A REPORT ON FREE-ROAMING DOMESTIC CAT ACTIVITIES IN URBAN AREAS:

What do owned free-ranging domestic cats get up to?

by

Mya J. Gaby

Research Project

Submitted in partial fulfilment of the requirements for the Summer Research Scholarship offered by:

THE VICTORIA UNIVERSITY OF WELLINGTON

THE WELLINGTON CITY COUNCIL

School of Geography, Environment and Earth Sciences

Victoria University of Wellington

Student ID: 300319800

Staff number: 80013870

Email: mya.gaby@vuw.ac.nz

21st February 2014

CONTENTS

Introduction

What do owned free-roaming cats get up to? In the midst of the timely 'Cat Debate' initiated by Dr. Gareth Morgan, this information couldn't be more significant. Many cat lovers refuse to accept that their domestic pet cats are capable of killing wildlife and believe that global research is not relevant to the New Zealand situation (Kikillus, pers. obs). In order to address these concerns, we need to provide local New Zealand-based research. Understanding domestic cat behaviour in the urban New Zealand setting will help inform and encourage the general public to make decisions regarding cat management based on scientific evidence rather than on emotion.

Implications of Felis catus *introduction in New Zealand*

Introduced mammalian predators in New Zealand coincided with the arrival of Europeans around the 19th century (Fitzgerald & Karl, 1986). The implications of this have been devastating for New Zealand's native wildlife which evolved in the absence of these predatory mammals (Dowding & Murphy, 2001; Moorhouse et al., 2003; O'Donnell, 1996; Reardon et al., 2012).

New Zealand has one of the highest numbers of domestic cat ownership per capita, with almost half of New Zealand households owning at least one cat (New Zealand Companion Animal Council Inc., 2011). Unnaturally high densities of domestic cats exist in urban spaces (Lepczyk et al., 2004; Sims et al., 2008); with around 77% of New Zealand's domestic cats located in urban areas (New Zealand Companion Animal Council Inc., 2011). This poses a substantial threat to local native fauna in these urban areas (van Heezik et al., 2010).

Cats in New Zealand contribute to native wildlife decline (Courchamp et al., 2003; Gillies & Clout, 2003; Medina et al., 2011; Reardon et al., 2012; Sanders & Maloney, 2002; van Heezik et al., 2010) but they may also play a key role in reducing the numbers of rats and mice which also heavily prey upon on New Zealand's' native species (Fitzgerald & Karl, 1979; Innes, 2001; Towns & Broome, 2003). As suggested by van Heezik et al. (2010); by controlling rodent populations, cats in New Zealand may be preventing even higher rates of native wildlife predation by rats and mice (Courchamp et al., 1999) – this phenomenon is known as meso-predator release.

The impact of domestic cat populations on New Zealand's native wildlife has become a major conservation, social and political issue (See Gareth Morgan's 'Cats to go' campaign[1]). Many New Zealanders are divided over what mitigation measures should be taken in regards to managing domestic cats (to reduce native wildlife decline).

Quantifying the environmental impact of domestic cats in New Zealand

Cat owner surveys and records (Gillies & Clout, 2003; van Heezik et al., 2010) or the use of GPS or radio tracking collars (Fitzgerald & Karl, 1986; Hansen, 2010; Metsers et al., 2010; Recio et al., 2010; van Heezik et al., 2010) have been the traditional methods used in New Zealand to ascertain the environmental impacts of domestic cats in New Zealand. There is, however, a need for further research on the environmental impact of owned domestic cats (Loyd et al., 2013a), particularly in the New Zealand urban setting.

Using owner surveys to identify the number and type of prey species brought home by domestic cats can be inaccurate as not all prey is returned (Loyd et al., 2013a) and owners can miss-identify prey species or under-report catches (Gillies & Clout, 2003; van Heezik et al., 2010).

In two separate studies conducted overseas by Loyd et al., (2013a; 2013b) small cameras were attached to the collars of free-roaming domestic cats in Georgia, USA, allowing researchers to gain a unique perspective into their activities and behaviours. The results from the first study (2013a)

[1]"Cats to go" http://garethsworld.com/catstogo/

highlighted the large quantities of wildlife hunted, with less than 25% of prey brought back to their homes. The second study (2013b) documented risk behaviours exhibited by free-roaming cats, which showed many roaming cats engaged in dangerous activities daily.

Our research

This study seeks to emulate research overseas in order to investigate New Zealand urban domestic cat activities and behaviours.

