, p= 0.21).

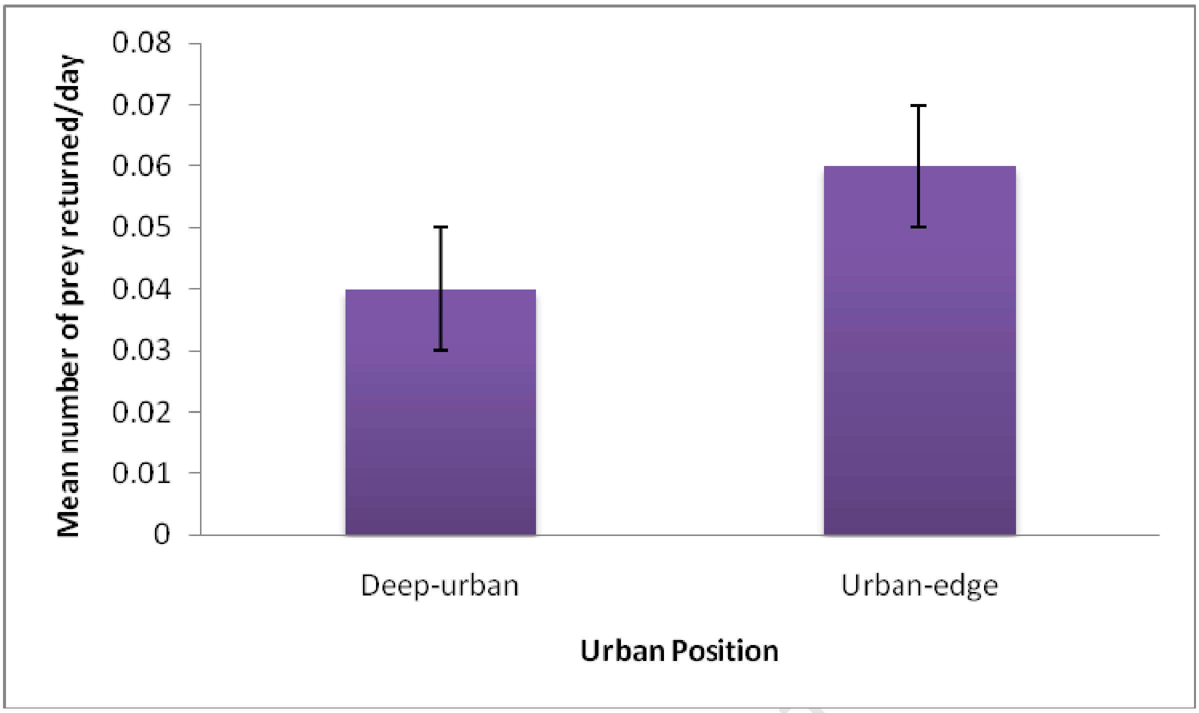


Figure 9. A comparison of mean daily predation rates for all cats relative to their urban location. *(Error bars = 1SE)*



**Age, sex and feeding frequency differences in prey return rates**

Spearman rank correlation analysis showed that the number of prey brought home per day was significantly negatively correlated to the age of the cats ($R_s = -0.41$, $p = 0.0002$, $N = 78$) (Figure 10) – non-hunters were included in this analysis. Cats above the age of 13 in my sample did not hunt at all. Daily predation rates of male cats (0.06 ± 0.01 prey/day) was 20% higher than female cats (0.05 ± 0.01 prey/day) but not significantly different (Mann-Whitney U-test: $U = 715$, $p = 0.67$).

Cats that had access to provisioned food at all times had a slightly lower predation rate (±SE) of 0.05 ± 0.01 prey/day compared to those that were fed only twice (0.06 ± 0.02 prey/day) or once a day (0.08 ± 0.04 prey/day); these differences were not significant (Kruskal-Wallis test: $H (2, N = 78) = 0.90$, $p = 0.64$).

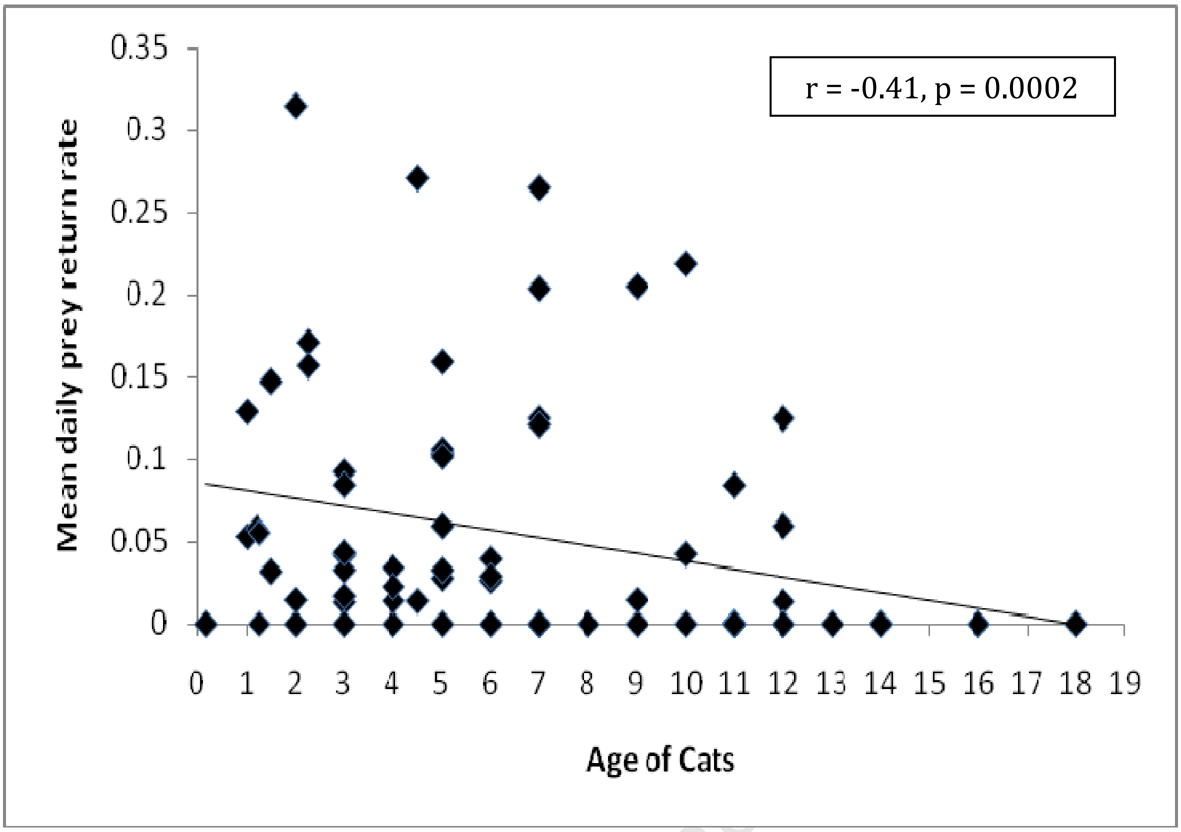


Figure 10. Negative correlation between prey return rate and the age of cats.

### 3.3 Overall predation impact of Cape Town's domestic cats

Cape Town has a projected 708, 126 formal households (excluding townships) by 2010 (City of Cape Town, 2010). Based on the door-to-door surveys of 264 households in two suburbs of Hout Bay and Glencairn Heights, an average of 12/100 households had domestic cats. Assuming these suburbs are representative of most of Cape Town households approximately 84, 975 households in Cape Town have cats. The average number of cats per household is roughly 2.3 cats/household. This is based on data from 32 questionnaires (2.45 cats/house) and door-to-door surveys of households (2.2 cats/household). Therefore, Cape Town is estimated to have a domestic cat population of approximately 195, 443 animals. This figure is supported by data from the pet food industry (AMPS Report on Dog and Cat Statistics, 2008) that estimates a domestic cat population of 320,000 for the whole of the

Western Cape. We can use this to provide a first-order estimate of the predation impact of Cape Town's domestic cats as follows.

**Using the predation rate of deep-urban cats: (0.04 prey/cat/ day)**

Min No. of Prey Killed Annually = [195 443 cats x 0.04 prey/cat/ day] x 365days

= 2, 853, 468 prey/year

**Using the predation rate of urban-edge cats: (0.06 prey/cat/ day)**

Max No. of Prey Killed Annually = [195 443 cats x 0.06 prey/cat/day x 365days

= 4, 280, 202 prey/year

Using the average rate of predation for urban and urban-edge cats combined (0.05prey/cat/day), I estimate 3, 566, 835 animals are captured per year by domestic cats in Cape Town.

The estimated predation impact of Cape Town cats is thus 3.6 million prey per year with a range of 2.9 – 4.3 million animals.

By averaging the prey spectrum captured over deep-urban and urban-edge area (from Fig. 5) we can estimate the impact on different prey types. The majority of these prey (44%) would comprise small mammals (1, 584, 000 individuals). Reptiles would account for 25% of all prey or 900, 000 animals; birds would account for 14% or 504, 000 individuals, insects and arachnids (16%) would account for 576, 000 specimens and amphibians (1%) would account for a mere 36, 000 animals.

### 3.4 Public perception and general attitudes towards cats

A total of 169 opinions were randomly obtained during the study period either during door-to-door surveys, telephone calls or emails received. Of these, 15 people (9%) were totally opposed to domestic cats and voiced their support of the project (none owned cats), 84 (50%) remained neutral and showed great interest in the project (comprising mostly cat-owners), four people refrained from giving an opinion and 66 (39%) were in support of cats and suspicious and wary of the project (mostly cat owners and feral cat 'lovers').

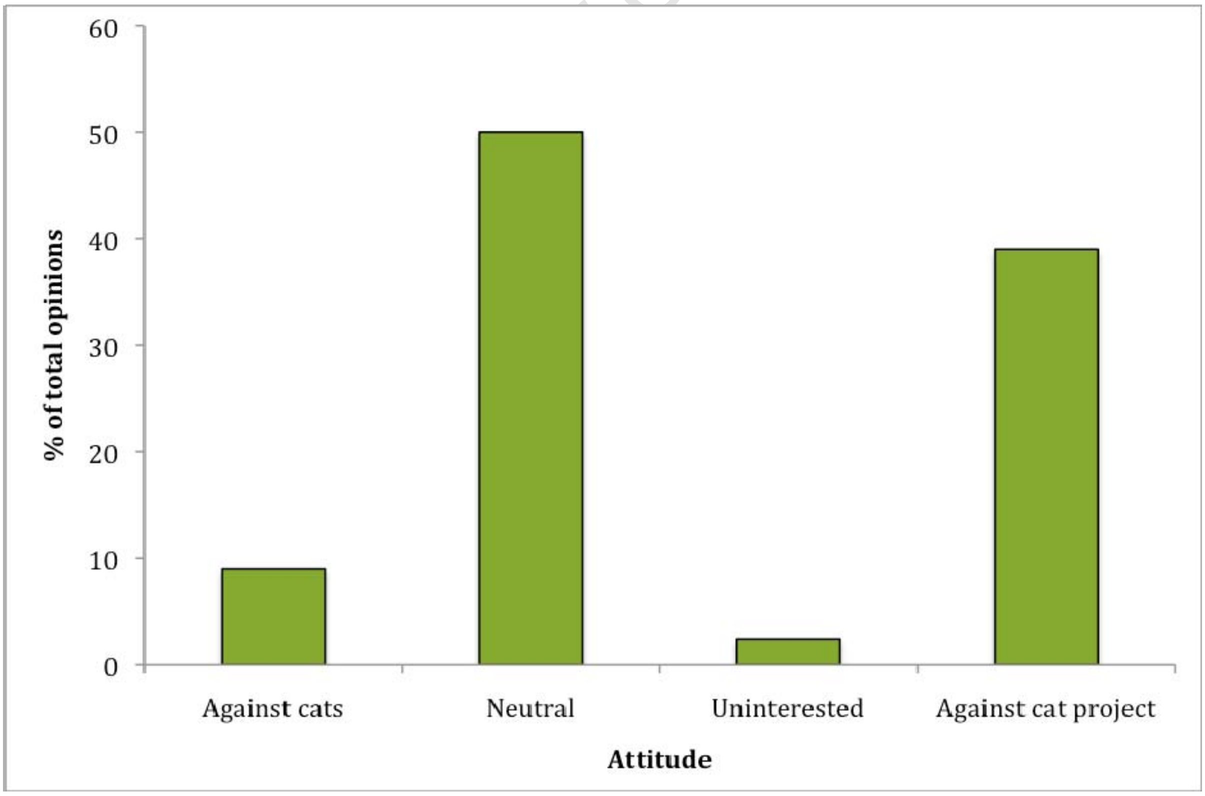



Figure 11. Attitudes of people towards cats and this cat project among cat owners and non-owners.

### 3.5 Movement patterns

A total of 14 domestic cats (7 deep-urban and 7 urban-edge cats) were tracked using GPS loggers over periods not exceeding 10 days. The minimum tracking period was 5 days and the mean tracking period was 7.4 days. The sex ratio of the 7 deep-urban cats was 2F:5M and for the urban-edge cats was 4F:3M. The mean age (±SD) of deep-urban cats was 7.6 ± 7.2 years and for urban-edge cats was 3.8 ± 4.0 years. All cats had been sterilized (Table 2). There was no significant correlation ($R^2 = 0.248$, df = 1,12, $p = 0.071$) between the hours that each cat was tracked and the size of the area it covered.

Representative examples of the largest and smallest GPS tracks generated by the loggers and the MCP boundary and kernels for deep-urban and urban-edge cats are shown in Figures 12-15.

Table 3. The name, location, breed, age, sex, number of hours tracked, MCP area, kernel areas, mean distance travelled daily and maximum displacement from owner's house for each of the 14 study cats. The position of each cat owner's home within the urban environment was assigned to one of two exclusive categories namely deep-urban (DU) or urban-edge (UE).

| Cat Name | Location | Urban Position | Breed | Age | Sex | Total hours tracked | MCP area (ha) | 95% Kernal area (ha) | 50% Kernal area (ha) | Mean distance travelled/day (km) | Max displacement from owner's house (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Mountain | Glencairn Heights | UE | Abyssinian cross | 5 | M | 168 | 31.45 | 2.71 | 0.42 | 13.0 | 567.2 |
| Truffles | Glencairn Heights | UE | Birman-Persian cross | 5 | F | 168 | 28.41 | 3.70 | 0.58 | 16.3 | 417.3 |
| Drooler | Welcome Glen | UE | Domestic Shorthaired | 6 | F | 240 | 47.4 | 1.47 | 0.04 | 10.2 | 848.8 |
| Bengie | Hout Bay | UE | Bengal cross | 12 | M | 168 | 51.15 | 9.09 | 0.79 | 16.6 | 841.1 |
| Stompie | Noordehoek | UE | Manx | 9 | M | 168 | 33.8 | 2.76 | 0.15 | 16.9 | 461.6 |
| Lulu-Belle | Simon's Town | UE | Domestic Shorthaired | 1.25 | F | 168 | 36.11 | 4.22 | 0.65 | 16.1 | 581.6 |
| Avatar | Noordehoek | UE | Domestic Shorthaired | 12 | F | 168 | 24.39 | 2.27 | 0.19 | 12.5 | 399.0 |
| Sebastian | Rosebank | DU | Siamese cross | 7 | M | 168 | 14.55 | 1.24 | 0.09 | 5.6 | 413.4 |
| Mysti | Edgemead | DU | Domestic Shorthaired | 5 | M | 120 | 15.93 | 2.46 | 0.06 | 4.6 | 424.1 |
| Smudge | Fish Hoek | DU | Domestic Shorthaired | 11 | F | 120 | 0.57 | 0.14 | 0.03 | 1.0 | 73.3 |
| Jessica | Claremont | DU | Domestic Shorthaired | 10 | F | 168 | 49.95 | 1.00 | 0.08 | 4.1 | 726.2 |
| Peanut | Lakeside | DU | Domestic Shorthaired | 12 | M | 240 | 26.94 | 1.90 | 0.11 | 12.6 | 442.8 |
| Scamp | Vredehoek | DU | Domestic Shorthaired | 1.2 | M | 168 | 42.75 | 2.50 | 0.25 | 18.1 | 612.0 |
| Benjy | Claremont | DU | Siamese cross | 7 | M | 240 | 39.69 | 6.55 | 0.32 | 17.7 | 576.8 |

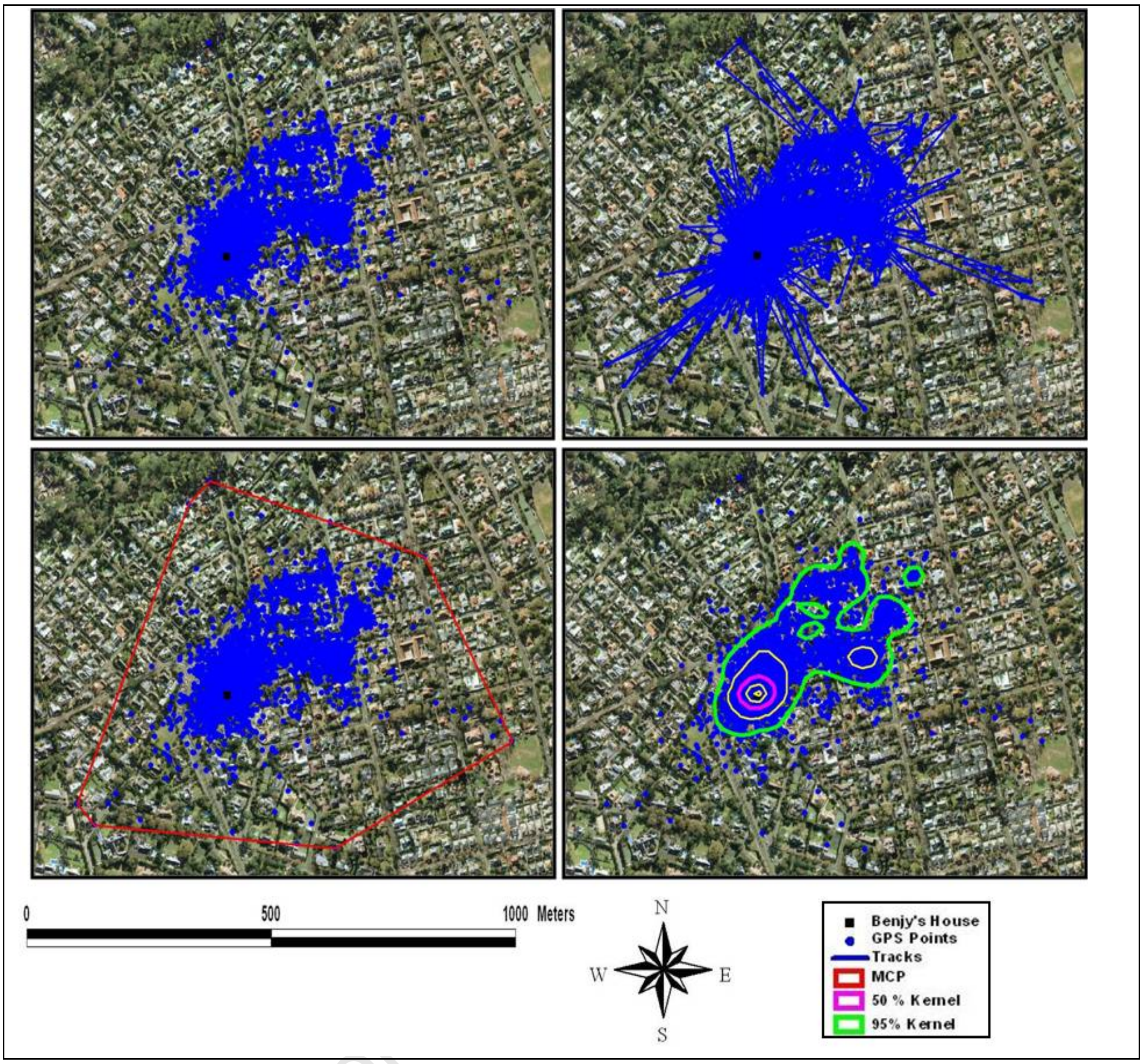



Figure 12. The largest home range from GPS data obtained from a randomly selected deep-urban cat (Benjy in Claremont). The images depict the areas covered by the cat after leaving its owners home throughout the 10-day study period (top left), and the individual GPS data points that were recorded by the collar and used to construct the routes (top right). From these, a minimum convex polygon was drawn (bottom left) to estimate the habitats assumed to be available within the cat's 10-day home range. The core home range (50%) estimated from the kernel method was 0.32 ha (bottom right) and shows the 50% and 95% home range estimates.

