EUROPEAN JOURNAL OF ECOLOGY

EJE 2017, 3(1): 85-90, doi: 10.1515/eje-2017-0009

Comparison of predation by two suburban cats in New Zealand

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ABSTRACT

To study the effects domestic cats may have on surrounding wildlife, a complete list was made of 558 items caught in the garden or brought into the house by one cat over 17 years, from 1988 to 2005. The effect on prey populations was assessed by comparing their abundance with the previous 15 years' population without a cat. On balance, this cat (Cat 1) was clearly beneficial to the native bird species by killing rodents and deterring mustelids. The diet of a second cat (Cat 2) was recorded in the same way from 2006 to 2016. This cat caught half the number of items 148:287, but in the same proportions: house mice (37.8:42.6); ship rats (12.8:12.1); European rabbits (all young) (8.1:6.7); weasels (0.7:0.4); dunnock (12.8:9.2); house sparrow (2.0:3.1); blackbird (2.7:2.5); song thrush (1.4:1.3); European greenfinch (0.7:5.8); chaffinch (0.7:3.3); silvereye (10.1:8.3); New Zealand fantail (2.0:1.0); lizards (8.1:1.7). Despite this, there were significant differences: Cat 2 avoided finches (2:28, P = 0.004), and took a few more lizards (12:5). For both cats, birds apparently formed about a third of their diet: 33.4% and 34.5%, but comparison of the proportion of birds and rodents brought into the house (12:92) and found dead away from the house (49:45) implies that 320 rodent kills may have been missed, being far more difficult to find. As top predators, these cats were clearly beneficial to native birds, and proposed control or elimination may precipitate mesopredator release and a rabbit problem.

KEYWORDS

domestic cat; *Felis catus;* birds; rodents; rabbits; mustelids; predation.

INTRODUCTION

Concern regarding the role of Domestic cats (*Felis catus* Linnaeus, 1758) as bird killers has a long history: 'to put the cat among the pigeons' dates back to colonial India (Jain, 2006). The earliest most comprehensive review (Forbush, 1916) has an enlightened ecological approach, considering such aspects as the damage to trees caused by cat predation on birds, which control defoliating insects, and even suggests a solution: 'The useful and nearly harmless cat possibly might be produced by selection and breeding.' Bradt (1949) recorded that a farm cat in America caught 1628 mammals and 62 birds in 18 months, casting doubt on their negative reputation. Pioneering studies by George (1974), Borkenhagen (1978), and of cats in an English village (Churcher & Lawton 1987) started a flood of similar investigations around the world. Most of these merely estimate how many animals (often only birds) are being killed by cats, with no regard to how many birds have been saved by cats from rodent, mustelid, and other predators. This is understandable where the food webs are complex (e.g., Europe, America, or Australia).

The impoverished fauna in New Zealand offers an apparently simpler problem, and Gillies & Fitzgerald (2005) review 17 studies of cat diet in mainland New Zealand based on gut or scat analyses; seven from offshore islands, and four of what the urban cats brought home. For Kiwi *Apteryx spp.*, three had been killed by cats, and almost all the rest 38, by stoats (*Mustela erminea* Linnaeus, 1758). Would kiwi populations benefit by increasing cat numbers to control stoats? As King et al. (1996) points out, having studied the food of nine mammalian predators for five years in the 75000 ha of Pureora Forest Park in central New Zealand, in view of 'uncertainty about which predator is most damaging, and also the possibilities of diet switching and/or rodent population release', all should be controlled together.

Unfortunately, as in America (Marra & Santella 2016), the relationship of cats to bird conservation in New Zealand has become a polarised debate, addressed by emotional rhetoric 'Cats to go'; car bumper stickers 'I love cats'/ 'I love flat cats'; wide extrapolations – one Bellbird (*Anthornis melanura*, Sparrman, 1786) caught in Dunedin by a cat becomes an annual kill of 413 (van Heezik et al. 2010); dubious identifications of prey from questionnaires rather than collecting prey for accurate identification [Dunnocks, formerly called hedge sparrows (*Prunella modularis*, Linnaeus, 1758) and juvenile finches become house sparrows (*Passer domesticus*, Linnaeus 1758), and fledgling Eurasian blackbirds (*Turdus merula*, Linnaeus, 1758) become song thrushes (*Turdus philomelos* Brehm, 1831)]; and selectively misleading facts – New Zealand has 'the highest rate of cat ownership in the world' (Linklater 2013), but one of the lowest densities of cats: 5.2/100 ha, compared with 19.6/100 ha in Japan, and 31.7/100 ha in Britain.