An interesting and unique aspect of Wellington City is the presence of "Zealandia", a wildlife sanctuary which is home to many species of native birds. Although a predator-proof fence surrounding the sanctuary prevents pests from entering, many birds are capable of flying into the surrounding neighbourhoods where they are at risk from many factors, including introduced mammals (such as domestic cats).

The objectives of this study were (1) to gain a better understanding of the behaviours and habits of domestic cats in New Zealand, and (2) to engage the public and generate interest in investigating the potential impacts of pet cats on the New Zealand environment.

Materials and Methods

Study area

Wellington, New Zealand (41' 17" S, 174' 47" E) is the nation's capital with a population of approximately 180,000 within the city limits (Positively Wellington Tourism 2013). The number of pet cats in the city is unknown; however New Zealand has one of the highest recorded rates of cat ownership in the developed world (MacKay, 2011).

Participants were recruited for this study by displaying flyers in local veterinary clinics and via social media. Households that volunteered their pet cat were chosen from suburbs surrounding Zealandia, where there is more likely to be a spill over effect of wildlife. These areas/suburbs are known as the ecological buffer zone or "halo". A map of the general locations of participant households is included in Figure 1.

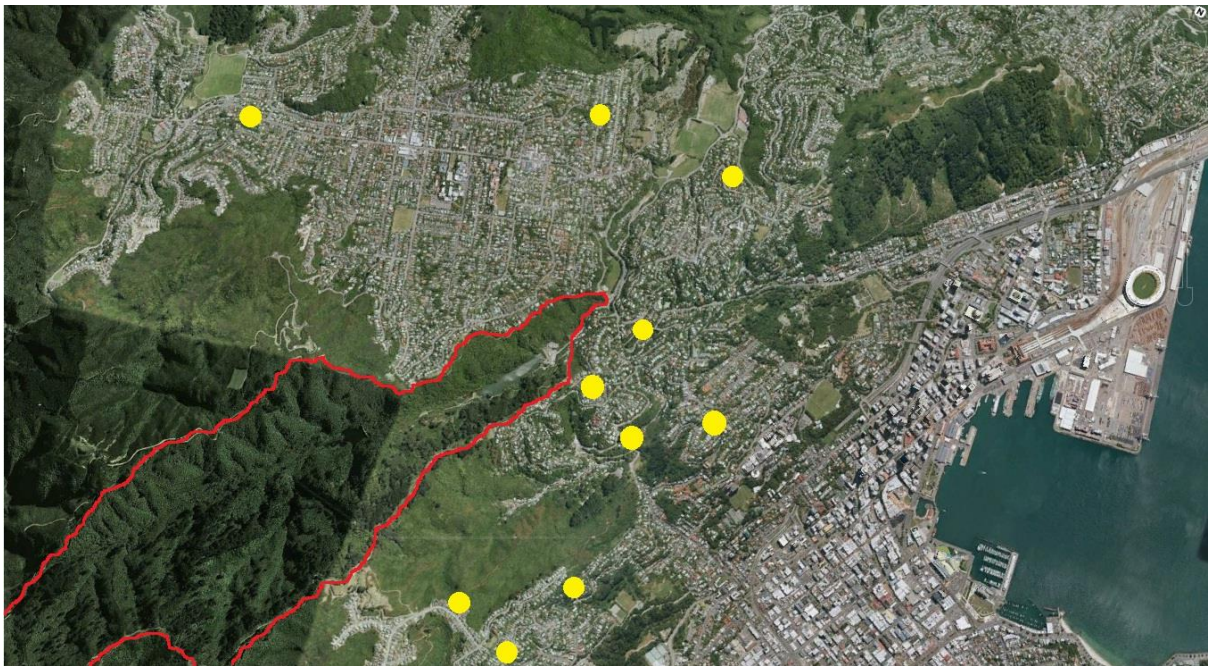


Figure 1: Map of the general locations of free-roaming pet cats' households (yellow dots) monitored by an Eyenimal™ Cat Videocam. The Zealandia Wildlife Sanctuary is outlined in red.

Study species
Ten adult pet cats living in the Zealandia "Halo" area, which were volunteered by their caregivers, took part in this study.