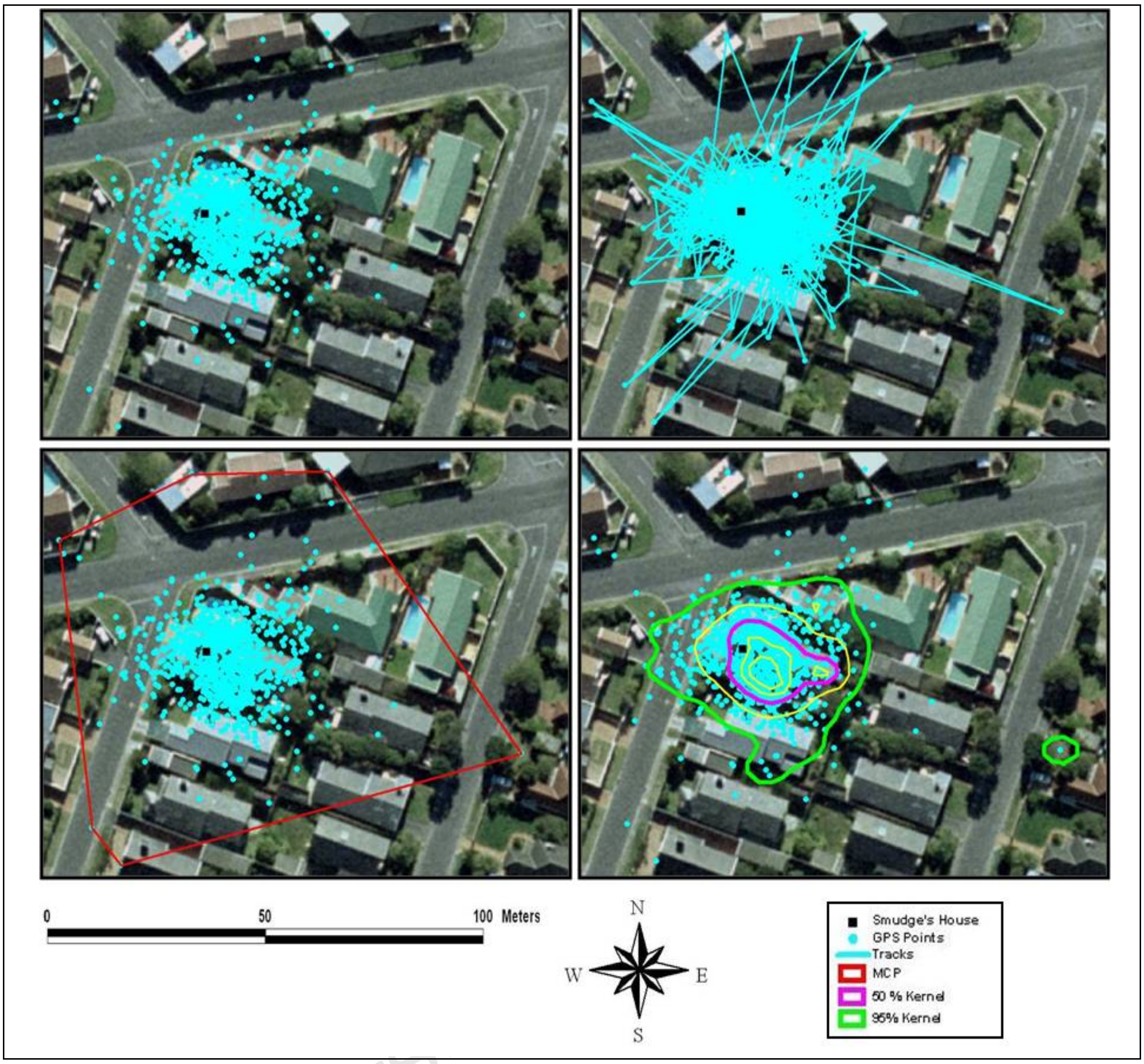



Figure 13. The smallest home range from GPS data obtained from a randomly selected deep-urban cat (Smudge in Fish Hoek). The images depict the areas covered by the cat after leaving its owners home throughout the 5-day study period (top left), and the individual GPS data points that were recorded by the collar and used to construct the routes (top right). From these, a minimum convex polygon was drawn (bottom left) to estimate the habitats assumed to be available within the cat's 5-day home range. The core home range (50%) estimated from the kernel method was 0.03 ha (bottom right) and shows the 50% and 95% home range estimates.

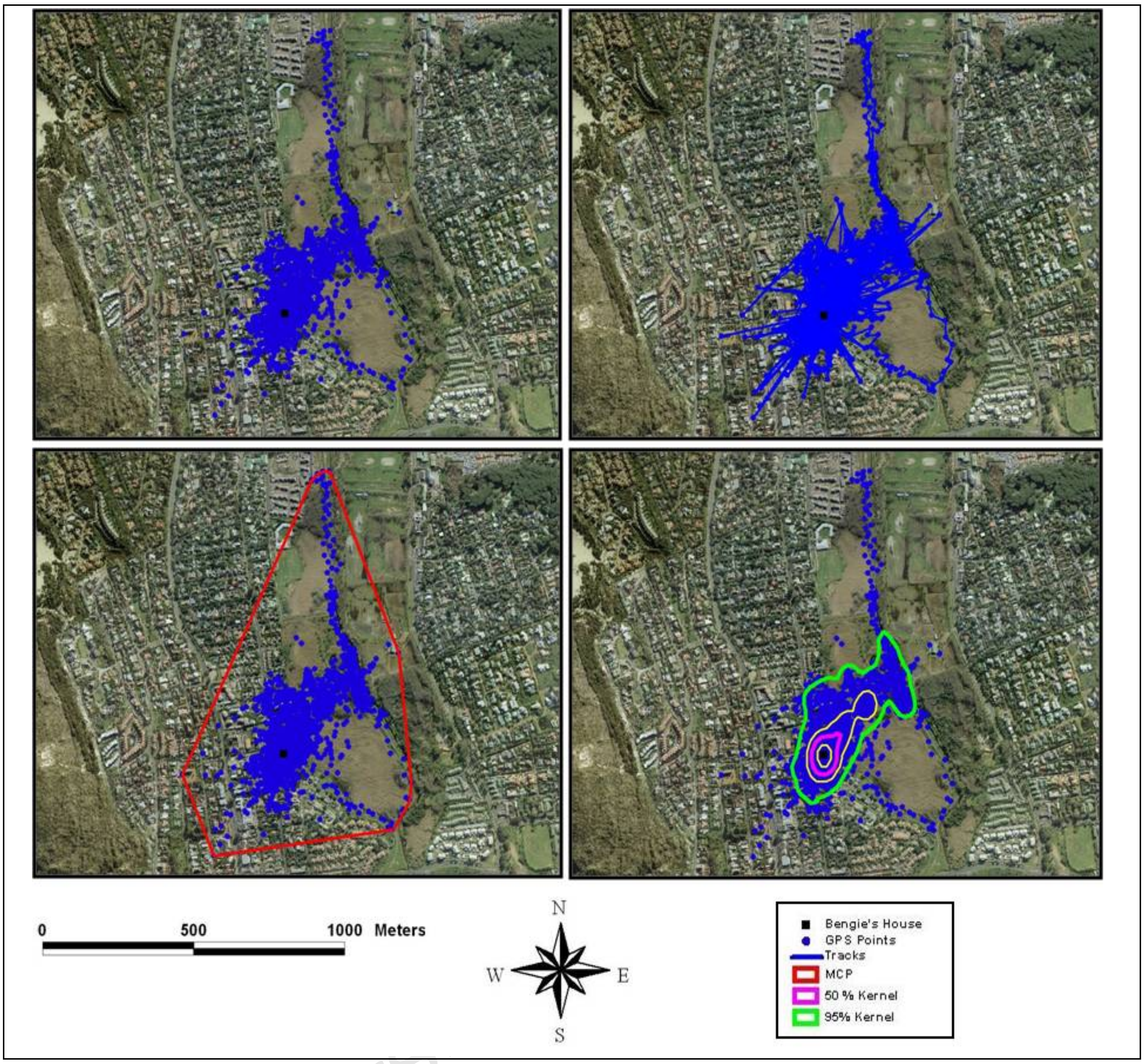



Figure 14. The largest home range from GPS data obtained from a randomly selected urban-edge cat (Bengie in Hout Bay). The images depict the areas covered by the cat after leaving its owners home throughout the 7-day study period (top left), and the individual GPS data points that were recorded by the collar and used to construct the routes (top right). From these, a minimum convex polygon was drawn (bottom left) to estimate the habitats assumed to be available within the cat's 7-day home range. The core home range (50%) estimated from the kernel method was 0.79 ha (bottom right) and shows the 50% and 95% home range estimates.

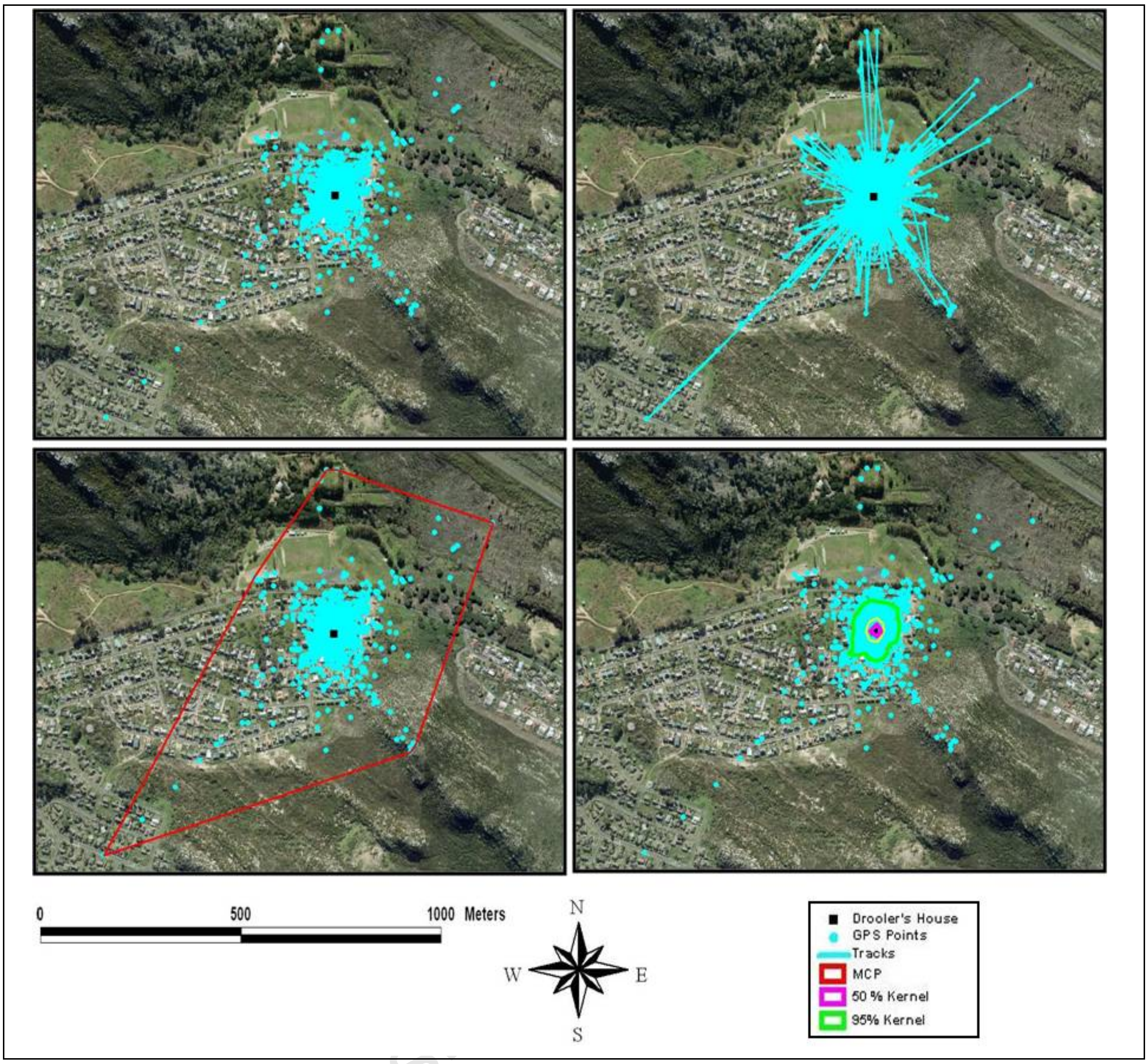



Figure 15. The smallest home range from GPS data obtained from a randomly selected urban-edge cat (Drooler in Welcome Glen). The images depict the areas covered by the cat after leaving its owners home throughout the 10-day study period (top left), and the individual GPS data points that were recorded by the collar and used to construct the routes (top right). From these, a minimum convex polygon was drawn (bottom left) to estimate the habitats assumed to be available within the cat's 10-day home range. The core home range estimated from the kernel method was 0.04 ha (bottom right) and shows the 50% and 95% home range estimates.

There was no significant difference (Mann-Whitney U-test: U = 17, p = 0.37) in the mean (±SE) area covered by deep-urban (27.2 ± 6.74 ha) compared to urban-edge cats (36.10 ± 3.70 ha) (Figure 16). Bengie, a male urban-edge cat covered the largest area (51.15 ha) (Figure 14), whilst Smudge, a female deep-urban cat covered the smallest area (0.57 ha)(Figure 13). Mean area used was not significantly different for male and female cats (Mann-Whitney U-test: U = 24, p = 1.00) and there was no significant correlation (Spearman rank: Rs = -0.09, p = 0.76) between area used and the age of the cat across both urban categories.

Fixed kernel estimates for total area covered (95%) were smaller than MCP areas (Table 3). There was no significant difference (Mann-Whitney U-test: U = 11, p = 0.10) in the mean area used (95% Kernel) (±SE) by deep-urban cats (2.26 ± 0.78) ha compared to urban-edge cats (3.75 ± 0.95) ha (Figure 17). Kernel estimates (95%) were not significantly different for male and female cats (Mann-Whitney U-test: U = 15, p = 0.27) and there was no correlation (Spearman rank correlation analysis: rs = -0.26, p = 0.38) between area used and the age of the cat across both urban categories.



The mean core area covered (50% Kernel) by deep-urban cats (±SE) was 0.13 ± 0.05 ha was not significantly different (Mann-Whitney U-test: U = 10, p = 0.07) from that of urban-edge cats at 0.40 ± 0.11 ha (Figure 17). Kernel estimates (50%) were not significantly different for male and female cats (Mann-Whitney U-test: U = 19, p = 0.56) and was not dependent on the age of the cats (Spearman rank correlation analysis: rs = -0.20, p = 0.48).

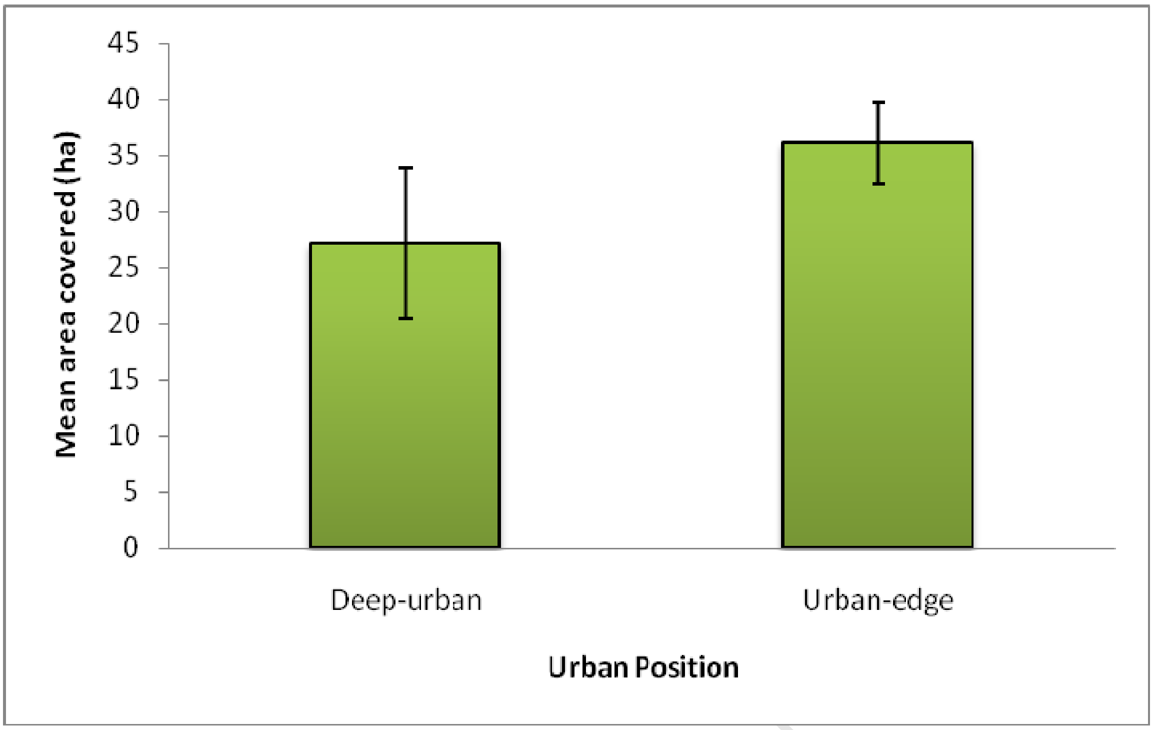



Figure 16. The mean area covered (estimated using MCP method) by deep-urban and urban-edge cats. *(Error bars = 1SE)*

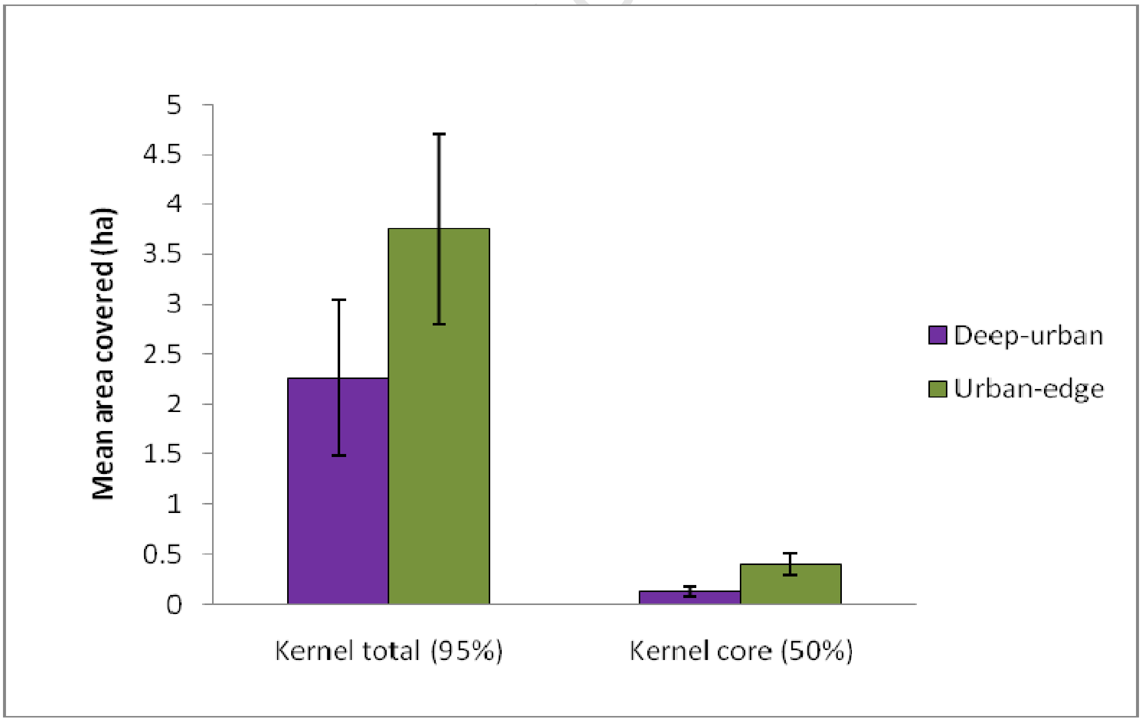



Figure 17. Kernel total (95%) and Kernel core (50%) for deep-urban and urban-edge cats. *(Error bars = 1SE)*

There was no significant difference (Mann-Whitney U-test; U = 16, p = 0.31) in the mean (±SE) distance travelled per day by deep-urban (9.1 ± 2.6 km, n = 7) versus urban-edge cats (14.5 ± 1.0 km, n = 7) (Figure 18). The longest mean distance travelled per day (18.1 km) was by a male deep-urban cat (Scamp) and the lowest mean distance travelled per day (1.0 km) was by a female deep-urban cat (Smudge) (Table 3). The sex of the cats had no significant impact on the mean distance travelled per day (Mann-Whitney U-test: U = 12, p = 0.14, n = 14) and there was no correlation between the mean distance travelled daily and the age of the cats (Spearman rank correlation analysis: Rs = -0.25, p = 0.38).

Mean maximum displacement from home (±SE) for deep-urban cats at 466.9 ± 78.6 m was about 20% lower than, but not significantly different from (Mann-Whitney U-test: U = 19, p = 0.52), the mean maximum displacement for urban-edge cats (588.1 ± 71.2 m) (Figure 19). The cat that travelled the furthest away from home (848.8m) was a female urban-edge cat (Drooler). Smallest maximum displacement from home (73.3m) was by a female deep-urban cat (Smudge) (Table 3). The sex of the cats had no significant impact on the maximum displacement from home (Mann-Whitney U-test: U = 22, p = 0.85) and there was no correlation between the mean maximum displacement from home and the age of the cats (Spearman Rank correlation analysis: Rs = -0.21, p = 0.47).

Deep-urban cats travelled a mean distance (±SE) of 4.8 ± 1.5 km during the day and a mean distance of 4.3 ± 1.2 km during the night. Urban-edge cats travelled a mean distance of 8.6 ± 0.9 km during the day and 6.0 ± 0.7 km at night. Both deep-urban and urban-edge cats travelled significantly more (Wilcoxon Matched Pairs Test: T = 17, N = 14, p = 0.03) during the day than at night (Figure 20). Deep-urban cats also travelled slightly faster during the day than at night. Mean speed during the day for deep-urban cats was 0.97 ± 0.16 km/h and during the night was 0.73 ± 0.16 km/h. The difference was not significant (Mann-Whitney U-test: U = 22, p = 0.80). However, at night, urban-edge cats travelled slightly faster during the night than during the day though not significantly faster (Mann-Whitney U-test: U = 16, p = 0.31). Mean speed (±SE) during the day for urban-edge cats was 0.88 ± 0.18 km/h and was 1.08 ± 0.12 km/h at night (Figure 21).