Because the first complete life-time record of the prey brought in by a cat, from 1987 to 2005 (Flux 2007), was severely criticised for 'extrapolating' from one cat (e.g., Linklater 2013), it is worth pointing out that my interest is in the 558 accurately identified prey items; and that even large studies of whole towns (van Heezik et al. 2010) do not allow 'scaling up of mortality estimates to broad regions' (Loss et al. 2012). Indeed, it is important to realise that every area will be different, depending on the other predators and prey present. Thus, in America, native predators are able to control rodent pests (Forbush 1916) and, as in Britain (Baker et al. 2008) and Europe (Tschanz et al. 2011; Krauze-Gryz et al. 2012; Kauhala et al. 2015;), there is no problem of tree-climbing ship rats (*Rattus rattus*, Linnaeus, 1758). The devastating effect the cats (and other predators) have had on islands is beyond dispute (Medina et al. 2011; Doherty et al. 2016).

This note presents some accurate data, and discusses its relevance to the debate. The hypothesis that cats may be beneficial to birds was supported.

1. METHODS

The diet of a replacement cat (for convenience hereafter denoted Cat 2) was studied from 2006 to 2016 to check for individual differences in prey selection, kill rates, location, and amount eaten, at the same house in Belmont, Lower Hutt (41 11 S, 174 55 E), Wellington.

This cat, a neutered female tortoiseshell, weighed 3.6 kg, and was six years old when adopted from the Society for the Protection of Cruelty to Animals (Fig. 1). Unfortunately, nothing was known of its previous location or hunting history. The prey brought into the house and found in the garden was recorded from January 2006 to January 2016 in the same way: species, age, location (inside house or at door, within 20 m; 20–50 m, outside garden) and amount eaten. The garden was traversed daily, and a gardener employed one day a week also reported kills. Both cats were fed ad lib and allowed to hunt day and night. As before, all cats seen in the garden were photographed for identification by pattern; none hunted in the garden, but two took over and retained distant parts of the previous cat's range. The study area remained as described (Flux 2007): a half hectare garden with a mature pine plantation on one side and grass fields on the others. Both cats hunted within this area (except for rabbits), and were never photographed at my son's house 300 m below ours, or seen by the neighbour 100 m above us.

The only changes in the bird species present were the arrival of eastern rosellas (*Platycercus eximius*, Shaw, 1792) in 1982, and the establishment of a local flock of seven from 2006 (the cat stalked a pair unsuccessfully on 16 March 2012); whiteheads (*Mohoua albicilla*, Lesson, 1830) arrived in 2009 but stayed only six months; a pair of bellbirds (*A. melanura*) was resident from August 2009 until March 2012 when driven out by increasing numbers of tui (*Prosthemadera novaeseelandiae*, Gmelin, 1788), as was the nesting morepork (*Ninox novaeseelandiae*, Gmelin, 1788) in 2007. The abundance of other birds breeding in the garden remained same as before: house sparrow (*P. domesticus*) 5–10 pairs; dunnock (*P. modularis*) 2–3 pairs; starling (*Sturnus vulgaris*, Linnaeus, 1758) 2–7 pairs; blackbird (*T. merula*) 3–5 pairs; song thrush (*T. philomelos*), chaffinch (*Fringilla coelebs*, Linnaeus, 1758), European greenfinch (*Carduelis chloris*, Linnaeus, 1758), silvereye (*Zosterops lateralis*, Latham, 1802), New Zealand fantail (*Rhipidura fuliginosa*, Sparrman, 1787), and grey warbler (*Gerygone igata*, Quoy & Gaimard, 1830), 1–2 pairs each.

A poison bait station 80 m from the house, operated by Greater Wellington Regional Council since 2004–5 to kill brushtail possums (*Trichosurus vulpecula* Kerr, 1792 and ship rats (*Rattus rattus*) has greatly reduced possum numbers.

All statistical probabilities quoted are calculated from Fisher's exact two-tailed Chi square tests based on the original data.