Technology
Previous studies overseas have used animal-borne video systems (Crittercams™), which record from an animal's point-of-view, in order to gain insight into the lives of a range of different species (see Loyd et. al. 2013 and references therein).
Whilst unable to obtain Crittercams™, we were able to source Eyenimal™ Cat Videocams. The Eyenimal™ Cat Videocam is a commercially-available, purpose-designed video camera which clips onto a cat's collar. It weighs 32 grams, has a battery life of approximately 2.5 hours, is capable of night-vision (LED light), and is motion-activated (PetVision 2013). See Figure 2a) and b).

a) 

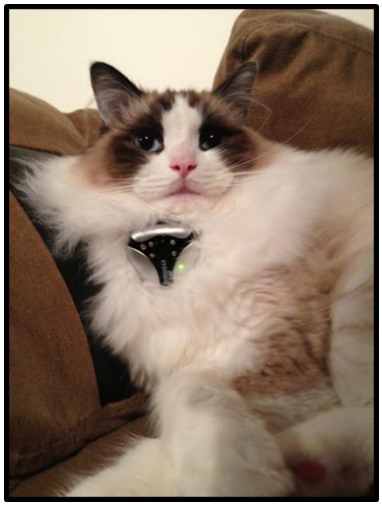
b) 

Figure 2a): Eyenimal™ Cat Videocam distributed by PetVision, Auckland; **b)** a domestic cat (*Felis catus*) equipped with an Eyenimal™ Cat Videocam.

Domestic cats accustomed to wearing collars were fitted with Eyenimal™ Cat Videocams to monitor their movements and activities. Volunteer participants were provided with an Eyenimal™ Cat Videocams, an instruction manual, a USB flash drive, and face-to-face training covering attachment of the camera to their cat's collar, downloading video footage, and recharging the camera batteries.

Volunteer cat caregivers placed an Eyenimal™ Cat Videocams on their pet for up to 10 days over an 8 week period. Volunteers were asked to deploy the camera 10 separate times at their convenience and download the footage after each recording session onto a USB stick. Volunteers chose when to record according to their cats' activity times (day and/or night). USB flash drives were collected regularly and were exchanged for a blank one to enable cat owners to continue recording footage of their cats.

Information regarding the pet cats was also collected, such as age, sex, and whether or not the cats were microchipped and desexed. Participants were also asked about the risk behaviours and hunting habits exhibited by their pet cats. If catches were brought home, the owners agreed to report this and if possible collect the carcasses for future analysis by investigators.

Victoria University of Wellington Human Ethics (#20218) and Animal Ethics (#2013R16) were granted for this research project.

Data collection/video analysis
A list of main cat behaviours was made and reviewed by researchers. These were;

- **Ingestion** (e.g., eating grass, licking dew – a non-predation event)
- **Locomotor** (e.g., walk, run, jump etc.)
- **Grooming** (e.g., licking, scratch etc.)
- **Investigation** (e.g., staring at matter (incl. prey species), sniffing objects etc.)
- **Predation** (e.g., stalking prey, capturing & eating prey etc.)
- **Risk behaviours** (e.g., crossing roads, climbing trees, entering crawl spaces, interacting with other cats etc.)
- **Other** (other behaviours that didn't fit in categories above e.g., interacting with owner, interacting with other family pets etc.)

Predation behaviours and risk behaviours were modelled on previous research by Loyd et al., (2013a & b). If the camera view was obstructed this was also noted and recorded. Time spent inside was also recorded but behaviour exhibited by cats indoors was not analysed. Additionally, as the cameras were motion-activated, sleeping and resting behaviour were not recorded.

All outdoor recordings were reviewed for each participating cat.

Results

Ten domestic pet cats were monitored during the course of this project. Cats ranged in ages from 2-12 years old (mean = 6 years old) with an unequal number of males and females (2 and 8 respectively).
All cats were de-sexed and had reportedly been vaccinated, de-flead and wormed. Nine cats were microchipped. Four of the ten cats wore bells.
All owners reported at least one previous predation event by their cat before this study took place (see Figure 1).