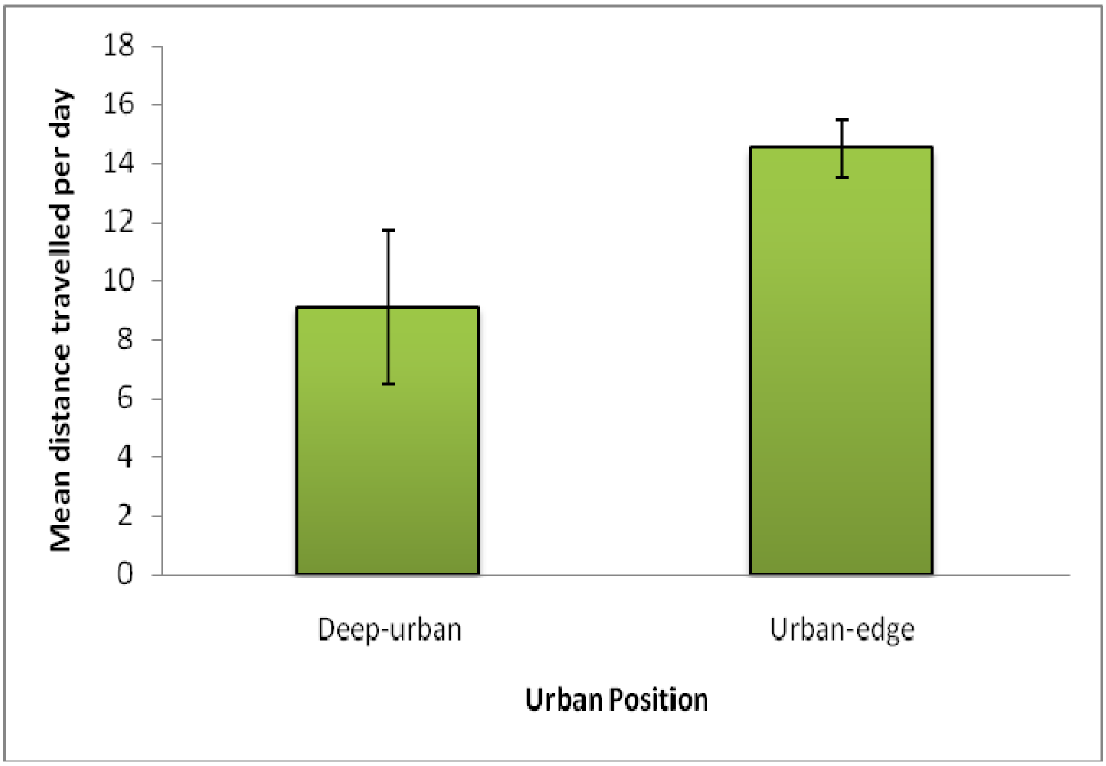



Figure 18. Mean (±SE) distance travelled per day for deep-urban and urban-edge cats. *(Error bars = 1SE)*

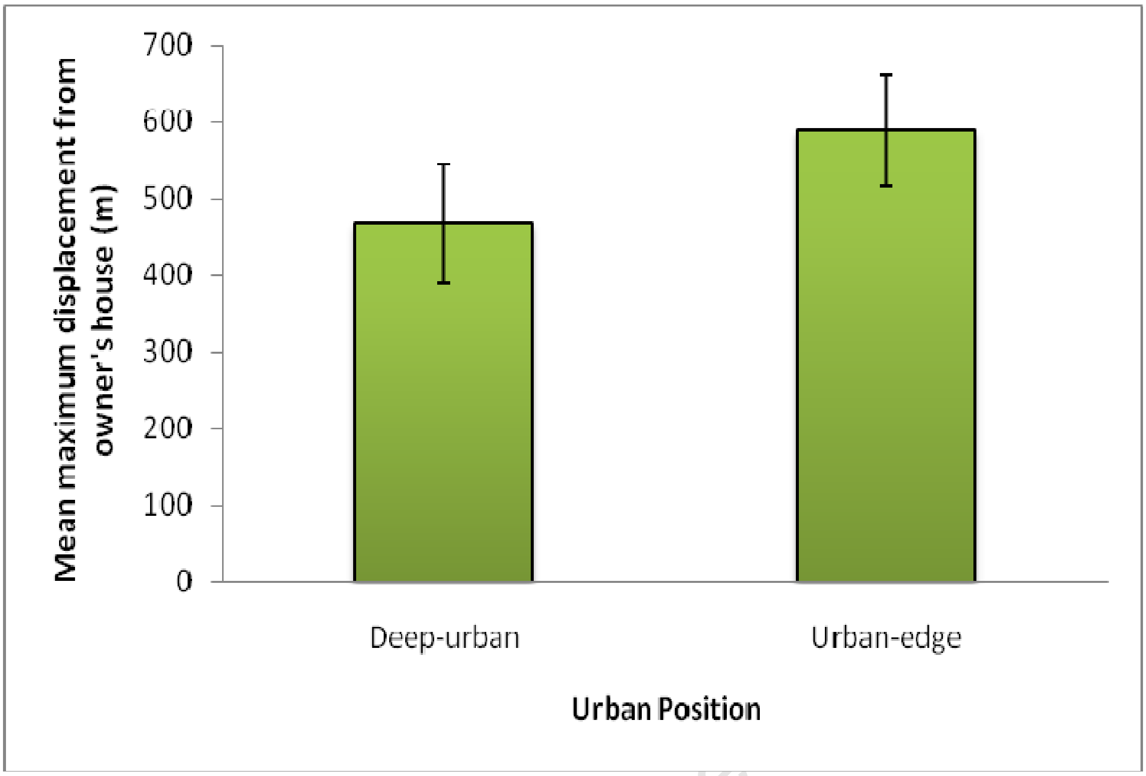



Figure 19. The mean maximum displacement from their owners house of deep-urban and urban-edge cats. *(Error bars = 1SE)*

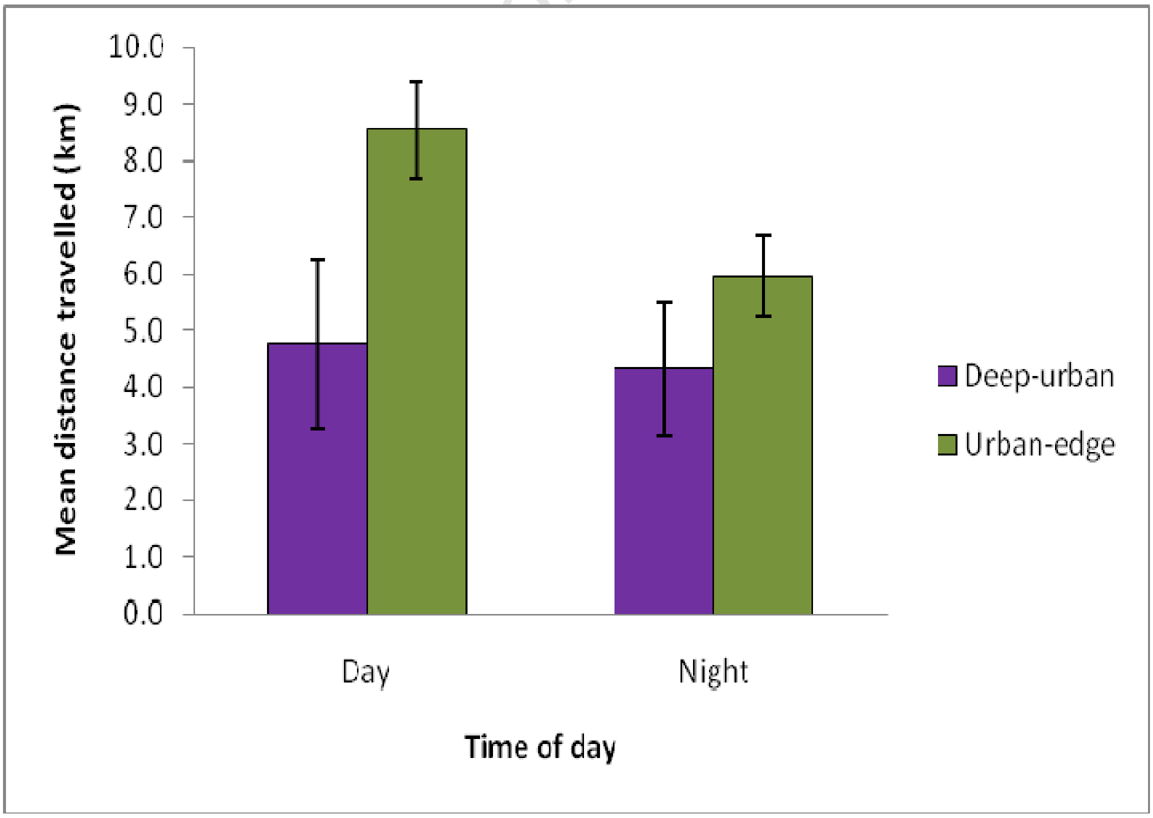



Figure 20. Total distance travelled during daylight and at night. *(Error bars = 1SE)*

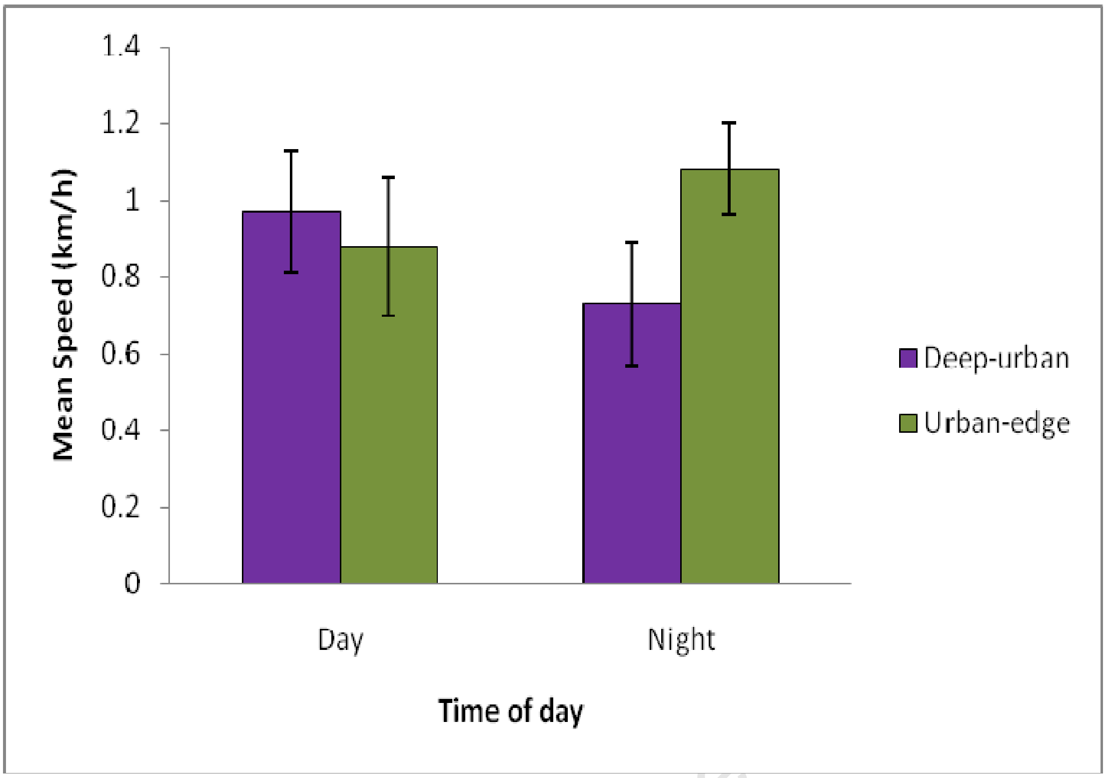



Figure 21. The mean speed during the day and night for deep-urban and urban-edge cats. *(Error bars = 1SE)*



**3.6 Movement in relation to green space**

In this section I assess, using the GPS data loggers how domestic cats use the habitat available to them and whether they venture into protected areas around Cape Town. The percentage of habitats available to deep-urban cats differed from that available to urban-edge cats. Only 2.6 ± 2.6 % of natural habitat was available to deep-urban cats while urban-edge cats had 55.3 ± 4.1 % available to them within their range as defined by the MCP. Urban-edge cats spent 17 ± 7.1 % of their time in natural habitat and deep-urban cats spent a mere 0.1 ± 0.1 % of their time in natural habitat. The difference between use and availability of natural habitat by urban and urban-edge cats was highly significant ($\chi^2$ = 27.7, df =1, P < 0.01)

On the other hand, deep-urban cats had 89.6 ± 4.5 % of urban habitat available to them and spent 98.9 ± 0.7 % of their time there. Urban-edge cats had a total of 36.9 ± 2.8 % of urban habitat available to them and spent 77.2 ± 7.0 % of their time there. The difference between use and availability of urban (built-up) habitats by deep-urban and urban-edge cats was highly significant ($\chi^2$ = 45, df = 1, P < 0.01).

The availability of green belts to deep-urban and urban-edge cats was similar (7.8 ± 2.6 % and 7.8 ± 2.1 % respectively of their MCP ranges). However, deep-urban cats only spent 1.1 ± 0.6 % of their time exploiting green belts while urban-edge cats spent 4.9 ± 3.5 % of their time in green belts (Figure 22). These differences were significant ($\chi^2$ = 6.8, df = 1, P < 0.01).

Time spent in urban habitat included time spent at home. Deep-urban cats spent more time at home (59.5 ± 8.5 %) than urban-edge cats (43.8 ± 15.3 (Figure 23), and this was marginally significant at p= 0.055 (Mann-Whitney U-test: U = 9.0). Time spent at home was not significantly different between male and female cats (Mann-Whitney U-test: U = 22, p = 0.85). Spearman's correlation analysis (N=14) indicated that the amount of time spent at home and the age of the cat was not significantly correlated (Rs = 0.52, p = 0.06).

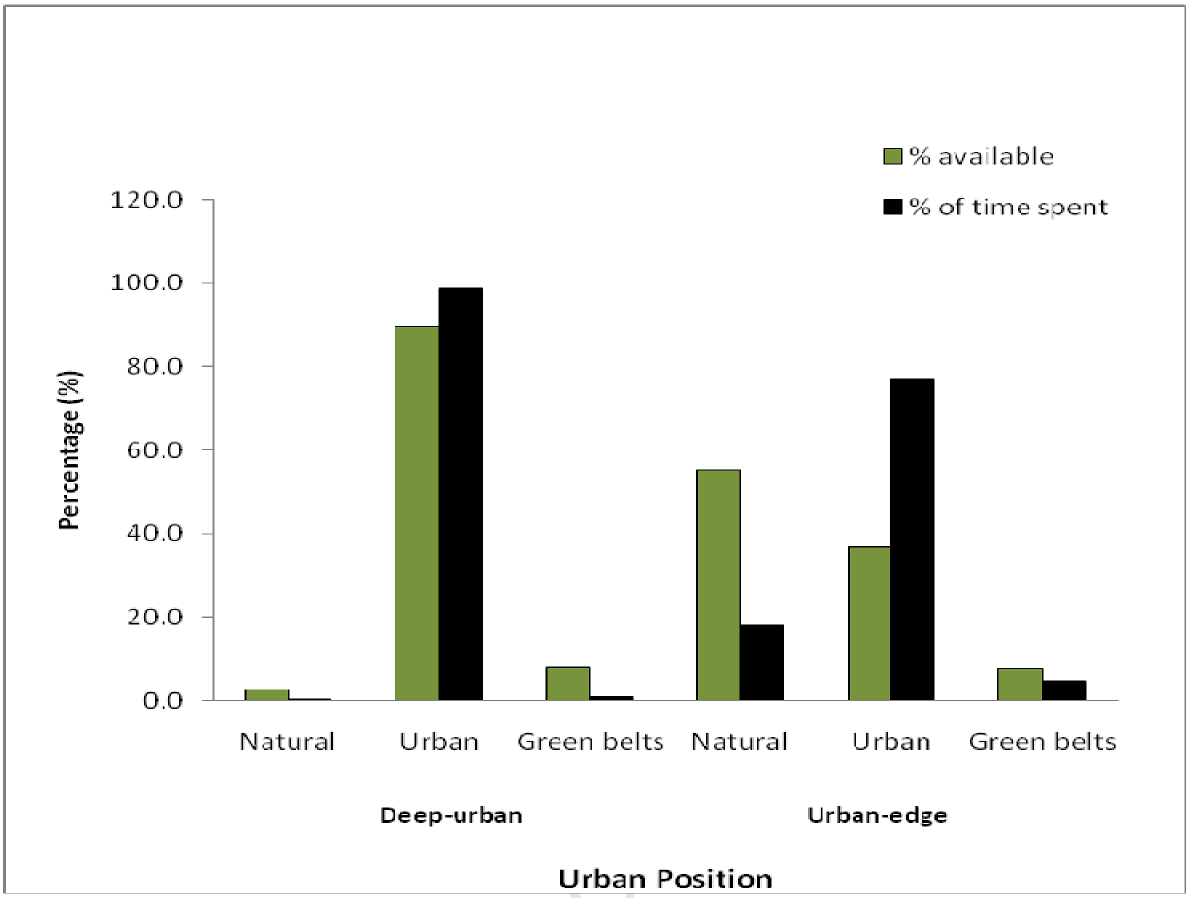



Figure 22. Proportion of habitat available and proportion of time spent within each habitat by both categories of cats.

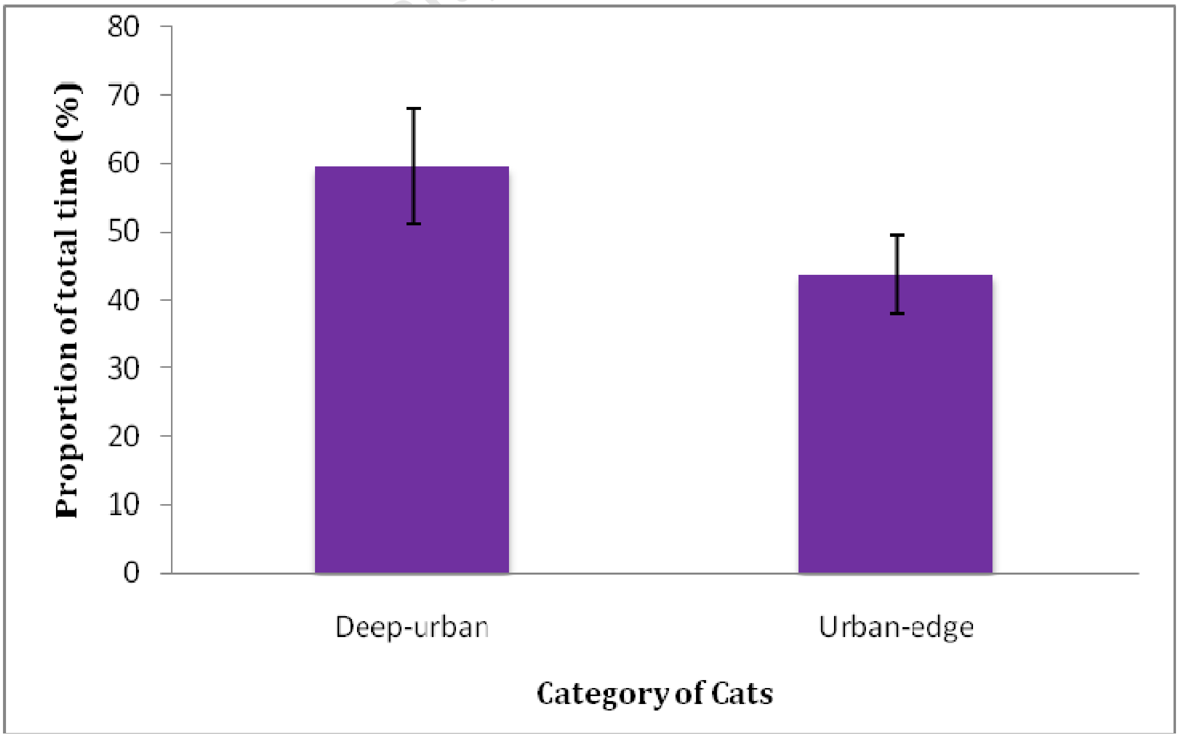



Figure 23. Proportion of time spent at home by both categories. *(Error bars = 1SE)*

# CHAPTER FOUR

# DISCUSSION

Domestic cats are a major predator of wild animals in many urban ecosystems simply because of their high densities and innate tendency to hunt. Though this impact and the accompanying control measures have been a source of some controversy, data on the numbers of prey animals affected and the factors that affect predation success is unknown in Africa. I did not intend to determine the impact of predation by cats on the population dynamics of their prey but rather to focus on the numbers of animals brought home by cats and to determine the factors that influence this. For this reason, no data on prey populations were collected.



This is the first study of domestic cat predation on mainland Africa and gives some of the first estimates of predation rates, systematic prey data, and the first data on temporal and spatial movement patterns and areas covered by GPS-tracked cats. While it breaks new ground in these areas it has various weaknesses that I consider below, in relation to other studies and how this study might be improved.