2. RESULTS

The total number of each prey species caught by Cat 2 in 10 years (age 6 to 16), compared with Cat 1's tally over the same years of age (Fig. 2), shows that the choice of prey was almost identical for both cats. The only obvious differences were that the second cat caught half the previous cat's total, 148:287 items; avoided finches (2:28, $P = 0.004$, Fisher's exact two-tailed Chi square test on original data), and took a few more lizards (12:5), comprising one New Zealand common gecko (*Hoplodactylus maculatus*, Gray, 1845) and 11 copper skinks (*Cyclodina aenea*, Girard, 1857). Expressed as percent occurrence of species caught, the similarity between the second and first cats is evident: house mice (*Mus musculus*, Linnaeus, 1758) (37.8:42.6); ship rats (*R. rattus*) (12.8:12.1); rabbits (*Oryctolagus cuniculus*, Linnaeus, 1758), all young (8.1:6.7); weasels (*Mustela nivalis*, Erxleben, 1777) (0.7:0.4); dunnock (*P. modularis*) (12.8:9.2); house sparrow (*P. domesticus*) (2.0:3.1); blackbird (*T. merula*) (2.7:2.5); song thrush (*T. philomelos*) (1.4:1.3); greenfinch (*C. chloris*) (0.7:5.8); chaffinch (*F. coelebs*) (0.7:3.3); silvereye (*Z. lateralis*) (10.1:8.3); fantail (*R. fuliginosa*)

Figure 1. Cat 2, a generalist predator with special preference for rabbits.

(2.0:1.0); lizards (8.1:1.7). For both cats, birds formed about a third of their diet: 33.4% and 34.5%.

As with Cat 1, the number of prey caught each year declined with age, tallies from 2006 to 2015 being: 38, 28, 17, 14, 8, 12, 13, 10, 4, 4. There was also the same, but less marked, seasonal pattern, with more prey caught in summer (89) than in winter (59) (cf. 371:187 for Cat 1, P = 0.174, Fisher's exact two-tailed Chi square test). The only exceptions were mice (*M. musculus*) with peak numbers in April and May (26 summer, 30 winter) (cf. 117:104 for Cat 1, P = 0.455), and silvereyes (*Z. lateralis*), which flock into gardens in winter (6 summer, 9 winter) (cf. 27:16 for Cat 1, P = 0.143). For Dunnocks (*P. modularis*), the summer bias was equally strong for Cat 1 (54:7) and Cat 2 (19:1) (P = 0.672).

Despite the similarity in numbers of prey species caught, there were some significant differences in the proportions eaten. The first cat ate 54 of 145 mice (*M. musculus*) caught; the second 35 of 56, significantly more (P = 0.0015, Fisher's exact two-tailed Chi square test). The ship rat's (*R. rattus*) proportions eaten were very similar (23 of 33, and 13 of 21), and both cats ate all the rabbits (*O. cuniculus*) they caught. Both cats travelled 200 to 600 m to reach rabbit burrows, which were only found in the garden from 1972 to 1987 before Cat 1 arrived, and between September 2005 and January 2006 before Cat 2 arrived. Although both cats caught more dunnocks (*P. modularis*) than any other bird, the first cat ate significantly more than the second cat (23 of 33 vs. 4 of 19, P = 0.0013). The first cat ate a significantly greater proportion of dunnocks (*P. modularis*) than it did of other birds (details in Flux 2007); the second cat ate fewer (4 of 19 vs. 14 of 29), but this difference is not significant (P = 0.07).

The location of the bird carcases found (12 in the house, 49 in the garden) differs significantly (P < 0.0001, Fisher's exact two-tailed Chi square test) from that of rodents (92 in the house, 45 in the garden). Bird kills leave conspicuous piles of feathers, and usually a beak, legs and wings, which last a long time. Some mice and young rats were eaten whole, leaving no trace; others were represented by a nose, tail or discarded stomach, hard to find in an overgrown garden. If the house to garden ratio of birds is correct, and there is no difference in the proportions of birds and rodents brought home (as Krauze-Gryz et al. 2012 found), it implies that 320 rodent kills were missed. Dr B. M. Fitzgerald (personal communication) suggested that this might be a result of cool temperatures at night, when most rodents are caught, encouraging the cats to eat indoors, and to check for seasonal variation. This led to a strange result comparing winter (April to September) with summer (October to March): in winter, Cat 1 brought in 25 of 29 rodents, while Cat 2 brought in only 16 of 36 (P = 0.0007); there were no significant differences in the summer, nor in the bird proportions in winter or summer, for either cat.