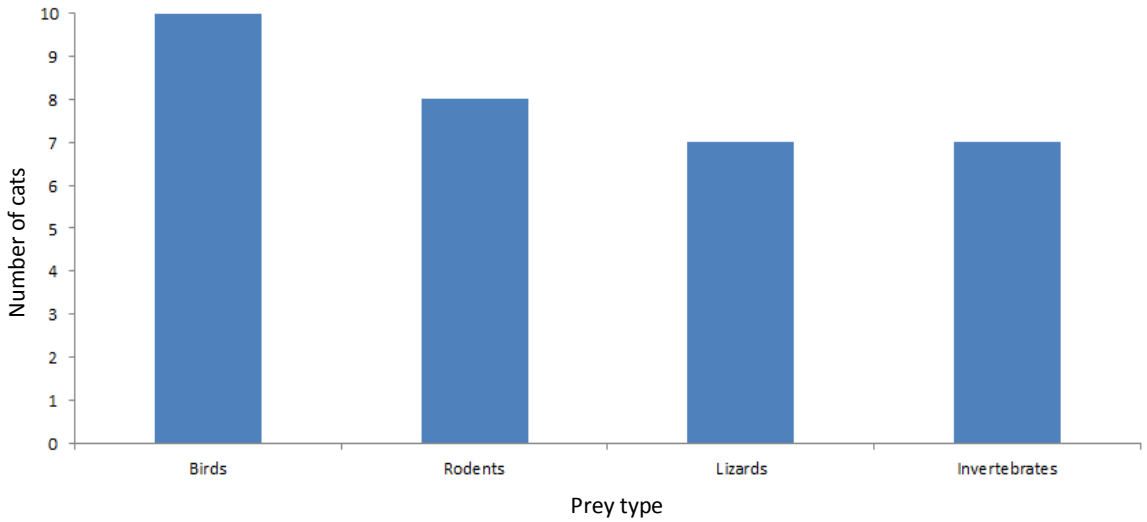


Figure 1: This graph is based on owner's reports of prey type previously caught by 10 individual free-roaming domestic cats

Owners also reported on risk behaviours of their cats; with seven of the ten cats reported to have been involved in previous cat fights with stranger cats.

Video analysis results

A total of eighty five video recordings were collected during the eight week period, with the number of video recording session ranging from 5-10 per cat (mean = 8.5).

A total of 79 hours, 45 minutes and 45 seconds of video footage was collected and analysed (an average of 7.9 hours total per cat).

Thirteen hours, 36mins and 7 seconds of the 79 total hours were recorded at night (17%) represented by 5 cats. "Night" was between the hours of 7pm-5am when the LED light was continuously on.

Although only ten cats participated in this pilot study, a total of seventeen different cameras were used during the course of the study due to technological faults or cameras being destroyed or lost by cats.

During the period of data collection, cats spent the majority of their time either investigating matter or staying indoors (see Figure 2). Behaviours such as locomotion, engaging in risky activities, grooming, ingestion of matter and predation were only a small percentage of each free-roaming domestic cat's total recorded activities (See Figure 2).

Staring at birds that didn't lead on to a predatory behaviour was classified as "investigation". Half of the cats involved in our study were observed staring at birds.

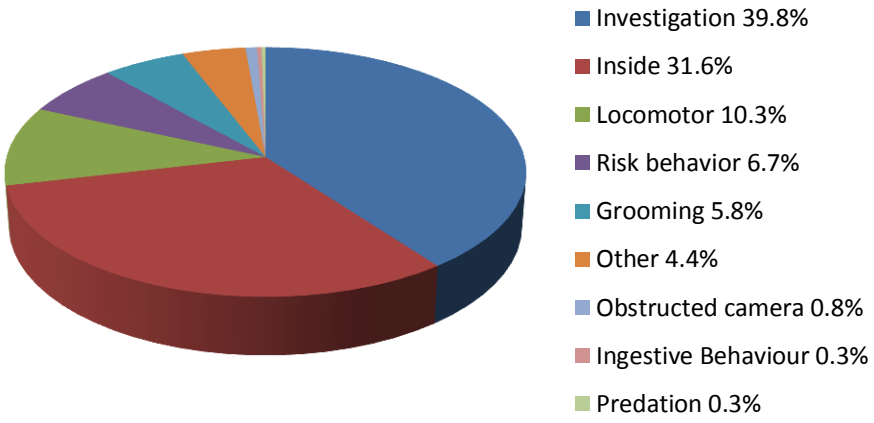


Figure 2: Behaviours exhibited by 10 domestic free-ranging cats over an eight week period monitored by Eyenimal™ Cat Videocams in Wellington, New Zealand.

All ten cats exhibited at least one risk behaviour during the eight weeks of data collection. The most common risk behaviours exhibited by suburban, domestic free-roaming cats in Wellington included: climbing trees or onto a roof (80 per cent of individuals), entering crawl spaces (70 per cent), consuming liquids not left by owner (60 per cent), encountering cats that were not from the same household (60 per cent) and crossing roads (40 per cent).

Most participants encountering cats (not from the same household) had non-aggressive encounters (76 per cent of the time). However, cat fights were witnessed with 40 per cent of participants engaging in one aggressive physical contact with a stranger cat (see Figure 3).