**Participants**

It is important to understand that data collected via public participation is subject to bias and has a number of limitations. The selection of participants was based mainly on the willingness of the cat owners to take part in the study. This could have led to an over-representation of cat owners keen to demonstrate the hunting prowess of their cats. On the other hand, some cat owners whose cats hunt frequently may have felt that they might face consequences if they reported this, and therefore either chose not to participate in the study or may not have been honest in reporting on the prey items brought in by their cats. Also, some cat owners whose cats brought in few prey might have chosen to consider that information as insignificant. There is also the risk of cat owners under-reporting as the study progressed simply because they had lost interest in the study. However, most of the cat owners that participated in this study seemed to have gained interest as the study progressed. There is no way of determining if the sample of cats or the behavior of these cats is representative of the population in general.

The general response and participation of the public in the survey was very poor with only 32 of 600 questionnaires being returned. The project in general was very challenging because of the way many cat owners perceived it. The majority of cat owners were unwilling to participate in the study because they felt it was 'against' cats and would lead to extreme measures being taken to control cat numbers.

**Domestic cat diet and predation rate**

Most studies that have investigated the diet of domestic cats did so for much longer than 10 weeks. Woods *et al.* (2003) conducted their survey over a 5-month period, Baker *et al.* (2005) over a 9-month period, Churcher and Lawton (1987), Baker *et al.* (2008), Morgan *et al.* (2009) and van Heezik *et al.* (2010) over a 12-month period. It therefore wouldn't make sense to use the simple average number of prey (total prey items returned/total number of cats) brought home as a measure of central tendency. However I have given a rate per 10-week period per cat to compare between studies: these figures are used below to gauge the Cape Town findings with other studies.  The simple average number of prey items brought home for this study was 3.67 items per cat over the 10-week study period. This was less than half that compared to the findings of Woods et al. (2003) who recorded an average of 8.3 items per cat per 10-week period in a 5-month study in the UK. However, it is slightly higher when compared to the findings of Churcher and Lawton (1987) who recorded a mean of only about 2.7 items per cat per 10-week period in a 12-month period in the UK. In Australia Barratt (1998) recorded even fewer prey (1.96 items per cat per 10-week period) over a 12-month. So, Cape Town's cats show slightly higher prey return rates than two of three other studies but seasonal differences were not accounted for in my study. Further studies carried out over a longer period of time in Africa are required to gain more accurate data. Further comparison between studies wouldn't make sense given that the different study areas are likely to have different characteristics (e.g. differences in prey abundance, climate and cat motivation).

One of the disadvantages of a short study such as this is that any seasonal variation in predation could not be accounted for. Seasonal weather variation and daily weather conditions are likely to influence the hunting behavior of cats as well as the abundance and availability of prey (including the seasonal cycles in availabilities of different prey types). Cats usually catch less prey in winter and on wet and windy days (Churcher and Lawton, 1987).

Like many previous investigators (Churcher and Lawton, 1987; Barratt, 1998; Woods *et al.,* 2003), I found great variation between individual cats in the both the number of prey items brought home as well as their movement patterns. This variation can be explained by characteristics of the cat, its household and the management regime used by the cat owners (Woods *et al.,* 2003).

While there was no significant difference in the mean daily predation rate between deep-urban and urban-edge cats when all cats (hunters and non-hunters alike) were considered, the study showed that when only those cats that actively hunted during the study were considered, urban-edge cats had a significantly higher mean daily predation rate (0.11 ± 0.02 prey/day) than deep-urban cats (0.06 ± 0.02 prey/ day). This almost doubling in predation rate is expected given that different habitats have different prey bases and that cats on the urban-edge are likely to have access to increased levels of available prey – especially native prey (Crooks *et al.,* 2004; van Heezik *et al.,* 2008; Sewell and Catterall, 1998). They may possibly face reduced levels of risk from dogs and other territorial cats. This could account for the urban-edge cats having substantially higher predation rates. Deep-urban cats are also subject to artificial barriers such as roads, railway lines and fences that may limit their movement and restrict their access to available prey. The Shannon-Weiner indices showed that prey diversity was slightly higher in urban-edge cats than in deep-urban cats. However, the Simpsons Reciprocal indices contradict this and show that prey diversity was higher in deep-urban cats than in urban-edge cats. Because of this inconsistency, I have been unable to draw any meaningful biological conclusions and further studies are required to investigate this aspect.

The number of prey brought home per day was significantly negatively correlated to the age of the cats. This has been reported in many other studies (e.g. Churcher and Lawton, 1987; Woods *et al.*, 2003). The study did not find any significant difference in the mean daily predation rate between male and female cats. Cats that had access to provisioned food at all times had slightly lower predation rates compared to those that were fed only twice or once a day (by 17% and 38% respectively). This finding however is inconsistent with the findings of other authors such as Barratt (1997a) and Meek (2003) whose studies showed that regular feeding by owners did not reduce the number of animals killed by cats. This inconsistency could be as a result of the small sample size used in this study. Further studies are required.

One of the aims of the study was to compare predation rates of cats that were sterile versus non-sterile cats, cats with bells versus those without bells, free roaming cats vs semi-restricted. However, this was not possible because all except two cat were sterilized, very few owners were willing to carry out the before and after bells experiment and the majority of cats (84%) were unrestricted free-roaming cats.



**Cat population estimates**

I estimated the cat population in Cape Town to be approximately 195, 443 animals. This figure relies on estimates from households with cats in only two suburbs of Cape Town (Hout Bay and Glencairn Heights) and the number of cats/household in these two locations as well as the average number of cats/household calculated from data in the questionnaires. It is important to note that the 'cats/household' figure that I estimated was based on a very small sample size which may have been subject to bias. I assumed that this was representative but this assumption may over-estimate the total cat population in Cape Town. Suburbs such as Rylands, Mowbray, Anthlone etc. are likely to have a reduced number of households with cats as well as the number of cats/household because cat ownership among students and certain racial groups has been reported to be less prevalent (AMPS Report on Dog and Cat Statistics, 2008). Areas like Cape Town's City Bowl are also likely to have a smaller cat population given that many residents live in high-rise apartments (where they are not permitted to own pets). However, the total number of cats did not take into account domestic cats in townships such as Guguletu and Khayelitsha. This may produce a minimal error given that the chances of people in the townships owning cats are very small (Y. Robson[6], pers. comm.). However, given these provisos my estimate was very close to that used by the cat food industry - 320 000 cats (AMPS Report on Dog and Cat Statistics, 2008), to market their products in the western Cape. Given that Cape Town is by far the largest centre of human population density (and thus domestic cats) my estimate appears to be relatively accurate.

I used the estimated cat population and the average rate of predation for urban and urban-edge cats combined (0.05prey/cat/day) and calculated that approx. 3.6 million prey per year are captured by Cape Town's domestic cats. For urban-edge cats, the majority of prey returned were small mammals as found in many other studies (e.g. Churcher and Lawton, 1987; Woods *et al.,* 2003; Baker *et al.,* 2005), but they included mainly native mammals and this is problematic on the edge of a National Park. For deep-urban cats, the majority of prey returned were invertebrates and this finding tallied with the findings of Gillies and Clout (2002). While I may have slightly over-estimated the total domestic cat population in the Cape Town region (above), the total predation is almost certainly under-estimated because it is based on the assumption that the cats brought

[6] Sunnydale Animal Sterilisation and Health Association, Cape Town. Email Id: sashapets@gmail.com

home all prey killed and that the rate at which prey is returned home is consistent for all cats. Cats that do not bring home any prey are either not killing any prey or are not bringing home their kills. Cats are highly unlikely to bring home all prey they kill even though George (1974), reported that the three farm cats he studied always brought the prey they killed back to his house or to the lawn. However, Baker *et al.* (2005) used a conversion factor of 3.3, based on the works of Kays and DeWan (2004) to estimate the actual number of prey killed. As noted by Baker *et al.*(2005) and Woods *et al.*(2003), who classified these types of cats as 'non-predatory' and 'non-retrieving' types of cats, this is likely to significantly underestimate the actual number of wild animals killed by domestic cats. The "under-estimation" factor of 3.3 given by Kays and DeWan (2004) is the only study able to quantify this parameter. Based on this, the actual number of wild animals being killed by Cape Town's domestic cats is predicted to be 11.9 million prey per year. However, there is need for additional studies to determine the consistency and accuracy of this estimate and, therefore, I conclude that between 2.9 and 11.9 million prey per year are killed by Cape Town's domestic cats.



**Cat movements in space and time**

A total of 14 cats were tacked using GPS loggers for a period of 5-10 days. Some surprising results were apparent: some cats ventured more than 800m from their homes and covered 51 ha when out hunting. This was always a surprise to the owners who were under the impression that their cats did not hunt far from home. Moreover, these data indicate much larger home ranges (below and Table 4) than found in other domestic cat studies. So, while the data obtained from this study were based on a very small sample over a very short time period, it suggests that Cape Town's cats range farther than most in the UK and Australia. Other studies have based their findings on even smaller samples (Edwards *et al.,* 2001; Tennent and Downs, 2008) although these cats were tracked over a much longer period of time. My initial plan was to track a minimum of 20-30 domestic cats with similar management regimes (e.g. with regards to feeding) for a standard 7 days. I had also hoped to be selective in my choice of the cats with regards to their sex, age, and breed to keep variation constant. However, this was not possible given the challenge it was to find cat owners willing to participate in the study. The result was that I worked with cat owners willing to volunteer their cats irrespective of the age, sex and breed of their cats.

The duration of 7 days was selected based on recommendations by van Heezik *et al.* (2010), that cats should be tracked for a period longer than 6 days. They tracked 32 cats for 6 days and carried out a sampling intensity-area analysis that indicated that asymptotes in home-range had been reached in 20 of the 32 cats in the 6 days. I was able to track 12 of the 14 cats for longer than the recommended 6 days to a get full home-range. Only two cats were tracked for less than 6 days due to logistical reasons. I only had three loggers to work with and they all had different levels of battery life. For this reason, some cat owners charged the loggers everyday while their cats were at home. While this inconsistency was beyond my control the analysis showed that the duration of the tracking was not correlated to the areas covered and distances travelled. However, ideally I advise that the tracking duration be kept standard for all individuals within a sample. I did not carry out a sample intensity-area analysis on my data and therefore the mean area covered by the domestic cats in this study should be considered a conservative 7-day home-range assessment.

Contrary to expectation, the mean area covered by urban-edge cats was not significantly larger when compared to deep-urban cats. I expected that deep-urban cats would be restricted by artificial boundaries and obstacles such as roads (with busy traffic), fences, buildings, railway lines, people and other cats etc. However, in many cases, the cats did cross busy highways on their way to urban gardens and other natural patches of land. However, the cat covering the largest area (51.15 ha) was a male, urban-edge cat that had access to a wetland and spent a substantial amount of time there. This individual also travelled the furthest from home (841 m). A female, deep-urban cat covered the smallest area (0.57 ha) and value that was much smaller when compared to the other 13 cats. This could simply have been as a result of the individual cat's personality as well as the fact that the cat was 11 yrs of age.

The estimated mean area covered (by the MCP method) by the domestic cats in Cape Town was ten fold higher relative to other studies (Table 4). I only compared the findings of my study to the findings of other similar studies that involved domestic cats and *not* feral cats. The cats in this study had a much higher mean 7-day home range even in comparison with the 12-month home-range of domestic cats in South Island, New Zealand (Morgan *et al.*, 2009). This is not readily explained but is more likely to arise from differences in prey density close at hand and the risks involved in venturing far from the safety of home. One possible explanation why cats in this study covered much larger areas than cats in other studies is that all (except two) cats in this study were sterilized and these cats were therefore less territorial allowing them more freedom to move over large areas without being challenged by other territorial cats (more so for male cats than for females). Direct comparisons between studies must take into account variables such as the different continents (albeit with temperate climates), differing prey base, possible cat density and the different methods in which data have been obtained (e.g. using GPS trackers/loggers or using VHS transmitters).

Table 4. Comparison of the mean area covered by adult domestic cats across published studies.

| Source | Type of Cat | Location | Duration | Mean area (ha) |
|---|---|---|---|---|
| This study | Domestic | Cape Town, South Africa | 5-10 days | 31.65 (MCP) |
| van Heezik *et al*. (2010) | Domestic | Dunedin, New Zealand | 6 days | 3.2 (MCP) |
| Morgan *et al*. (2009) | Domestic | South Island, New Zealand | 12 months | 1.8 (MCP) |
| Kays and De Wan (2004) | Domestic | New York, United States of America | 4 months | 0.24 (MCP) |
| Meek (2003) | Domestic | Sydney, Australia | 7 days | 2.92 (MCP) |
| Barratt (1997a) | Domestic | Canberra, Australia | 9 months | 2.7(day)-7.9(night) (MCP) |

Fixed kernel estimates for total areas covered were much smaller than MCP areas as expected. The MCP areas included sites that were rarely visited, whereas the fixed kernel areas encompassed areas covered by the cats very frequently such the cat owners' yards and immediate neighbourhoods. Core kernel areas were in most cases areas that encompassed the individual cats'/cat owners' houses.

The mean area covered (MCP), the mean fixed kernel estimate and mean core area covered were not significantly different for male and female cats. This was also found in other studies such as Barratt (1997a), Meek (2003), Morgan *et al.* (2009) and van Heezik *et al.* (2010). However, male cats have been reported to have much larger home-ranges than female cats (Liberg *et al.,*2000). This is usually the case for unsterilized male cats (both domestic and feral) that have home-ranges 3.5 times the size that of female cats (Liberg *et al.,*2000). The fact that all cats in my study were sterilized can explain why the mean area covered by male and female cats did not differ significantly. There was also no correlation between the mean area covered and the age of the cats. This finding was inconsistent with other studies that have shown a negative correlation between age and the mean area covered/distances travelled. Younger cats usually travel more than older cats in order to avoid other territorial cats (Liberg *et al.,* 2000; Morgan *et al.,* 2009). Again, the small sample in this study may explain the result for Cape Town's cats.



**Diurnal vs nocturnal activity**

The study showed that both deep-urban and urban-edge cat travelled significantly more during the day than at night. Deep-urban cats also travelled slightly faster (though not significantly so) during the day than at night. These findings suggest that domestic cats in Cape Town are probably more active (and therefore hunt more) during the day than at night. This might be attributed to the management regime adopted by cat owners that ensure that their cats are conditioned to come home and spend the night indoors (for most of the night – voluntarily). Deep-urban cats travelled faster during the day possibly due to the disturbances that surround these cats such as traffic, people and dogs. Analyses of the data did not distinguish the crepuscular hours from other periods and only divided the day into ‘day’ and ‘night’. In hindsight this would have been useful to determine if Cape Town cats are also most active then.

The difference between use and availability of natural habitat by deep-urban and urban-edge cats was highly significant. Deep-urban cats barely spent any time within natural habitat and spent most of their time in urban habitat (including their home). Though urban-edge cats spent more time in natural habitat than deep-urban cats, they also spent a significant amount of time within urban habitat. This is expected given that urban habitat included the cats’ houses and it is only natural that they would spend more time close to home/their owners. Male and female cats in this study did not differ in the amount of time they spent at home. As before, this could arise from the fact that all cats in this study were sterilized.

## CHAPTER FIVE

## CONCLUSIONS AND RECOMMENDATIONS

In conclusion, this study found that domestic cats in Cape Town are major predators of wildlife. I found that Cape Town's estimated cat population of 272 189 cats, capture approximately 5.2 million prey per year. The main target group for deep-urban cats was invertebrates, which included moths, stick insects, spiders, scorpions, cockroaches, grasshoppers, dragonflies and beetles. The main target group for urban-edge cats was small mammals, which included native mice, rats, shrews, moles and squirrels with the Striped Mouse (*Rhabdomys pumilio*) being the most common prey item. Other target groups included reptiles with the main prey item being he Rock Agama (*Agama agama*); birds with the main prey item being the European Starling (*Sturnus vulgaris*); and amphibians with the main species being the Cape Rain Frog (*Breviceps gibbbosus*). While the study cats did catch prey that are considered pests such as rats and European starlings, they also caught mainly indigenous species such as vlei rats and Red-winged starlings. From a conservation view, the most significant of the prey items collected was the endemic Cape Rain Frog (*Breviceps gibbbosus*), listed as Vulnerable by the IUCN. Predation rates were also slightly higher for urban-edge cats than for deep-urban cats. This may simply arise because urban-edge cats have access to natural areas with much higher levels of prey abundance compared to deep-urban cats. There was no significant correlation between supplemental feeding and prey return rates though cats that had access to food at all times had slightly lower predation rates compared to those cats that were fed only once or twice a day (by 17% and 38% respectively). The study found that the number of prey brought home per day was negatively correlated to the age of the cats. Cats above the age of 13 did not hunt at all. Prey return rates were not significantly different between male and female cats. Movement patterns by both deep-urban and urban-edge cats were not affected by the age or the sex of the cats. Urban-edge cats were found to venture into Table Mountain National Park and other natural areas such as wetlands. A male urban-edge cat covered the largest area (51.15 ha) and a female urban-edge cat travelled the furthest away from home (849m). There was no significant difference in the mean area covered or the mean maximum displacement from home between deep-urban and urban-edge cats. Both deep-urban and urban-edge cats travelled significantly more during the day than at night. Deep-urban cats spent significantly more time at home than urban-edge cats. Urban-edge cats spent more time in natural areas than deep-urban cats but both categories of cats spent significantly more time in urban/built-up areas than in natural areas.

There has been a growing interest by local authorities, conservation biologists and members of the public to protect environmentally sensitive areas from the predation impacts of domestic cats. The data generated from this study provides only the first indication of the scale of predation for Cape Town's cats. Further long-term studies are required to determine the magnitude, extent and the nature of the impact that domestic cats have on their prey populations. This is essential in order to make stronger inferences and develop more specific recommendations. However, based on the findings and challenges/weaknesses of this study, the following recommendations are made:

**Recommendations for the management of domestic cats in urban and peri-urban areas**

1. Consult and educate cat owners on responsible pet ownership (e.g. keeping their cats within an enclosed area during certain times of the day, sterilizing their cats etc.). This is probably the best way to ensure the implementation of cat management strategies will be successful. Owners need to be informed of the benefits this has to protecting not only native wildlife but also their pet cats.

2. Sterilize owned cats. Cat owners should be responsible and ensure that their cats are sterilized to prevent unwanted litters of kittens that will eventually contribute to the feral and stray pool. Sterilized cats are known to live longer, are less territorial, wander less and make better pets.

3. Make it compulsory for all cat owners to bell their cats. The effect of bells on the predation rate of domestic cats has shown conflicting results. In the earliest studies Paton (1991) and Barratt (1998), found that bells had no apparent effect on the predation rates of domestic cats. However, their studies were not experimental and were therefore of limited use. Since then every study has shown an effect: a study by Ruxton *et al.* (2002), showed than bells on collars reduced predation rate of domestic cats by 50%. Another study conducted by Woods *et al*. (2003), showed that bells reduced the number of mammals brought home by cats. The same study found that though bells might have warned smaller mammals of the presence of the cat, they had no effect on the capture rates of birds and herpetofauna (Woods *et al*., 2003). The most recent experimental study

conducted in New Zealand by Gordon *et al.* (2010) over a 12-week period (6-weeks without bells and 6-weeks with bells) confirms that bells reduced the predation of birds and rodents by 50% and 61% respectively. So while cats with bells on their collars for long period of time may adapt their hunting behavior to reduce the effects of the bell (Ruxton *et al.*, 2002), the use of bells on collars appears to show a reduction in prey capture success. An alternative approach tested the efficacy of a collar-worn pounce protector called the 'CatBib'. These CatBibs stopped 81% of cats from catching birds, 45% from catching mammals and 33% from catching herpetofauna (Calver *et al.*, 2007). Both methods should be tested in an African setting.

4. Prevent cats from roaming by introducing cat curfews. Night curfews are likely to reduce predation of nocturnal mammals by domestic cats but will have no effect on the predation impact on diurnal bird and reptile species. Recent studies have shown that modern domestic cats have shifted their hunting activities into the daylight hours compared to their wild ancestors (McCarthy, 2005). For this reason, cat confinement (24 hours cat curfews) is recommended. This requires the confinement of domestic cats to the owner's premises at all times. These cats could either be indoors or allowed access to an outdoor cat enclosure. Continuous curfews may eventually modify cat behaviour away from hunting prey (Meek, 2003). This is likely to be a highly contentious issue and implementation and enforcement of these curfews are likely to be very challenging. Cat owners are likely to view confinement as a cruel and unnatural way of managing cats. However, this need not be true provided cats are allowed access to outdoor cat

enclosures with an enriched environment to ensure that they are able to exercise and stay entertained. Cat owners need to be informed of the benefits of keeping their cats confined. Confined cats are protected from being hit by cars, injured by other cats and dogs and from catching diseases from stray and feral cats. Confining cats also reduces the chances of domestic cats transmitting diseases such as toxoplasmosis (Dickman, 1996; McCarthy, 2005).

5. Either introduce cat-exclusion zones or enforce strict management regulations in specific areas such as areas adjacent to delicate protected areas. This option should be considered with caution by local authorities and must only be enforced if it is absolutely necessary.