Below, Table 1 lists the type of risk behaviours witnessed via Eyenimal™ Cat Videocams and includes the collective sum for the number of times each was counted. Unexpectedly, we also found one cat entered a stranger's home and nine out of ten cats in this study left their properties on at least one occasion.

TABLE 1: Risk behaviours exhibited by 10 free-roaming cats monitored via Eyenimal™ Cat Videocams in Wellington, New Zealand

Risk behaviour	**Cumulative Count**
Entering crawl spaces (Risk of getting stuck/trapped)	32
Climbing tree (Injury risk, Risk of getting stuck/trapped)	19
Consuming liquids not left by owner (Poisoning risk)	16
Non-aggressive contact with stranger cat (Disease risk)	13
Crossing road (Injury risk)	6
Aggressive contact with stranger cat (Injury risk, Disease risk)	4
Climbing on roof (Injury risk, Risk of getting stuck)	3

Whilst most cats (70 per cent) exhibited at least one predatory behaviour during the period of data collection, only 6 cats made a total of 15 successful prey captures on camera. The most common predation behaviours observed included: Consuming or manipulating an invertebrate (50 per cent) and consuming lizards (20 per cent). Invertebrates were the most prevalent prey captured by Wellington cats during the period of data collection (see Table 2) followed by lizards (See Figure 3).
No predation of birds or rodents was observed on camera however one owner reported their cat bringing home both a bird (species unidentifiable due to the condition of the carcass) and a mouse "off camera" during the study period. There was also an observation of a bird being stalked by one of the study cats.

TABLE 2: Predation behaviours exhibited by 10 free-roaming cats monitored via Eyenimal™ Cat Videocams in Wellington, New Zealand

Predation behaviour		Cumulative Count
On screen:	Invertebrate eaten	11
	Skink eaten	3
	Manipulating invertebrate (not eaten)	2
	Gecko eaten	1
	Stalking bird	1
Off screen:		
(owner reported)	Skink killed	2
	Bird killed	1
	Mouse killed	1
	Invertebrate killed	1
Total predation events		23

Figure 3: Still images pulled from Eyenimal™ Cat Videocams recorded by 10 free-roaming cats in Wellington, New Zealand. 3a) an unknown roaming cat attacks study participant. 3b and c) a native skink being chased, caught (and subsequently eaten) by study participant. 3d) study participant about to get a claw to the face.

Discussion

Eyenimal™ Cat Videocams videos were useful in providing insight into the behaviours and activities of free-roaming domestic cats in the Wellington region.

Maybe curiosity does kill the cat - with "investigation" being the behaviour most commonly exhibited by free-roaming domestic cats in this study. Although classified within "investigation", staring at birds was an activity exhibited by half of the cats in this study.
Cat presence may have sub-lethal effects for birds (such as reduced fecundity and parental provisioning rates) owing to "fear of cats" (Beckerman et al., 2007; Bonnington et al., 2013). Beckerman et al., (2007) has suggested that cat density in urban environments may detrimentally impact bird productivity ultimately resulting in reduced avian population sizes. Documenting low predation rates of cats killing birds, like in our study, may then just reflect the low population numbers of bird species in this area due to high cat density (Beckerman et al., 2007).
Determining the sub-lethal effects of domestic cats on avian fauna is something that needs to be addressed within the NZ context.

Predation behaviours
It is well documented that domestic cats, *Felis catus*, are highly efficient, opportunistic predators (Loyd et al., 2013a; van Heezik et al., 2010). Prey selection includes mammals, birds, reptiles, invertebrates and amphibians (American Bird Conservancy, 2010; Gillies, 2001; Gillies & Clout, 2003; Lepczyk et al., 2004; van Heezik et al., 2010).
All cats in this study were previous hunters, with all owners reporting that their pet had previously brought in prey items. However, evidence of predatory behaviour through the use of Eyenimal™ Cat Videocams was only evident for some cats. Invertebrates and lizards were the only observed prey species caught. This is similar to the results of a study conducted by Gillies & Clout (2003), where invertebrates were found to be the most common prey item for fully urban cats in Auckland. A study in Dunedin found birds and rodents to be most common menu items (van Heezik et al. 2009). Surprisingly, no birds or rodents were caught on camera during our study, despite all cat owners reporting that their cat had previously killed birds, and 8 reporting rodent predation.
Whilst predation of mammals and birds by domestic cats is well documented, less is known about the effects domestic cats have on lizard and invertebrate populations within the New Zealand context. Globally, lizards are known to be a large dietary component of feral cats in areas of conservation concern (Gillies, 2001., Lardner et al., 2013), however our study shows that pet cats in urban areas may also contribute to population declines in species of native skinks and geckos.