6. Limit the number of cats per household.

7. Feed your cats more than twice a day. Several authors have suggested that even well fed cats pose a threat to native wildlife because hunger has nothing to do with the level of hunting in domestic cats (Meek, 2003; Hutchings, 2003; Longcore *et al.*, 2009). Studies have shown that even well fed cats hunt and kill small mammals, birds, lizards and insects (Liberg, 1984; Hutchings, 2003) as was the case documented by George (1974), who reported that the three cats he studied made continuous kills over 4 years despite the fact that they were well fed. The findings of this study, however, showed that the cats that had access to food at all times had lower predation rates (by 38%) than those than were fed only once a

day. This requires further examination through experimental testing of ad-libidum vs once-a-day feeding for target cats.

Though there have been several arguments for and against the recommendations made above, it is only safe to apply the precautionary principle given that we know very little regarding the impact of Cape Town's cats on native wildlife populations. While we have established that the cats in Cape Town are impacting wildlife, the big question is whether the impact of these cats is significantly affecting species population dynamics. The degree to which the above recommendations should be enforced will be determined by the severity of this impact. The precautionary principle states that given the seemingly large numbers of prey taken, and the wide ranging behaviour of Cape Town's cats relative to cats elsewhere, that these recommendations must be implemented if we are to reduce the impact on our remaining fauna.



**Recommendations for future studies:**

1. Recruit participants (cat owners) well in advance of the study. This will ensure a larger and more representative sample of cats and will also enable the researcher to be selective in the choice of cats that are to be studied. This will also enable the researcher to determine the factors that affect predation rates (e.g. sterilized vs. unsterilized cats, free-roaming cats vs. semi-confined cats, cats with bells vs. cats without bells, and well-fed vs less well fed animals).

2. Design the questionnaire in such a way that it is attractive and stimulates interest and curiosity without scaring participants off by using words such as 'impacts of

3. The prey-recording exercise should ideally be carried out over a longer period of time (at least a year) and take into consideration factors such as weather and seasonal variation.

4. Information on prey abundance and diversity should be obtained in order to determine the magnitude and significance of predation impact on prey populations. For specific areas, this could be done by conducting a before and after experiment (i.e. determine prey abundance in an area without cats and determine the prey abundance of the same area after the introduction of cats).

5. Estimate the proportion of prey returned home of the actual number of prey killed in order to determine a consistent conversion factor. This requires detailed observation of cats in the field. Physically following cats for this purpose might be difficult unless a high vantage point with night-vision equipment is available. However, an alternative way is to attach a 'cat cam' (a small video camera) to the collars of cats.

6. Determine whether bells on collars actually reduce predation rates by carrying out a before and after bells-on-collars experiment.

7. Determine the cat population by conducting door-to-door surveys and/or conducting telephone interviews in more than two suburbs to obtain data on the number of cat owners and the number of cats per household. This will result in a more representative estimate of the actual cat population.

8. Track a larger sample of cats (at least 30 deep urban cats and 30 urban-edge cats). Ensure that these cats have similar management regimes and characteristics (e.g. ideally a balanced number of males and females within each category and ideally all cats are free-roaming).

9. Track these cats for a longer period of time to determine both the 24-hour home range and the long term home range. While 6 days has been reported to be sufficient to record a conservative home range (van Heezik *et al.*, 2010), I suggest that domestic cats should be tracked for at least 3-4 weeks. One important step in determining how many days a domestic cat should be tracked for to reveal its full home range size is to carry out a sampling intensity-area analysis.

10. The GPS loggers used for the study should also have VHF radio transmitters to enable the location of lost collars.

11. The GPS loggers/trackers should have increased battery life (at least 5 days) to enable continuous tracking and avoid having to remove the collars every day or every second day to re-charge them. This will result in more accurate tracks and

avoid the assumption that the cats were at home while the loggers/trackers were charging.

12. Account for location error and habitat biases. Use GPS trackers that provide an HDOP (Horizontal Dilution of Precision) value per location. This would give an indication of the error associated around each location.

13. Track data should be divided based on the time of the day and should include the crepuscular period for more detailed analysis.

## REFERENCES

Alley Cat Allies. 2005. Understanding cats and predation. Alley Cat Allies, Bethesda, Maryland.

AMPS. 2008. Main Branded AB: Jan 2008 - Dec 2008. South Africa.

Apps, P. J. 1986. Home ranges of feral cats on Dassen Island. Journal of Mammology **67**: 199-200.

Atkinson, I. 1989. Introduced animals and extinctions. Pages 54-75 in D. Western and M. C. Pearl, editors. Conservation for the twenty-first century. Oxford University Press, New York.

Atkinson, I. A. E. 1996. Introductions of wildlife as a cause of species extinctions. Wildlife Biology **2**: 135-141.

Baker, P. J., A. J. Bentley, R. J. Ansell, and S. Harris. 2005. Impact of predation by domestic cats *Felis catus* in an urban area. Mammal Review **35**: 302-312.

Baker, P. J., S. E. Molony, E. Stone, I. C. Cuthill, and S. Harris. 2008. Cats about town: is predation by free-ranging pet cats *Felis catus* likely to affect urban bird populations? Ibis **150**: 86-99.

Barnes, K. N., editor. 2000. The Eskom red data book of birds of South Africa, Lesotho and Swaziland. Birdlife South Africa, Johannesburg.

Barratt, D. G. 1997a. Home range size, habitat utilization and movement patterns of suburban and farm cats *Felis catus.* Ecography **20**: 271-280.

Barratt, D. G. 1998. Predation by house cats, *Felis catus* (L.), in Canberra, Australia II. Factors affecting the amount of prey caught, and estimates of the impact on wildlife. Wildlife Research **25**: 475-487.

Beckerman, A. P., M. Boots, and K. J. Gaston. 2007. Urban bird declines and the fear of cats. Animal Conservation **10**: 320-325.

Bester, M. N., J. P. Bloomer, R. J. van Aarde, B. H. Erasmus, P. J. J. van Rensburg, J. D. Skinner, P. G. Howell, and T. W. Naude. 2002. A review of the successful eradication of feral cats from sub-Antarctic Marion Island, Southern Indian Ocean. South African Journal of Wildlife Research **32**: 65-73.

Bradt, G. W. 1949. Farm cat as a predator. Michigan Conservation **18**: 23-25.

Branch, W. R. 1988. South African red data book – reptiles and amphibians: a report of the Committee for Nature and Conservation National Program for Ecosystem Research. Pretoria. CSIR Report 151.

Brickner, I. 2003. The impact of domestic cats (*Felis catus*) on wildlife welfare and conservation: a literature review. Tel Aviv University, Isreal.

Butchart, S. H. M., A. J. Stattersfield, and T. M. Brooks. 2006. Going or gone: 'Possibly extinct' species to give a truer picture of recent extinctions. Bull. B.O.C. 126 A.

Calver, M., S. Thomas, S. Bradley, and H. McCutcheon. 2007. Reducing the rate of predation on wildlife by pet cats: The efficacy and practicability of collar-mounted pounce protectors. Biological Conservation **137**: 341-348.

Churcher, P. B., and J. H. Lawton. 1987. Predation by domestic cats in an English village. Journal of Zoology, London **212**: 439-455.

City of Cape Town. 2010. Household Numbers in Cape Town – Discussion Document

.

<http://www.capetown.gov.za/en/stats/Documents/Households.htm>

Coleman, J. S., and S. A. Temple. 1996. On the prowl. Wisconsin Natural Resources **20**: 4-8.

Coleman, J. S., S. A. Temple, and S. R. Craven. 1997. Cats and wildlife: A conservation dilemma. <http://wildlife.wisc.edu/extension/catfly3.htm>.

Coman, B. J., and H. Brunner. 1972. Foods habits of the feral house cat in Victoria. Journal of Wildlife Management **36**: 848-853.

Conservation International. 2008. The encyclopedia of earth: Biological diversity in the Cape Floristic Region. <http://www.eoearth.org/article/Biological_diversity_in_the_Cape_Floristic_Region>.

Courchamp, F., M. Langlais, and G. Sugihara. 1999. Cats protecting birds: modeling the mesopredator release effect. Journal of Animal Ecology **68**: 282-292.

Crooks, K. R., and M. E. Soule. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature **400**: 563-566.

Crooks, K. R., A. V. Suarez, and D. T. Bolger. 2004. Avian assemblages along a gradient of urbanization in a highly fragmented landscape. Biological Conservation **115**: 451-462.

Davey, C., A. R. E. Sinclair, R. P. Pech, A. D. Arthur, C. J. Krebs, A. E. Newsome, D. Hik, R. Molsher, and K. Allcock. 2006. Do vertebrates structure the biota of Australia? An experimental test in New South Wales. Ecosystems **9**: 992-1008.

D'Eon, R. G., R. Serroya, G. Smith, and C. O. Kochanny. 2002. GPS radiotelemetry error and bias in mountainous terrain. Wildlife Society Bulletin **30**: 430-439.

Denny, E., P. Yakovlevich, M. Eldridge, and C. Dickman. 2002. Social and genetic analysis of a population of free-living cats exploiting a resource rich habitat. Wildlife Research **29**: 405-413.

Dickman, C. R. 1996. Overview of the impacts of feral cats on Australian Native Fauna. Australian Nature Conservation Agency. Canberra.

Dickman, C. R., R. L. Pressey, L. Lim, and H. E. Parnaby. 1993. Mammals of particular conservation concern in the Western division of New South Wales. Biological Conservation **65**: 219-248.

Edwards, G. P., N. de Preu, B. J. Shakeshaft, I. V. Crealy, and R. M. Paltridge. 2001. Home range and movements of male feral cats (*Felis catus*) in a semiarid woodland environment in central Australia. Australian Ecology **26**: 93-101.

Fitzgerald, B. M. 1988. Diet of domestic cats and their impact on prey populations. Pages 123-150 in D. C. Turner and P. Bateson, editors. The domestic cat: The biology of its behavior. Cambridge University Press, Cambridge, United Kingdom.

Fitzgerald, B. M. 1990. Is cat control needed to protect urban wildlife? Environmental Conservation **17**: 168-169.

Fitzgerald, B. M., and D. C. Turner. 2000. Hunting behavior of domestic cats and their impact on prey populations. Pages 151-175 in D. C. Turner and P. Bateson, editors. The domestic cat: The biology of its behavior. Cambridge University Press, Cambridge, United Kingdom.

Flux, J. E. C. 2007. Seventeen years of predation by one suburban cat in New Zealand. New Zealand Journal of Zoology **34**: 289-296.

Fuller, E. 2000. Extinct birds. Oxford University Press, Oxford, United Kingdom.

Galbreath, R., and D. Brown. 2004. The tale of the lighthouse-keeper's cat: discovery and extinction of the Stephens Island wren (*Traversia lyalli*). Notornis **51**: 193-200.

Gaston, K. J., P. H. Warren, K. Thompson, and R. M. Smith. 2005. Urban domestic gardens (IV): the extent of the resource and its associated features. Biodiversity Conservation **14**: 3327-3349.

George, W. G. 1974. Domestic cats as predators and factors in winter shortages of raptor prey. The Wilson Bulletin **86**: 384-396.

Gibbons, J. 1984. Iguanas of the South Pacific. Oryx **18**: 82-91.

Gibson, D. F., G. Lundie-Jenkins, D. G. Langford, J. R. Cole, D. E. Clarke, and K. A. Johnson. 1994. Predation by feral cats, *Felis catus,* on the rufous hare-wallaby, *Lagorchestes hirsutus,* in the Tanami Desert. Australian Mammal **17**: 103-107.

Gillies, C. A. 2007. Notes on New Zealand mammals 5. How far did a neighbour's pet cat venture into Trounson Kauri park? New Zealand Journal of Zoology **34**: 335-336.

Gillies, C., and M. Clout. 2003. The prey of domestic cats (*Felis catus*) in two suburbs of Auckland City, New Zealand. Journal of Zoology, London **259**: 309-315.

Gordon, J. K., C. Matthaei, and Y. van Heezik. 2010. Belled collars reduce catch of domestic cats in New Zealand by half. Wildlife Research **37**: 372-378.

Harper, G. A. 2007. Habitat selection of feral cats (*Felis catus*) on a temperate, forested island. Austral Ecology **32**: 305-314.

Hutchings, S. 2003. The diet of feral house cats (*Felis catus*) at a regional rubbish tip, Victoria. Wildlife Research **30**: 103-110.

IUCN. 2009. <http://www.iucn.org/iyb/about/biodiversity_crisis/>

Iverson, J. B. 1978. The impact of feral cats and dogs on populations of the West Indian rock iguana, *Cyclura carinata.* Biological Conservation **14**: 63-73.

Jarvis, P. 1990 Urban cats as pests and pets. Environmental Conservation. **17**: 169-171.

Jones, E., and B. Coman. 1982. Ecology of the feral cat, *Felis catus*, in South-Eastern Australia; Home ranges and population ecology in semi-arid North-west Victoria. Australian Wildlife Research **9**: 409-420.

Kawakami, K., and H. Higuchi. 2002. Bird predation by domestic cats on Hajima Island, Bonin Islands, Japan. Ornithological Science **1**: 143-144.

Kays, R., and A. DeWan. 2004. Ecological Impact of inside/outside house cats around a suburban nature preserve. Animal Conservation **7**: 273-283.

Kirkpatrick, R. D., and M. J. Rauzon. 1986. Foods for feral cats *Felis catus* on Jarvis and Howland Islands, central Pacific Ocean. Biotropica **18**: 72-75.

Konecny, M. J. 1987. Food habits and energetics of feral house cats in the Galapagos Islands. Oikos **50**:24-32.

Lepczyk, C. A., A. G. Mertig, and J. G. Liu. 2003. Landowners and cat predation across rural-to-urban landscapes. Biological Conservation **115**: 191-201.

Lever, C. 1994. Naturalized animals. T and A.D. Poyser Natural History, London.

Levy, J. K., J. E. Woods, S. L. Turick, and D. L. Etheridge. 2003. Number of unowned free-roaming cats in a college community in the southern United States and the characteristics of community residents who feed them. Journal of American Veterinary Medical Association **223**: 202-205.

Liberg, O. 1984.Food habits and prey impact by feral and house-based domestic cats in a rural area in southern Sweden. Journal of Mammalogy **65**: 424-432.

Liberg, O., M. Sandell, D. Pontier, and E. Natoli. 2000. Density, spatial organization and reproductive tactics in the domestic cat and other felids. Pages 119-147 in D. C. Turner and P. Bateson, editors. The domestic cat: The biology of its behavior. Cambridge University Press. Cambridge.

Lilith, M. 2007. Do pet cats (*Felis catus*) have an impact on species richness and abundance of native mammals in low-density Western Australian suburbia? PhD Thesis. Murdoch University, Perth, Western Australia.

Lilith, M., M. Calver, I. Styles, and M. Garkaklis. 2006. Protecting wildlife from predation by owned domestic cats: Application of a precautionary approach to the acceptability of proposed cat regulations. Austral Ecology **31**: 176-189.

Lima, S. L. 1987. Clutch size in birds: a predation perspective. Ecology **68**: 1062-1070.

Longcore, T., C. Rich, and L. M. Sullivan. 2009. Critical assessment of claims regarding management of feral cats by Trap-Neuter-Return. Conservation Biology **23**: 887-894.

Lowe, S., M. Browne, and S. Boudjelas. 2000. 100 of the world's worst invasive alien species: a selection from the global invasive species database. Invasive Species Specialist Group, International Union for Conservation of Nature, Auckland, New Zealand.

Mack, R. N., D. Simberloff, W. M. Lonsdale, H. Evans, M. Clout, and F. A. Bazzazz. 2000. Biotic invasions: causes, epidemiology, global consequences, and control. Ecological Applications **10**: 689-710.

May, R. M. 1988. Control or feline delinquency. Nature **332**: 392-393.

McCarthy, S. 2005. Managing impacts of domestic cats in peri-urban reserves. Urban Animal Management Conference Proceedings 2005.

Mead, C. J. 1982. Ringed birds killed by cats. Mammal Review **12**: 183-186.

Meek, P. D. 2003. Home range of house cats *Felis catus* living within a National Park. Australian Mammalogy **25**: 51-60.

Mills, G. S., J. B. Dunning Jr., and J. M. Bate. 1989. Effects of urbanization on breeding bird community structure in southwestern desert habitats. The Condor **91**: 416-428.

Mirmovitch, V. 1995. Spatial organization of urban feral cats (*Felis catus*) in Jerusalem. Wildlife Research **22**: 299-310.

Molsher, R. L. 2001. Trapping and demographics of feral cats (*Felis catus*) in central New South Wales. Wildlife Research **28**: 631-636.

Molsher, R. A. N., and C. Dickman. 1999. Feeding ecology and population dynamics of the feral cat (*Felis catus*) in relation to the availability of prey in central-eastern New South Wales. Wildlife Research **26**: 593-607.

Molsher, R., C. Dickman, A. Newsome, and W. Muller. 2005. Home ranges of feral cats (*Felis catus*) in central-western New South Wales, Australia. Wildlife Research **32**: 587-595.

Moodie, E. 1995. The potential for biological control of feral cats in Australia. Report to ANCA, Canberra.

Moors, P. J. 1985. Conservation of island birds: case studies for the management of threatened island birds. International Council for Bird Preservation, Cambridge, United Kingdom.

Morgan, S. A. 2002. Movements and hunting activity of house cats (*Felis catus*) living around Travis Wetland, Christchurch, New Zealand. Masters Thesis, Lincoln University, Christchurch.

Morgan, S. A., C. M. Hansen, J. G. Ross, G. J. Hickling, S. C. Ogilvie, and A. M. Paterson. 2009. Urban cat (*Felis catus*) movement and predation activity associated with a wetland reserve in New Zealand. Wildlife Research **36**: 574-580.

Myers, N. 1990. The Biodiversity Challenge: Expanded Hot-Spots Analysis. Environmentalist **10**: 243-256.

Nogales, M., J. C. Rando, A. Valido, and A. Martin. 2001. Discovery of a living giant lizard, genus *Gallotia* (Reptilia: Lacertidae), from La Gomera, Canary Islands. Herpetologica **57**: 169-179.

Nogales, M., A. Martin, B. R. Tershy, C. J. Donlan, D. Veitch, N. Puerta, B. Wood, and J. Alonso. 2004. A review of feral cat eradication on islands. Conservation Biology **18**: 310-319.

Paton, D. C. 1991. Loss of wildlife to domestic cats. Pages 64-69 in C. Potter, editor. Proceedings of a workshop on the impact of cats on native wildlife. Australian National Parks and Wildlife Service, Canberra.

Paton, D. 1993. Impacts of domestic and feral cats on wildlife. Pages 9-15 in G. Siepens and C. Owens, editors. Cat Management Workshop; Proceedings 1993. Queensland Department of Environment and Heritage: Brisbane.

Picker, M. D., and M. J. Samways. 1996. Faunal diversity and endemism of the Cape Peninsula, South Africa. Biodiversity and Conservation **5**: 591-606.

Preisser, E. L., D. I. Bolnick, and M. F. Benard. 2005. Scared to death? The effects of intimidation and consumption in predator-prey interactions. Ecology **86**: 501-509.

Randi, E., and B. Ragni. 1991. Genetic variability and biochemical systematics of domestic and wildcat populations (*Felis sylvestris:* Felidae). Journal of Mammalogy **72**: 79-88.

Rayner, M. J., M. E. Hauber, M. J. Imber, R. K. Stamp, and M. N. Clout. 2007. Spatial heterogeneity of mesopredator release within an oceanic island system. PNAS **104**: 20862-20865.

Ruxton, G. D., S. Thomas, and J. W. Wright. 2002. Bells reduce predation of wildlife by domestic cats. Journal of Zoology **256**: 81-83.

Say, L., J. M. Gaillard, and D. Pontier. 2002. Spatio-temporal variation in cat population density in a sub-Antarctic environment. Polar Biology **25**: 90-95.

Schmidt, P. M., R. R. Lopez, and B. A. Collier. 2007. Survival, fecundity and movements of free-roaming cats. Journal of Wildlife Management **71**: 915-919.

Serpell, S. A. 1988. The domestication of the cat. Pages 123-147 in D. C. Turner and P. Bateson, editors. The domestic cat: The biology of its behavior. Cambridge University Press. Cambridge.

Sewell, S. R., and C. P. Catterall. 1998. Bushland modification and styles of urban development: their effects on birds in south-east Queensland. Wildlife Research **25**: 41-63.

Simmons, R., and L. Komen. 2003. Pussyfooting around. Africa Geographic **11**: 69-71.

Sims, V., K. L. Evans, S. E. Newson, J. A. Tratalos, and K. J. Gaston. 2008. Avian assemblage structure and domestic cat densities in urban environments. Diversity and Distributions **14**: 387-399.

Sovacool, B. K. 2009. Contextualizing avian mortality: a preliminary appraisal of bird and bat fatalities from wind, fossil-fuel and nuclear electricity. Energy Policy **37**: 2241-2248.

Tabor, R. K. 1983. The wild life of the domestic cat. Arrow Books, London.

Tennent, J., and C. T. Downs. 2008. Abundance and home ranges of feral cats in an urban conservancy where there is supplemental feeding: a case study from South Africa. African Zoology **43**: 218-229.

Tennent, J. K., C. T. Downs, and M. Bodasing. 2009. Management recommendations for feral cat (*Felis catus*) populations within an urban conservancy in KwaZulu-Natal, South Africa. South African Journal of Wildlife Research **39**: 137-142.

Tennent, J., C. T. Downs, D. M. Wald, and H. Watson. 2010. Public perceptions of feral cats within an urban conservancy on a campus of the University of KwaZulu-Natal. South African Journal of Wildlife Research provisionally accepted.

Tershy, B. R., C. J. Donlan, B. S. Keitt, D. A. Croll, J. A. Sanchez, B. Wood, M. A. Hermosillo, G. R. Howald, and N. Biavaschi. 2002. Island conservation in north-west Mexico: a conservation model integrating research, education and exotic mammal eradication. Pages 293-300 in C. R. Veitch and M. N. Clout, editors. Turning the tide: the eradication of invasive species. World Conservation Union, Gland, Switzerland.

Tidemann, C. R. 1994. Do cats impact on wildlife? In: Proceedings of the Third National Conference on Urban Animal Management in Australia. Australian Veterinary Association. Canberra.

Towns, D. R., I. A. E. Atkinson, and C. H. Daugherty. 1990. Ecological restoration of New Zealand Islands: papers presented at conference on ecological restoration of New Zealand Islands 1989. Department of Conservation, Wellington, New Zealand.

Van Aarde, R. J. 1980. The diet and feeding behavior of feral cats, *Felis catus* at Marion Island. South African Journal of Wildlife Research **10**: 123-128.

Van Aarde, R. J. 1986. A case study of an alien predator (*Felis catus*) introduced on Marion Island: selective advantages. South African Antarctic Research **16**: 113-114.

Van Heezik, Y., A. Smyth, and R. Mathieu. 2008. Diversity of native and exotic birds across an urban gradient in a New Zealand city. Landscape and Urban Planning **87**: 223-232.

Van Heezik, Y., A. Smyth, A. Adams, and J. Gordon. 2010. Do domestic cats impose an unsustainable harvest on urban bird populations? Biological Conservation **143**: 121-130.

Veitch, C. R. 2001. The eradication of feral cats (*Felis catus*) from Little Barrier Island, New Zealand. New Zealand Journal of Zoology **28**: 1-12.

Wilcove, D. S., D. Rothstein, J. Dubow, A. Phillips, and E. Losos. 1998. Quantifying threats to imperiled species in the United States. BioScience **48**: 607-615.

Woods, M., R. A. McDonald, and S. Harris. 2003. Predation of wildlife by domestic cats *Felis catus* in Great Britain. Mammal Review **33**: 174-188

**APPENDIX 1: CAT QUESTIONNAIRE**

CAPE TOWN'S CATS AND THEIR PREY

# Cats…. What is their impact on biodiversity?

An assessment of the impact of domestic cats on the wildlife around Table Mountain National Park

This is part of a University of Cape Town research initiative

## WE NEED YOUR HELP TO DETERMINE……….

- the cat density in areas around TMNP and Cape Town
- whether cats venture into the national park?
- the main target prey species of your cat(s)
- how frequently these species targeted
- if cat hunting behavior altered by supplemental feeding
- if cat hunting behavior and range is sex or age specific?
- if cat hunting behavior is dependent on time of day
- if bells on collars make any difference in the impact cats have on their prey

## Instructions:

Please answer the following survey questions overleaf by ticking where applicable. The results of this survey will be analyzed for a master's project that aims to determine the impact domestic cats have on biodiversity. All data and information provided will be treated with confidentiality. We will provide feedback on the study on completion of the project in 4-5 months time. Thank you very much for your participation!

**CAPE TOWN'S CATS AND THEIR PREY**

Name and Street Address________________________________________

ERF Number (Please check your utility bill)______________________________

Email Address (If available)________________________ Contact No.____________

## Basic Information

1. What kind of housing do you live in?
   - ☐ High-rise apartment
   - ☐ Semi-detached house
   - ☐ Free-standing house
   - ☐ Security village
2. No. of Cats in household: ...............................
3. What is the age, sex, weight and length of you cat(s)? (Ask your local Vet for help if needed)

| Cat # | Age | Sex(M/F) | Weight(Kg) | Length(cm) | Sterilized(Yes/No) |
|---|---|---|---|---|---|
| 1 | ---------- | ------------ | ------------ | -------------- | --------------------------- |
| 2 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 3 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 4 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 5 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 6 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 7 | ----------- | ------------ | ------------ | -------------- | --------------------------- |
| 8 | ----------- | ------------ | ------------ | -------------- | --------------------------- |

## *Your Cooperation Is Highly Appreciated!!*

4. If your cat wears a bell on its collar, would you please remove the bell for half the duration of the study (approx. 5 weeks with the bell and 5 weeks without the bell)?

- ☐ Yes
- ☐ No

5. If your cat has no bell, would you please have your cat wear a bell on its collar for half the duration of the study (approx. 5 weeks)? - These bells and collars will be available, free of charge, on request.

- ☐ Yes
- ☐ No

6. How often do you feed your cat(s)?

- ☐ Never
- ☐ Once a day
- ☐ Twice a day
- ☐ More than twice a day/ Access to food at all times

7. Do you restrict the movement of your cat(s)?

- ☐ No, not at all – they are allowed outdoors all the time
- ☐ Yes, only let out during the day
- ☐ Yes, only let out at night
- ☐ Yes, they spend all their time indoors

8. Do your cats hunt?

- ☐ Yes
- ☐ No …….If "Yes" go to Q 9; If "No"go to Q 10
- ☐

| DATE | PREY TYPE | PREY NUMBER |
|---|---|---|

9. Kindly fill in the record sheet below:

***Please indicate exact date for each entry***

**(Please freeze prey remains collected and we will collect them)**

**-If your cat brings in live prey, please photograph it or tell us if it is a mouse, shrew, rat, bird, snake, lizard, frog or insect……..**

| DATE | PREY TYPE (Describe prey items in as much detail as possible) | PREY NUMBER |
|---|---|---|
| WEEK 1 | | |
| WEEK 2 | | |
| WEEK 3 | | |
| WEEK 4 | | |
| WEEK 5 | | |

***Please indicate exact date for each entry***

**(Please freeze prey remains collected and we will collect them)**

**-If your cat brings in live prey, please photograph it or tell us if it is a mouse, shrew, rat, bird, snake, lizard, frog or insect……..**

| DATE | PREY TYPE (Describe prey items in as much detail as possible) | PREY NUMBER |
|---|---|---|
| WEEK 6 | | |
| WEEK 7 | | |
| WEEK 8 | | |
| WEEK 9 | | |
| WEEK 10 | | |

10. Do you have birds/lizards/frogs/mice/other small mammals in your garden?

- ☐ Yes
- ☐ No

11. Do you feed these birds/lizards/frogs/mice/other small mammals?

- ☐ Yes
- ☐ No

12. Do you have any birds nesting in your garden?

- ☐ Yes
- ☐ No

***Thank you for your time!!!!***

For more information please contact:

**Sharon George** on 021 650 4098 OR 078 813 9161 (Sharon.george@uct.ac.za)

**Dr. Rob Simmons** on 021 650 3310 (Rob.simmons@uct.ac.za )

**Kindly send the completed questionnaire to your local vet by the 10th of January, 2010**

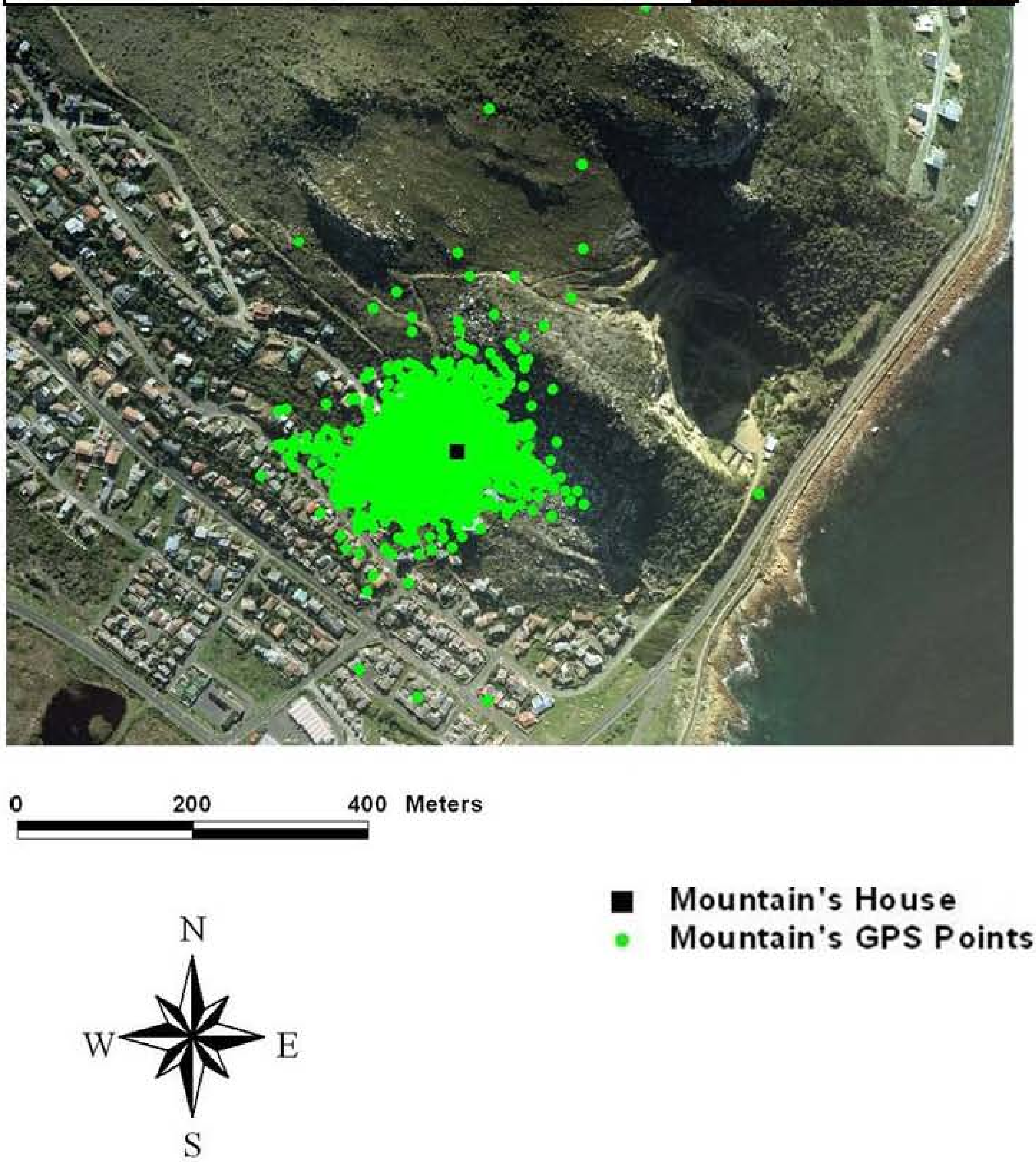
## APPENDIX 2: CAT TRACKS

**NAME: MOUNTAIN**

**SEX: MALE**

**AGE: 5 YRS**

**CATEGORY: URBAN-EDGE**

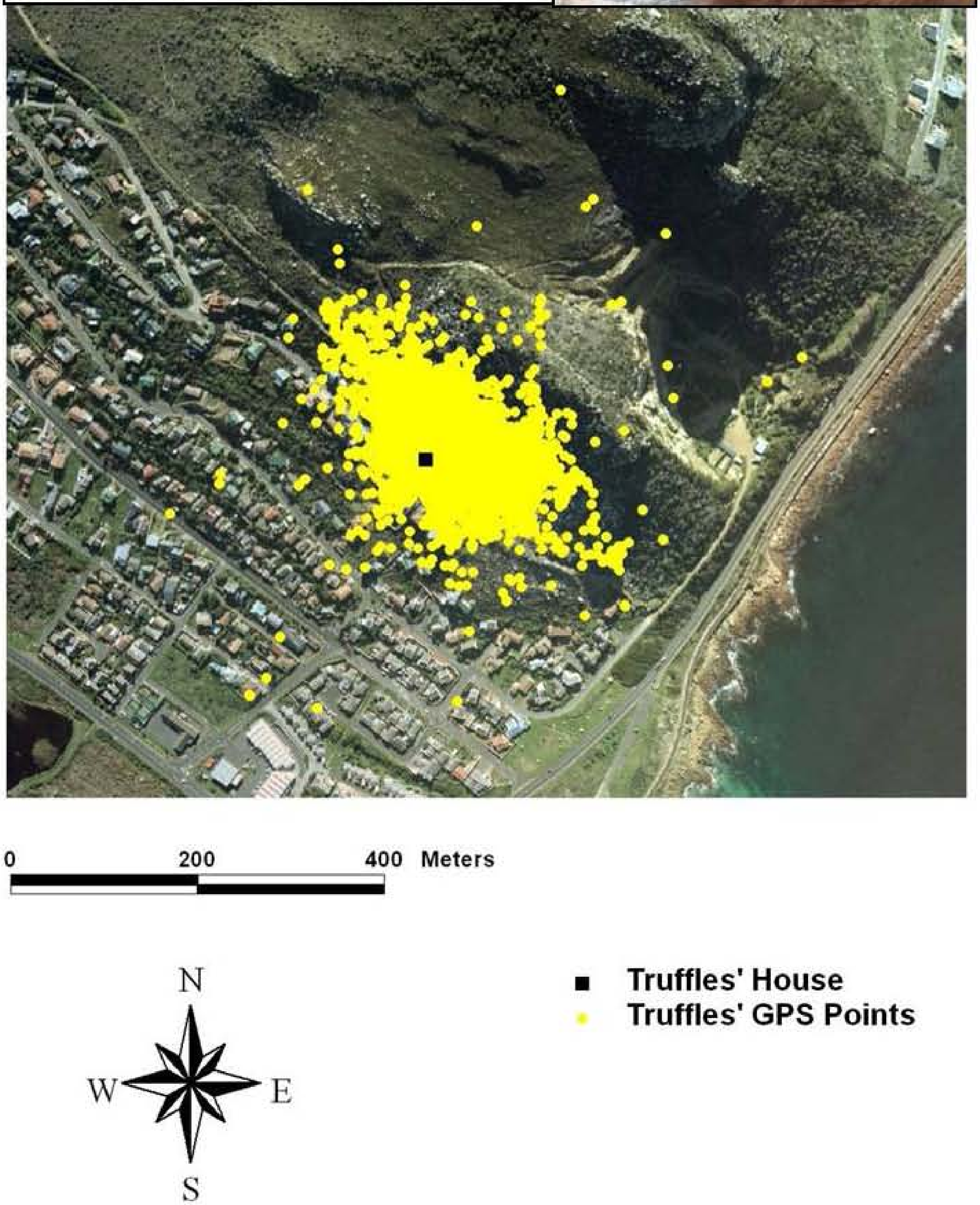


**NAME: TRUFFLES**

**SEX: FEMALE**

**AGE: 5 YRS**

**CATEGORY: URBAN-EDGE**

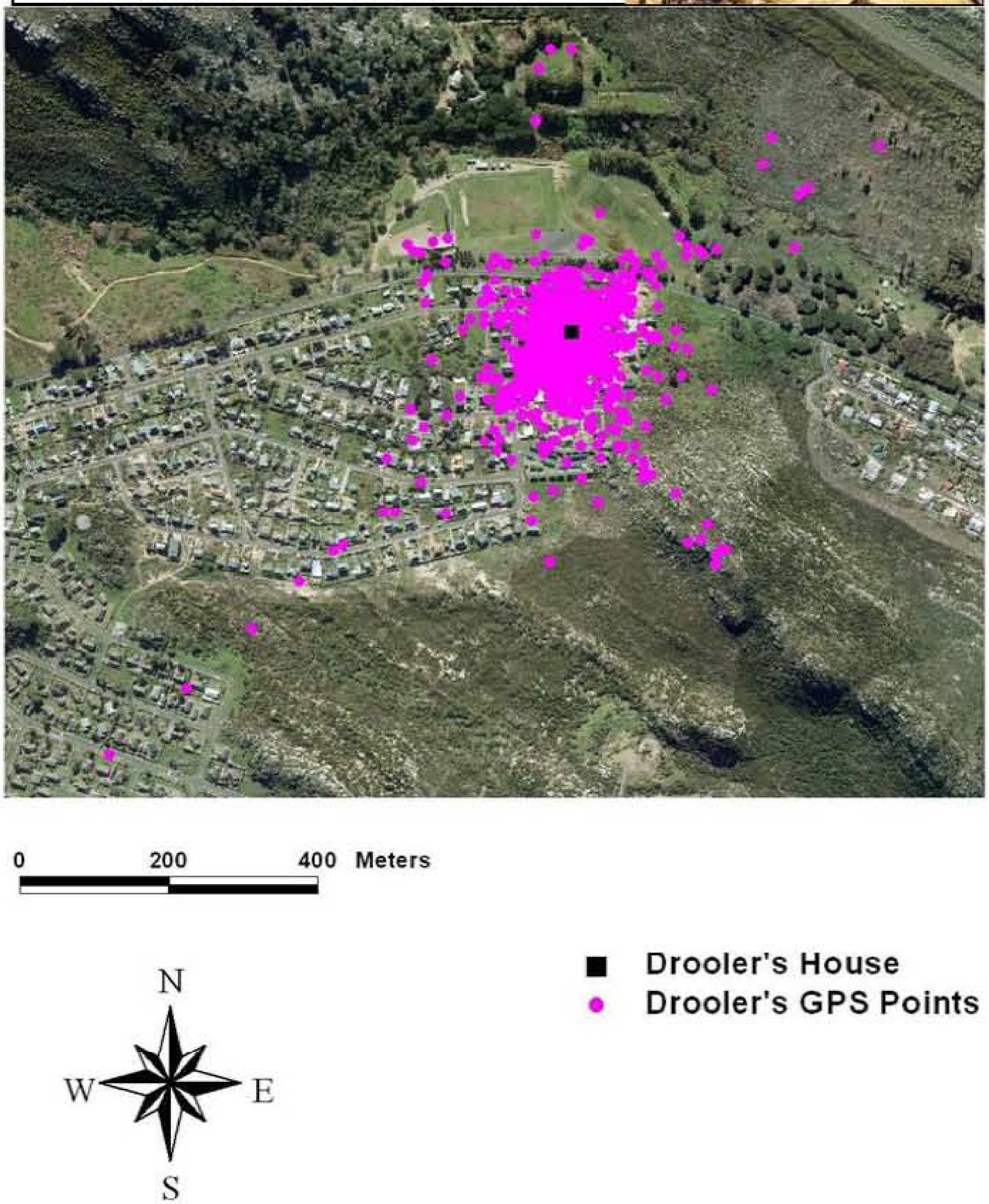


**NAME: DROOLER**

**SEX: FEMALE**

**AGE: 6 YRS**

**CATEGORY: URBAN-EDGE**

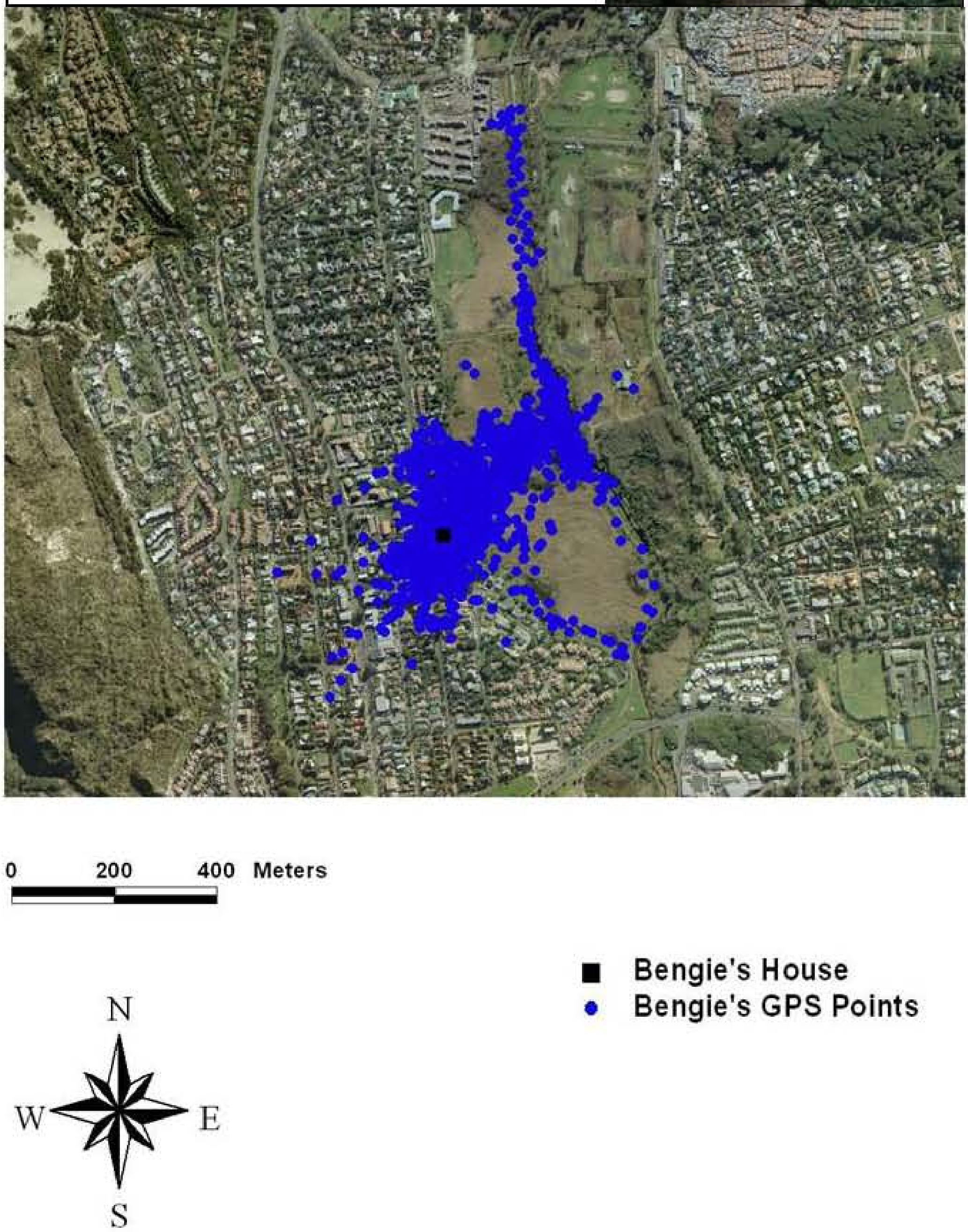


**NAME: BENGIE**

**SEX: MALE**

**AGE: 12 YRS**

**CATEGORY: URBAN-EDGE**

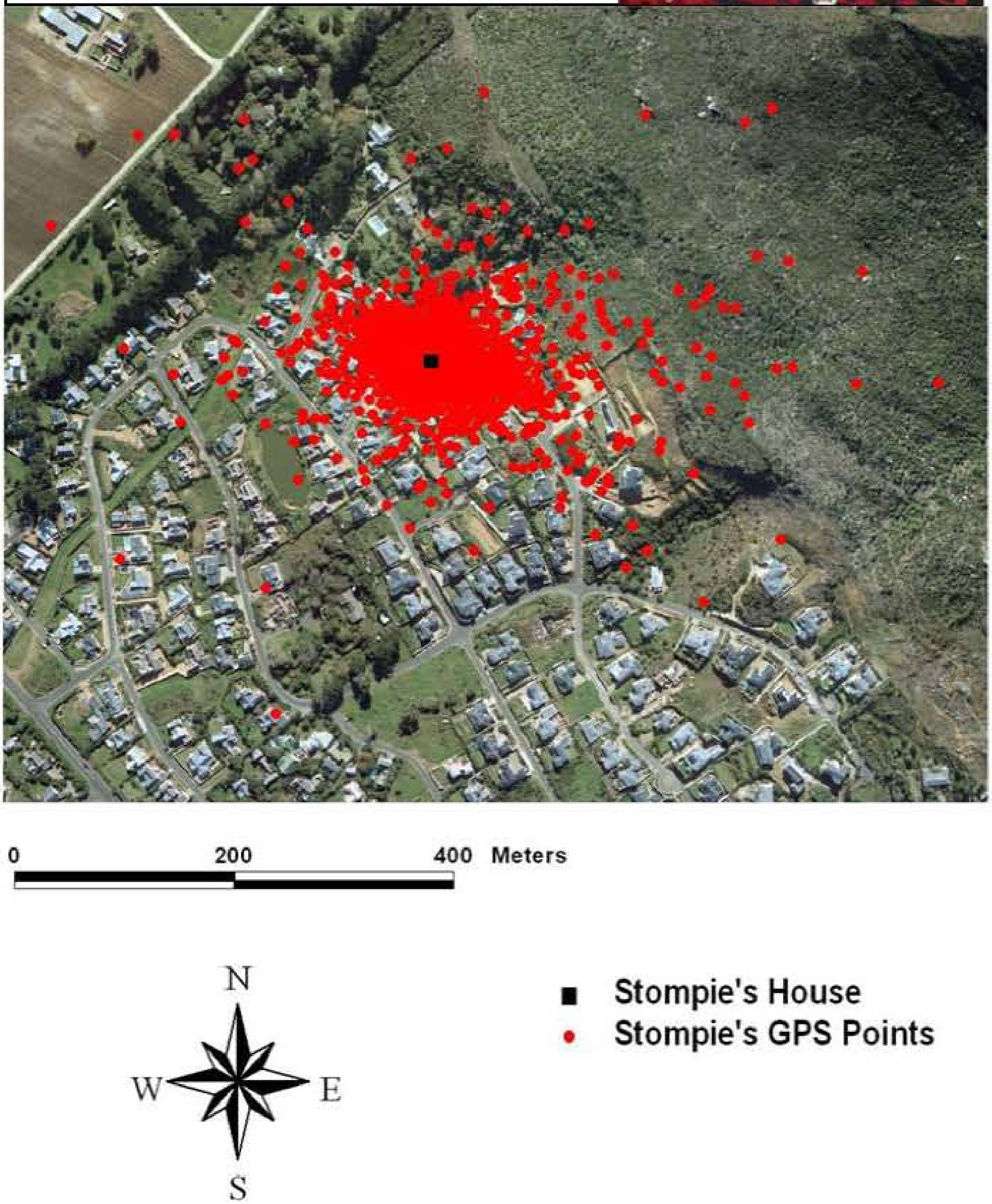


**NAME: STOMPIE**

**SEX: MALE**

**AGE: 9 YRS**

**CATEGORY: URBAN-EDGE**

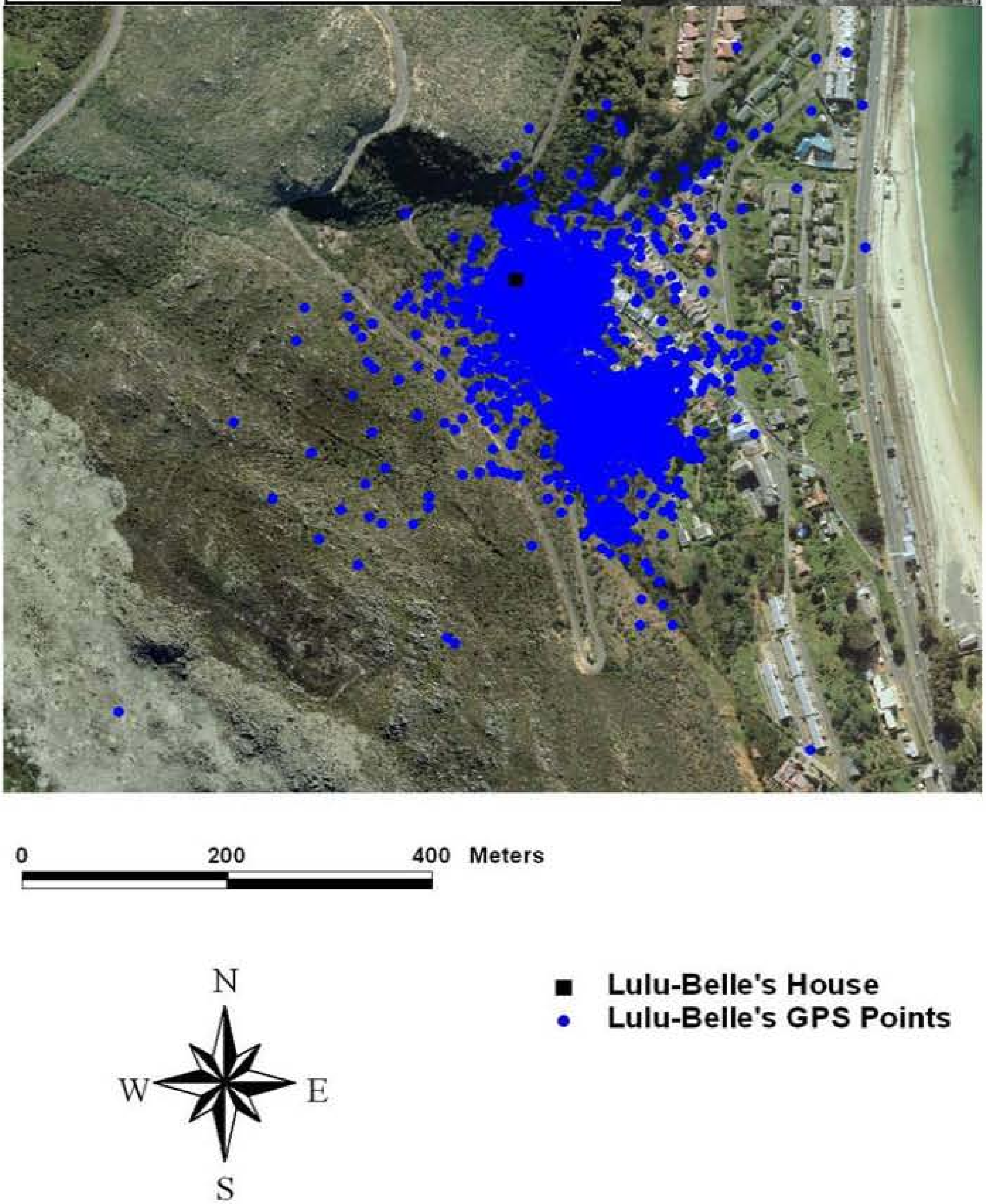


**NAME: LULU-BELLE**

**SEX: FEMALE**

**AGE: 1.25 YRS**

**CATEGORY: URBAN-EDGE**

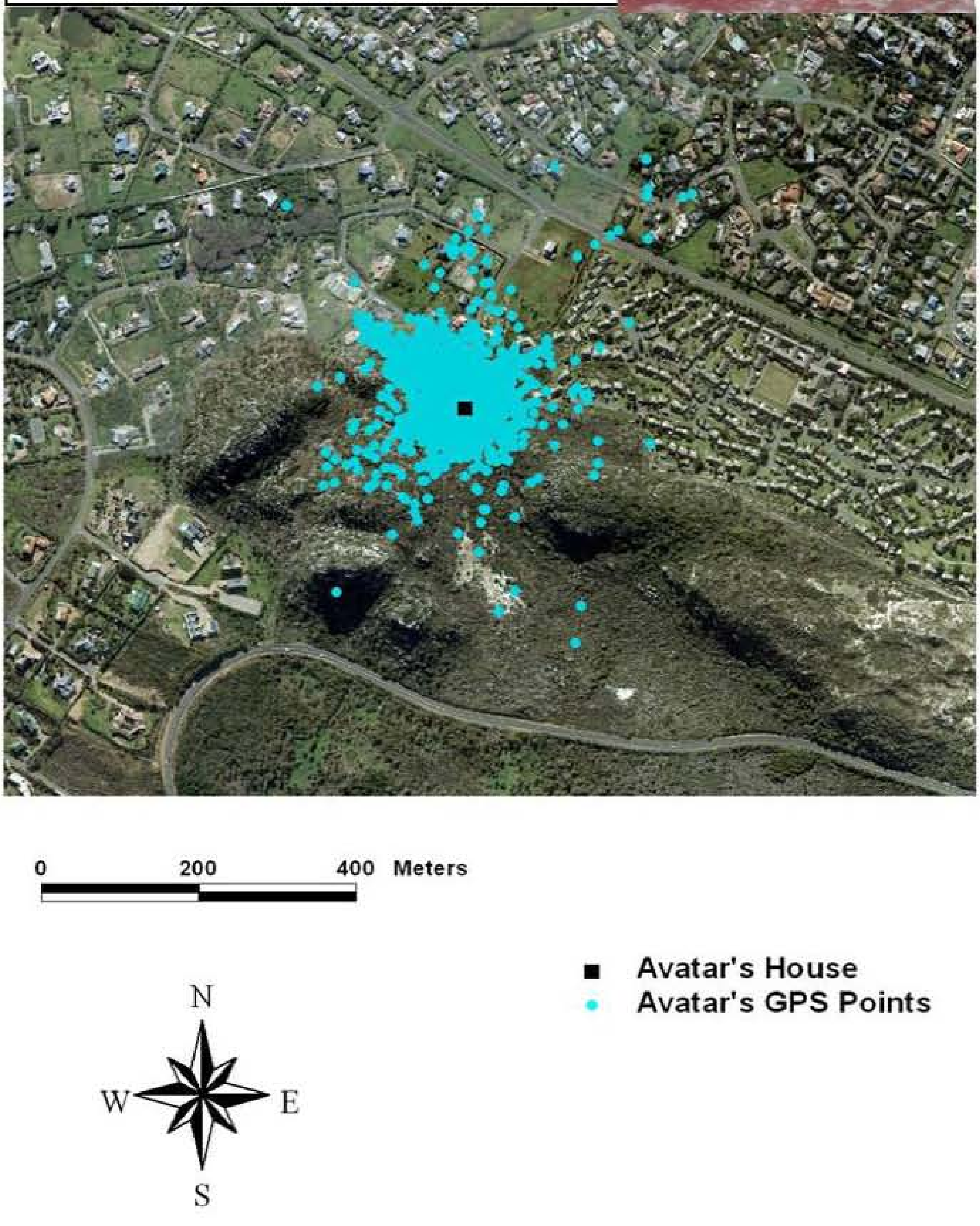


**NAME: AVATAR**

**SEX: FEMALE**

**AGE: 12 YRS**

**CATEGORY: URBAN-EDGE**

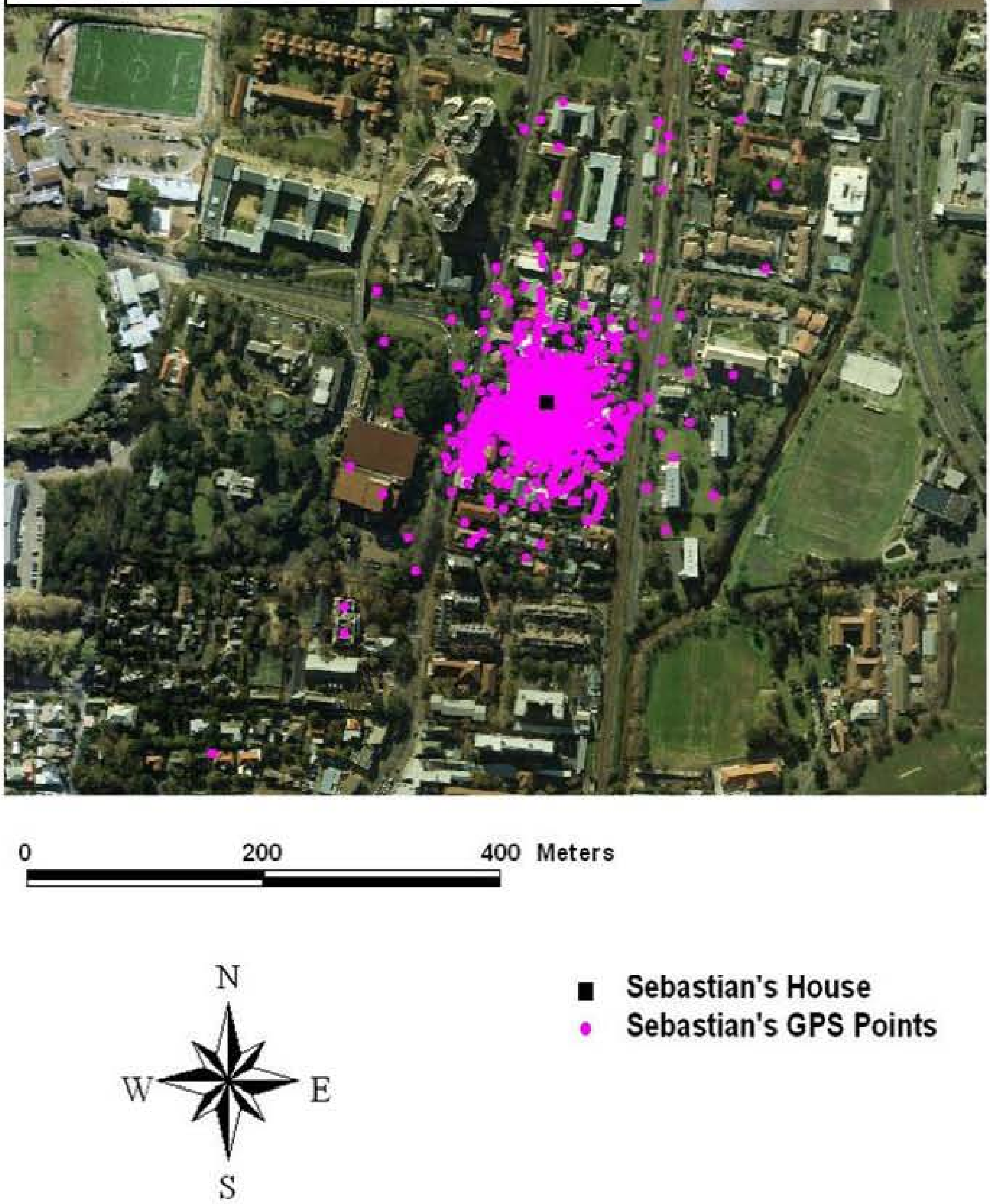


**NAME: SEBASTIAN**

**SEX: MALE**

**AGE: 7 YRS**

**CATEGORY: DEEP-URBAN**

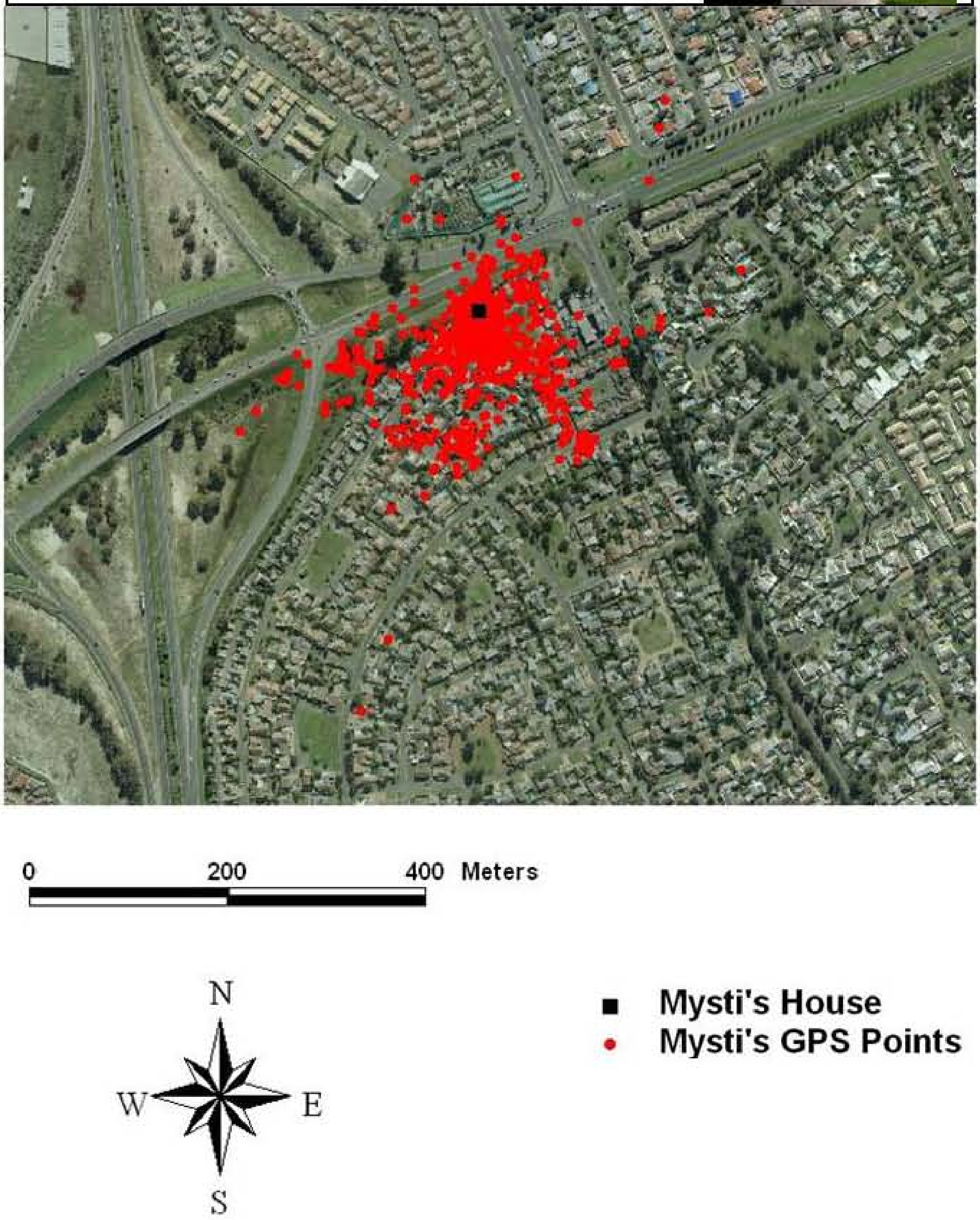


NAME: MYSTI

SEX: MALE

AGE: 5 YRS

CATEGORY: DEEP-URBAN

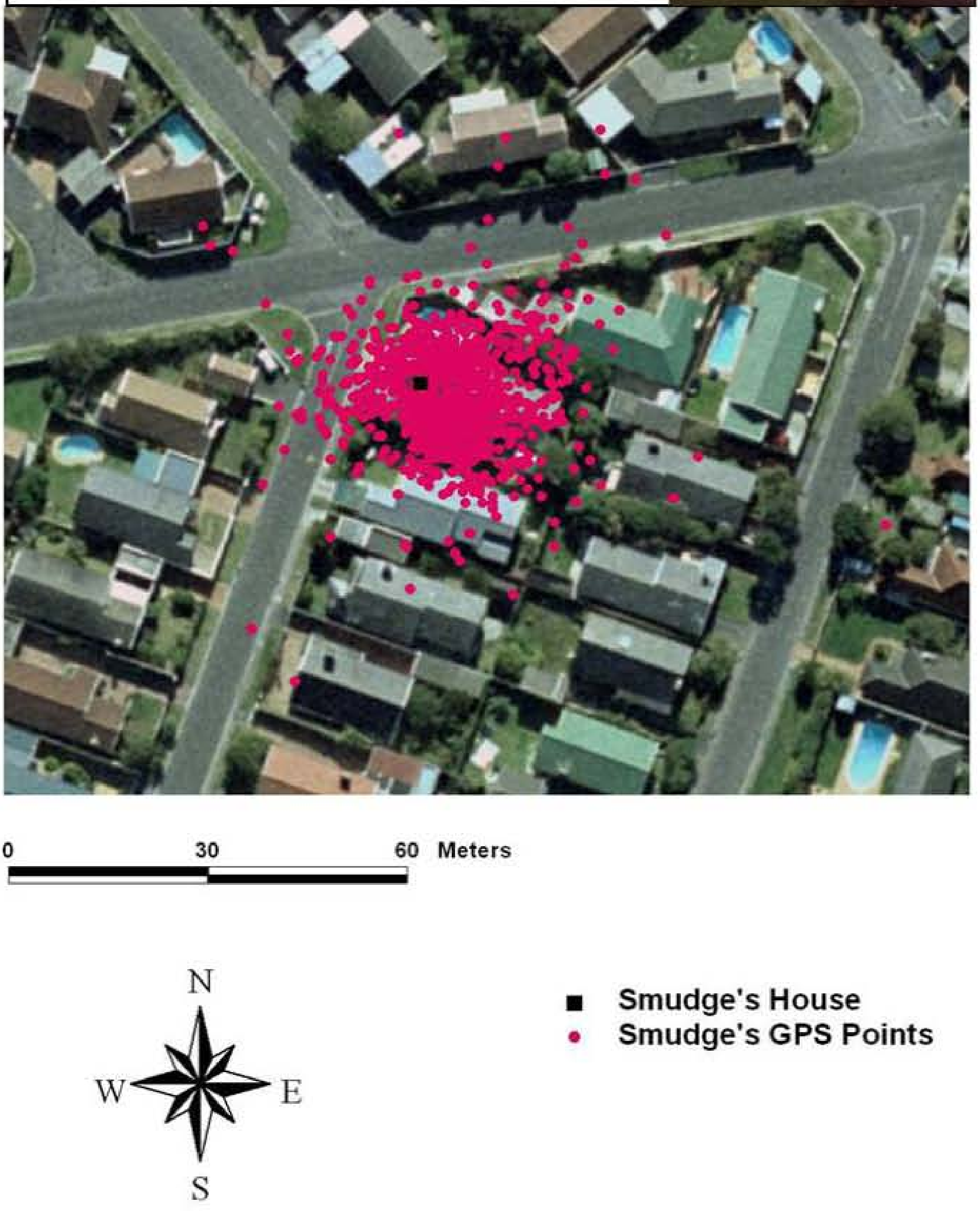


**NAME: SMUDGE**

**SEX: FEMALE**

**AGE: 11 YRS**

**CATEGORY: DEEP-URBAN**

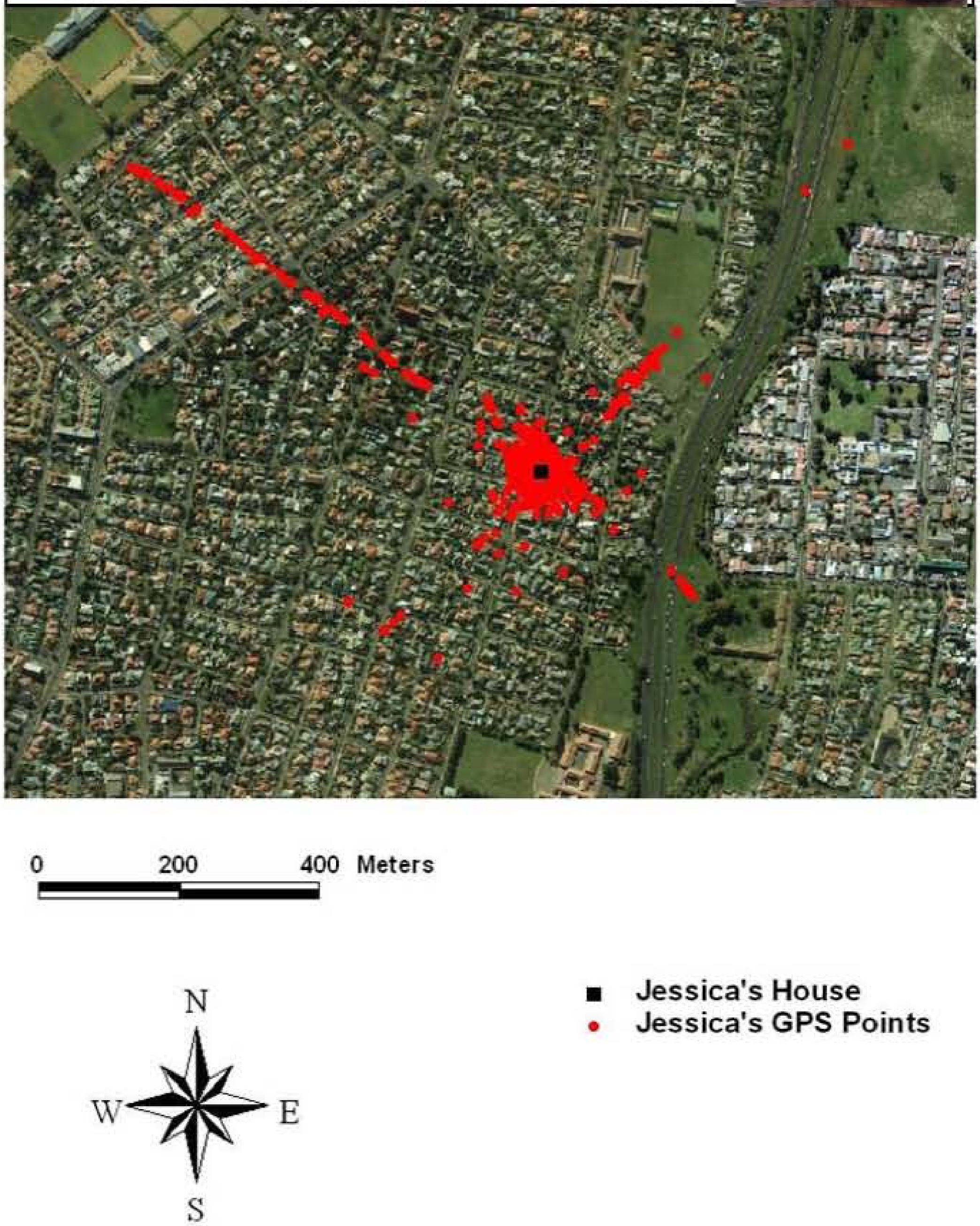


**NAME: JESSICA**

**SEX: FEMALE**

**AGE: 10 YRS**

**CATEGORY: DEEP-URBAN**

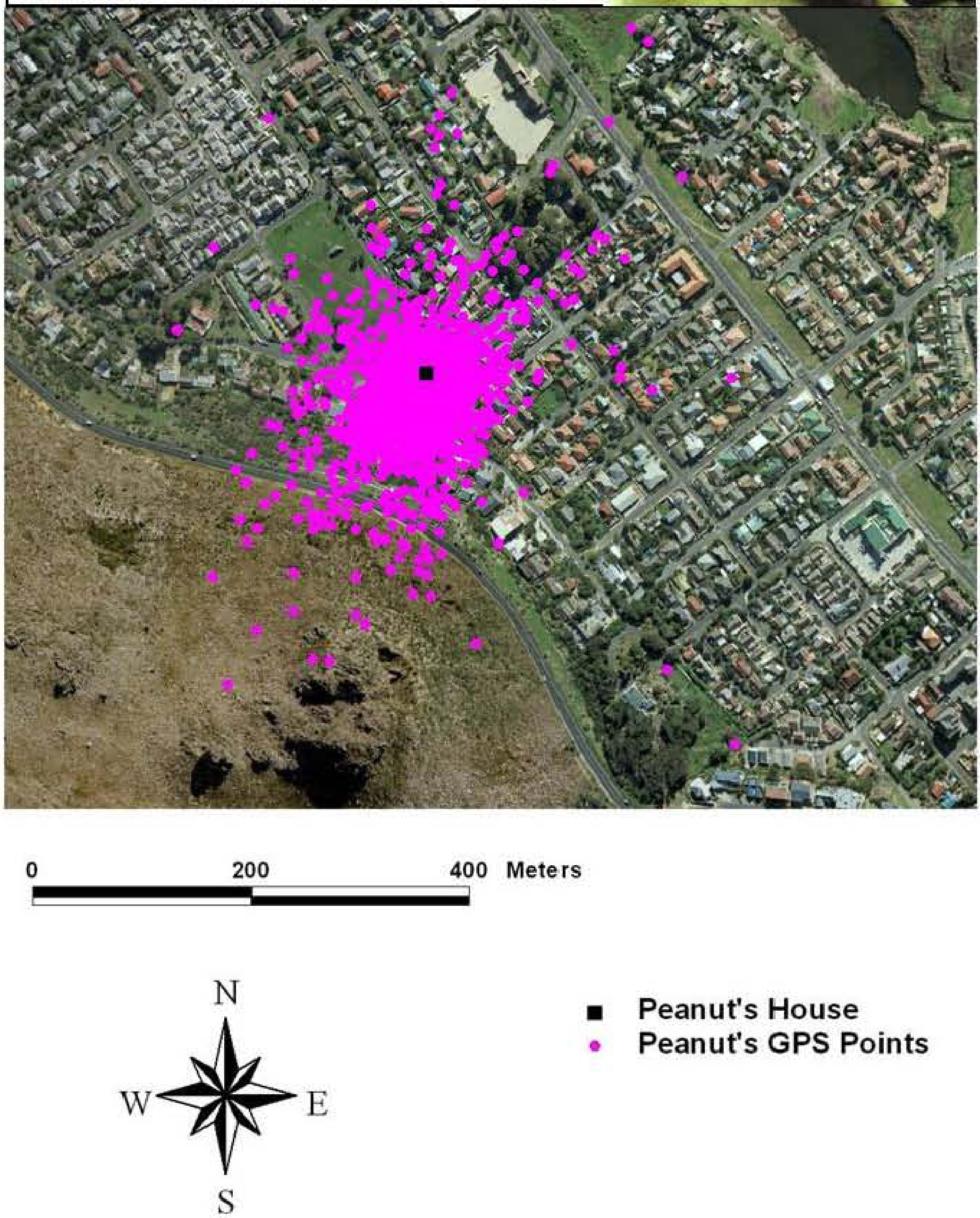


**NAME: PEANUT**

**SEX: MALE**

**AGE: 12 YRS**

**CATEGORY: DEEP-URBAN**

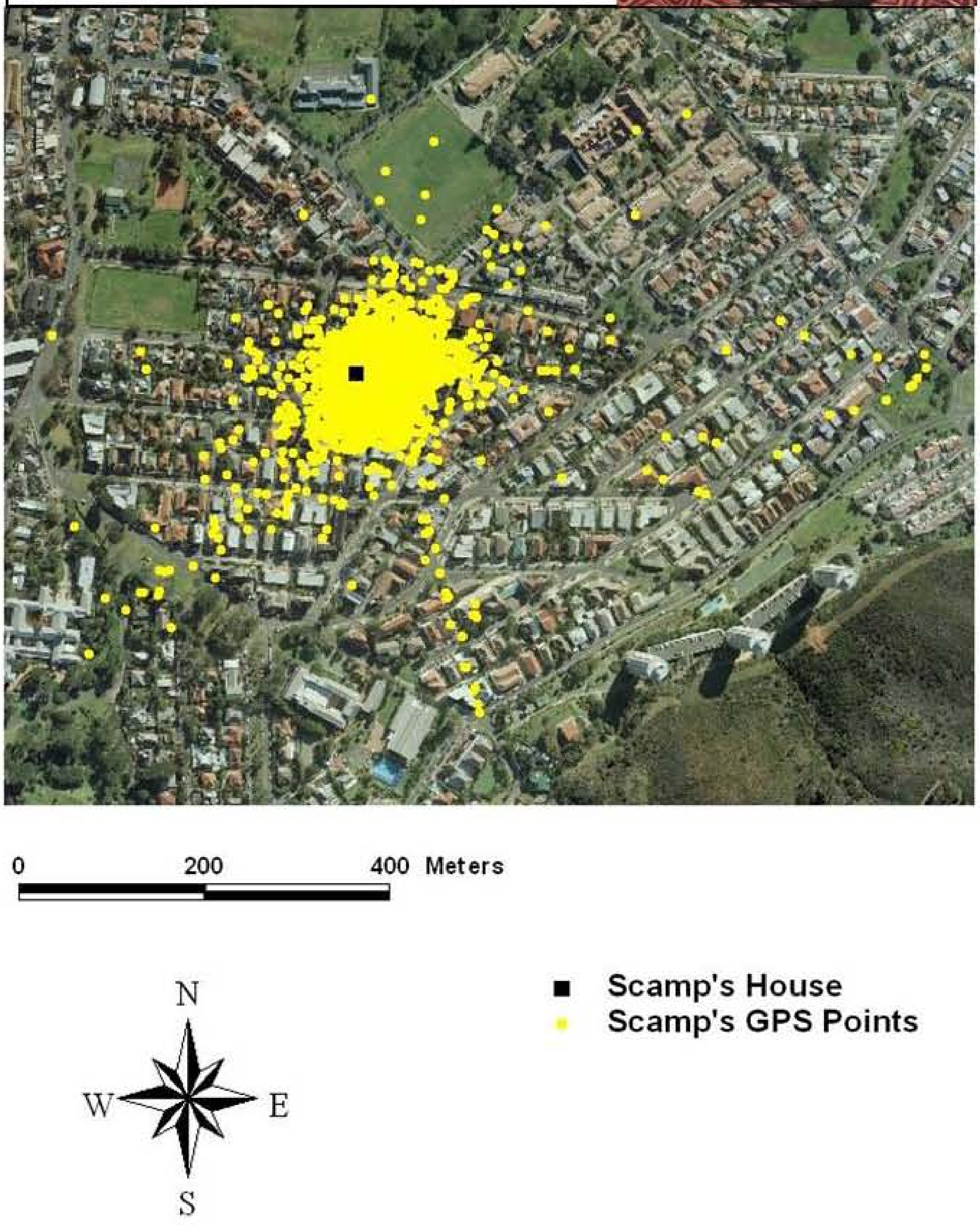


**NAME: SCAMP**

**SEX: MALE**

**AGE: 1.2 YRS**

**CATEGORY: DEEP-URBAN**

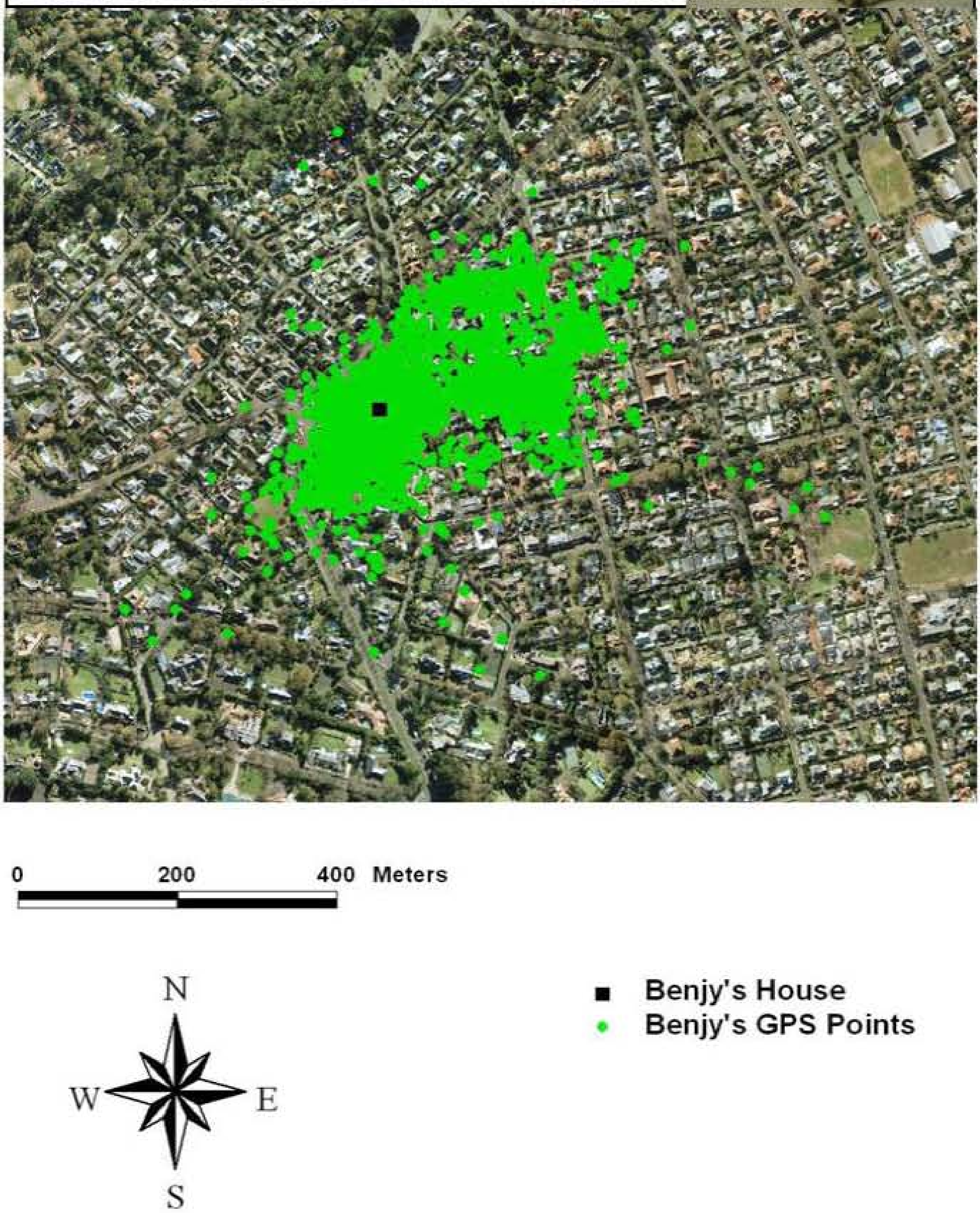


**NAME: BENJY**

**SEX: MALE**

**AGE: 7 YRS**

**CATEGORY: DEEP-URBAN**



**APPENDIX 3: PREY RECORDED**

| Urban Position | Prey Category | Prey Item | Quantity |
|---|---|---|---|
| Deep-urban | Mammals | Mole (Unidentified species) | 3 |