Four cats in the study wore bells on their collars, which have been shown to reduce the prey catch of domestic cats in New Zealand by half (Gordon et al., 2010), however Bonnington et al., (2013) suggests that cats wearing bells may have sublethal effects on birds. Bells increase the detectability of cats which may increase the spatial extent over which birds perceive an increase in predation risk (Bonnington et al., 2013).
The lack of rodent predation in this study may be attributed to Eyenimal™ Cat Videocams not often being deployed at night (only 17% of the total video recordings were at night) when mice and rats tend to be most active. Additionally, it is possible that the presence of a collar-mounted accessory may have physically hindered the hunting habits of cats in this study.

We are unable to determine the full extent of predation of native and non-native wildlife in the Wellington region based on the results of this pilot study and its small sample size. Further research into the extent domestic cats predate on native wildlife is needed. Pet cats may be depleting native fauna, but they may also indirectly be helping native wildlife by keeping other introduced predators, such as rodents, in check. Meso-predator release is a process where once a "superpredator" (such

as cats) is removed from an environment, other "meso-predators" (such as rats or mice) increase and can have an even more detrimental effect on wildlife (Courchamp et al., 1999).
Further research on ways to prevent domestic cat predation on native wildlife and also meso-predator release is warranted.

Risk behaviours
All cats in this study engaged in a number of risk behaviours which had the potential to threaten their survival. In a study by Loyd et al. (2013b), 85% of free-roaming cats in Georgia, USA exhibited at least one risk behaviour throughout the duration of their study, where crossing roads was the highest risk behaviour observed.

In the United States the average life-expectancy of a strictly indoors pet cat versus a free-roaming pet cat varies dramatically, 12-18 years versus 3 years, respectively (Humane Society of the United States, 2013). This is likely due to free-roaming domestic cats exhibiting risk behaviours whilst outdoors (Horn et al., 2011; Loyd et al., 2013b). Overseas, free-roaming cats may also encounter predators themselves, such as coyotes (*Canis latrans*) (Loyd et al. 2013b), whereas domestic cats in New Zealand have no predators.

Traffic accidents, conflict with other animals and exposure to poisons and disease are just some of the causes that can also contribute to free-roaming cat death (Loyd et al. 2013b).
Domestic free-roaming cats contracting an infectious disease or obtaining an injury is of particular concern as more than half of our study cats were witnessed encountering stranger cats.
Cats in New Zealand can carry a number of diseases (Gillies, 2001; Thompson, 1999) which includes, but is not limited to; toxoplasmosis, cat scratch disease and feline immunodeficiency virus (FIV). The exposure of cats to these diseases is heightened if cats are free-roaming, as they are more likely to come into contact with another infected individual (Gerhold & Jessup, 2013; Horn et al., 2011; Loyd et al. 2013b). Globally, cats are a potential source for a variety of zoonotic diseases (such as toxoplasmosis) and these infected cats can pose a serious health threat to other domestic animals, wildlife and humans (Gerhold & Jessup, 2013; Loyd et al. 2013b).

Confining domestic cats to owner properties or keeping pet cats indoors is potentially a way to reduce the risk of injury or mortality. This may also help reduce the impact hunting domestic cats have on the New Zealand fauna.

Limitations of this study
Whilst Eyenimal™ Cat Videocams were useful in providing baseline information on free-roaming cat activities they were only able to record up to 2.5 hours at a time so each recording was only a "snap shot" of each cats' day. Low recording times meant we were unable to observe all of the behaviours and activities exhibited by each cat on a day to day basis. Considering the small portion of each cat's day that we were able to observe it was surprising to see the amount of invertebrate and lizard predation.

Ideally we were aiming for 10 separate recordings from each cat but this was not possible for some participants due to issues with faulty technology or lost cameras. This study also coincided with the holiday period which affected data collection as many owners were away during this time. Initially we had difficulty recruiting suitable participants for this study, however after advertising in local veterinary clinics and online we received an overwhelming number of requests from cat owners wanting to participate.

We experienced multiple issues with the Eyenimal™ Cat Videocams, either through faults with the technology or cameras being destroyed or lost by cats. This was a major constraint and was very

time consuming. Petvision (Eyenimal™ Cat Videocams distributors) attributed malfunctions to a suspected faulty batch of internal batteries (Nick Mooyman, PetVision, pers. comm.) and were incredibly helpful when we had issues and extremely efficient at sending replacement cameras when needed.

The positioning of the camera (under cats chin) meant that sometimes it was not possible to see what the cat was looking at – this may have affected our results. The camera itself may have also been a deterrent to cats being able to catch prey.

Recommendations for future research

Whilst the collar-mounted cameras were useful in providing a 'cat's eye view' of the world (which their owners seemed to genuinely enjoy), the technology does not allow for determining where and how far domestic cats roam. Cat owners were sometimes able to ascertain where their cats were, based on landmarks that they were familiar with, and we relied on this information from owners to determine that cats left their properties. In the future, a GPS tracking system would allow for the collection of location information. Combined with camera use, a more comprehensive profile of Wellington's pet cats may be compiled.

Additionally, whilst the cameras were "shower-proof", they were not completely waterproof. At least 2 cats dunked their cameras in their water bowls, resulting in damage to the unit. We suggested that participants elevate their cats' water bowls for the remainder of the study. This suggestion should be incorporated into future studies involving collar-mounted cameras.

We found advertising in local veterinary clinics and via social media to be the most successful forms of contacting potential participants. Additionally, as this pilot study gained media attention, we received more requests for participation than we were able to accommodate. We have compiled a database with contact details for potential participants for future studies.

Conclusion

Cats in New Zealand contribute to native wildlife decline but also prey upon on invasive species such as rodents. There is a need for further research on owned free-roaming cat predation (Loyd et al. 2013a). Determining what New Zealand free-roaming domestic cats get up to will provide local cat owners with the information they have been requesting (i.e. relevant local research in regards to predation behaviours; Kikillus, pers. obs). It would allow researchers to begin to quantify the number of native and exotic species killed by domestic cats and also ascertain the type and regularity of risk behaviours exhibited by cats. And finally, it would satiate our curiosity by offering an insight into the 'secret lives of wandering cats'.

The results of this study will help design a larger and more comprehensive research project, which may involve other techniques, such as GPS tracking, and which may span up to 2 years.

Acknowledgements

- PetVision, Auckland, New Zealand
- Wellington moggies and their cat owners ☺

References:

Beckerman, A. P., Boots, M., & Gaston, K. J. (2007). Urban bird declines and the fear of cats. Animal Conservation, 10(3), 320-325

American Bird Conservancy. (2010). Cats Indoors. Available at: http://www.abcbirds.org/abcprograms/policy/cats/index.html (accessed 30 July, 2013). (Accessed 29, November, 2013).

Bonnington, C., Gaston, K. J., & Evans, K. L. (2013). Fearing the feline: domestic cats reduce avian fecundity through trait-mediated indirect effects that increase nest predation by other species. Journal of Applied Ecology, 50(1), 15-24.

Courchamp, F., Chapuis, J. L., & Pascal, M. (2003). Mammal invaders on islands: Impact, control and control impact. Biological Reviews of the Cambridge Philosophical Society, 78(3), 347-383.

Courchamp, F., Langlais, M., & Sugihara, G. (1999). Cats Protecting Birds: Modelling the Mesopredator Release Effect. Journal of Animal Ecology, 68(2), 282-292. doi: 10.2307/2647217

Dowding, J. E., & Murphy, E. C. (2001). The impact of predation by introduced mammals on endemic shorebirds in New Zealand: A conservation perspective. Biological Conservation, 99(1), 47-64.

Fitzgerald, A.M., Karl, B.J. (1979). Foods of feral house cats (Felis catus L.) in forest of the Orongorongo Valley, Wellington, New Zealand Journal of Zoology, 6:1, 107-126.

Fitzgerald, B. M., & Karl, B. J. (1986). Home range of feral house cats (Felis catus L.) in forest of the Orongorongo Valley, Wellington, New Zealand. New Zealand Journal of Ecology, 9, 71-81.

Gerhold, R. W., & Jessup, D. A. (2013). Zoonotic Diseases Associated with Free-Roaming Cats. Zoonoses and Public Health, 60(3), 189-195.

Gillies, C. (2001). Advances in New Zealand mammalogy 1990-2000: House cat. Journal of the Royal Society of New Zealand, 31(1), 205-218.

Gillies, C., & Clout, M. (2003). The prey of domestic cats (Felis catus) in two suburbs of Auckland City, New Zealand. Journal of Zoology, 259(3), 309-315.

Gordon, J. K., Matthaei, C., & Van Heezik, Y. (2010). Belled collars reduce catch of domestic cats in New Zealand by half. Wildlife research, 37(5), 372-378.

Hansen, C. M. (2010). Movements and predation activity of feral and domestic cats (Felis catus) on Banks Peninsula (Doctoral dissertation, Lincoln University).