| | | Mouse (Unidentified species) | 2 |
| | | Rat (Unidentified species) | 7 |
| | Total | | 12 |
| | Birds | Cape Sparrow | 1 |
| | | Dove (Unidentified species) | 7 |
| | | Pigeon (Unidentified species) | 2 |
| | | Red-winged Starling | 1 |
| | | Wagtail | 1 |
| | | European Starling (*Sturnus vulgaris*) | 3 |
| | Total | | 15 |
| | Reptiles | Cape Dwarf Day Gecko | 2 |
| | | Gecko (Unidentified species) | 11 |
| | | Mole snake | 1 |
| | Total | | 14 |
| | Insects | Rose Beetles | 1 |
| | | Cockroach (Unidentified species) | 8 |
| | | Dragonfly (Unidentified species) | 1 |
| | | Grasshopper (Unidentified species) | 1 |
| | | Moth (Unidentified species) | 10 |
| | | Stick insect (Unidentified species) | 10 |
| | Total | | 31 |
| Urban-edge | Mammals | Gerbil | 1 |
| | | Golden Mole | 2 |
| | | Grey Squirrel | 1 |
| | | Mole (Unidentified species) | 2 |
| | | Mouse (Unidentified species) | 10 |
| | | Rat (Unidentified species) | 14 |
| | | Shrew (Unidentified species) | 33 |
| | | Striped Field Mouse (*Rhabdomys pumilio*) | 45 |
| | | Vlei Rat | 6 |
| | Total | | 114 |
| | Birds | Cape Robin | 1 |
| | | Cape Turtle Dove | 1 |
| | | Cape White Eye | 3 |
| | | Common waxbill | 1 |
| | | Dove (Unidentified species) | 1 |
| | | Grassbird | 2 |
| | | Guinea Fowl | 2 |
| | | Robin | 1 |
| | | Rock Pigeon | 1 |
| | | Sunbird (Unidentified species) | 1 |
| | | Thrush | 1 |
| | | European Starling (*Sturnus vulgaris*) | 7 |
| | | Bulbull | 1 |
| | Total | | 23 |
| | Reptiles | Gecko (Unidentified species) | 5 |
| | | Lizard (Unidentified species) | 42 |
| | | Mole snake | 1 |
| | | Rock Agama (*Agama agama*) | 10 |
| | Total | | 58 |
| | Amphibians | Cape Rain Frog (*Breviceps gibbosus*) | 3 |
| | | Cape River Frog | 1 |
| | Total | | 4 |
| | Insects | Dragonfly (Unidentified species) | 1 |
| | | Grasshopper (Unidentified species) | 1 |
| | | Green Insect (Unidentified species) | 4 |
| | | Locust (Unidentified species) | 3 |
| | | Moth (Unidentified species) | 4 |
| | | Scorpion (Unidentified species) | 1 |
| | | Spider (Unidentified species) | 1 |
| | Total | | 15 |
| **Grand Total** | | | **286** |