Hervías, S., Oppel, S., Medina, F. M., Pipa, T., Díez, A., Ramos, J. A., . . . Nogales, M. (2013). Assessing the impact of introduced cats on island biodiversity by combining dietary and movement analysis. Journal of Zoology.

Horn, J. A., Mateus-Pinilla, N., Warner, R. E., & Heske, E. J. (2011). Home range, habitat use, and activity patterns of free-roaming domestic cats. Journal of Wildlife Management, 75(5), 1177-1185.

Innes, J. (2001). Advances in New Zealand mammalogy 1990-2000: European rats. Journal of the Royal Society of New Zealand, 31(1), 111-125.

Lepczyk, C. A., Mertig, A. G., & Liu, J. (2004). Landowners and cat predation across rural-to-urban landscapes. Biological Conservation, 115(2), 191-201.

Loyd, K. A. T., Hernandez, S. M., Carroll, J. P., Abernathy, K. J., & Marshall, G. J. (2013a). Quantifying free-roaming domestic cat predation using animal-borne video cameras. Biological Conservation, 160, 183-189.

Loyd, K. A. T., Hernandez, S. M., Abernathy, K. J., Shock, B. C., & Marshall, G. J. (2013b). Risk behaviours exhibited by free-roaming cats in a suburban US town. Veterinary Record, 173(12), 295.

MacKay, J. (2011). Companion animals in New Zealand. New Zealand Companion Animal Council, Auckland, New Zealand. Available at: http://www.nzcac.org.nz/images/stories/canz2011report/nzcac-canz2011.pdf (accessed 18th November 2013)

Medina, F. M., Bonnaud, E., Vidal, E., Tershy, B. R., Zavaleta, E. S., Josh Donlan, C., . . . Nogales, M. (2011). A global review of the impacts of invasive cats on island endangered vertebrates. Global Change Biology, 17(11).

Metsers, E. M., Seddon, P. J., & Van Heezik, Y. M. (2010). Cat-exclusion zones in rural and urban-fringe landscapes: How large would they have to be? Wildlife Research, 37(1), 47-56.

Moorhouse, R., Greene, T., Dilks, P., Powlesland, R., Moran, L., Taylor, G., . . . August, C. (2003). Control of introduced mammalian predators improves kaka Nestor meridionalis breeding success: Reversing the decline of a threatened New Zealand parrot. Biological Conservation, 110(1), 33-44.

New Zealand Companion Animal Council, Inc. (2011). Companion Animals in New Zealand. Available at: http://www.nzcac.org.nz/images/stories/canz2011report/nzcac-canz2011.pdf (accessed 28th November, 2013).

O'Donnell, C. F. J. (1996). Predators and the decline of New Zealand forest birds: An introduction to the hole-nesting bird and predator programme. New Zealand Journal of Zoology, 23(3), 213-219.

Positively Wellington Tourism (2013). Available at: http://www.wellingtonnz.com/visitor-information/essentials (accessed 30th November, 2013).

Reardon, J. T., Whitmore, N., Holmes, K. M., Judd, L. M., Hutcheon, A. D., Norbury, G., & Mackenzie, D. I. (2012). Predator control allows critically endangered lizards to recover on mainland New Zealand. New Zealand Journal of Ecology, 36(2),141.

Recio, M. R., Mathieu, R., Maloney, R., & Seddon, P. J. (2010). First results of feral cats (Felis catus) monitored with GPS collars in New Zealand. New Zealand Journal of Ecology, 34(3), 288-296.

Sanders, M. D., & Maloney, R. F. (2002). Causes of mortality at nests of ground-nesting birds in the Upper Waitaki Basin, South Island, New Zealand: A 5-year video study. Biological Conservation, 106(2), 225-236.

Sims, V., Evans, K. L., Newson, S. E., Tratalos, J. A., & Gaston, K. J. (2008). Avian assemblage structure and domestic cat densities in urban environments. Diversity and Distributions, 14(2), 387-399.

Thompson, J. (1999). Important infectious diseases of cats in New Zealand (Vol. 26): Ministry for Primary Industries.

Towns, D. R., & Broome, K. G. (2003). From small Maria to massive Campbell: Forty years of rat eradications from New Zealand islands. New Zealand Journal of Zoology, 30(4), 377-398.

van Heezik, Y., Smyth, A., Adams, A., & Gordon, J. (2010). Do domestic cats impose an unsustainable harvest on urban bird populations? Biological Conservation, 143(1), 121-130.