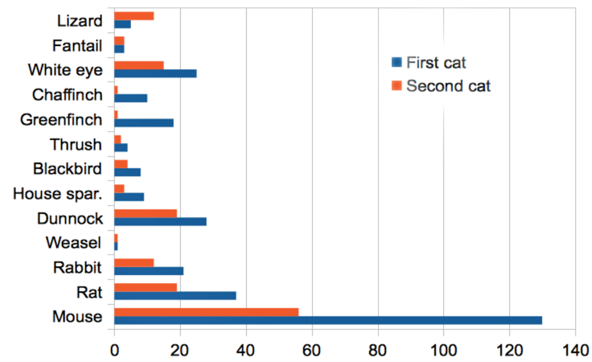

Figure 2. Numbers of prey items killed by Cat 1 and Cat 2 in ten years.

At Belmont, over 27 years, silvereyes (*Z. lateralis*) were the most common window casualty (12), followed by New Zealand pigeon (*Hemiphaga novaeseelandiae*, Gmelin, 1789) (8), shining cuckoo (*Chrysococcyx lucidus*, Gmelin, 1788) (7), grey warbler (*G. igata*) (2), and one each of sacred kingfisher (*Todiramphus sanctus*, Vigors & Horsfield, 1827), California quail (*Callipepla californica*, Shaw, 1798), song thrush (*T. philomelos*), and chaffinch (*F. coelebs*). How many birds that the cats brought in were actually window-kills is not known.

3. DISCUSSION

There were no noticeable changes in the abundance of birds nesting in the garden during the 10 years Cat 2 hunted, and chicks fledged successfully each year from the two house sparrow (*P. domesticus*) nests and one starling (*Sturnus vulgaris*) nest in a tree fern 2 m from the front door.

A fantail (*R. fuliginosa*) and a tui (*P. novaeseelandiae*) fledged young within 20 m of the house; all these nests were 2–-5 m above ground level, and easily accessible by the cat. As Mudge (2002) found from a 5-year study using automatic cameras to record 400 Fantail nests: 'breeding success is significantly greater near houses where there are cats – especially when rat numbers are high.'

One cannot extrapolate from a sample size of two, but it is valid to examine how representative these two cats are of the wider Wellington region. The best available study is of the 843 items brought in by 130 cats in Wellington city from January to April (Gillies & Cutler 2001). The percentage distribution of their prey, with the average of the two Belmont cats in brackets, is: mice (*M. musculus*) 37.2 (40.2); rats (*Rattus spp.*) 7.9 (12.4); rabbits (*O. cuniculus*) 0.4 (7.4); mustelids (*Mustela spp.*) 0.1 (0.5); birds 31.7 (33.4); lizards 22.7 (4.9). The suburban location of our garden explains the greater number of rabbits caught; why so many more lizards were caught in Wellington ($P < 0.0001$ Fisher's exact two-tailed Chi square test based on original data) is unclear. Since the capture rate of other prey is similar, a higher population of lizards is indicated, rather than a scarcity of bird and mammal prey. Brockie (2001) also found 27.3% lizards in 165 items, and Gaby (2014) 21.7% of 23 items, in Wellington city.

The second cat's preferential selection of dunnocks (*P. modularis*), but reluctance to eat them, is interesting. They are common throughout New Zealand, but are confused with house sparrows (*P. domesticus*) and generally under-represented in questionnaire studies of cat diet (Flux 2007). The first cat caught and ate more dunnocks (*P. modularis*) than any other bird, so it might have been selecting them on taste; but the second cat caught and discarded them. House sparrows (*P. domesticus*) were 5−10 times commoner in the garden, feeding on spilled hen food within reach of the cats, and were not noticeably unpalatable – one of three caught was eaten (and five of 15 by Cat 1). It seems that dunnocks (*P. modularis*) may be differentially selected on their more solitary, mouse-like behaviour: 'Hedge-creeper', 'Shuffle-wing', and 'Creepy' are the dialect names for it in Britain (Swann 1913).

The possibility that 87% of the rodents killed in the garden were being missed is important, as many studies of what cats bring back have had no way of estimating this source of error, being based on questionnaires reporting what cats bring into the house (Gillies & Cutler 2001; van Heezik et al. 2010; Metsers et al. 2010). Following the radio-tagged cats avoids this problem, and gives kill rates three to four times higher than reported as brought in (Kays & DeWan 2004; Loyd et al. 2013). The proportion of birds brought into our house, one fifth of those killed, is within the range of the few published estimates available, half to one sixth (reviewed by Blancher 2013); and the large garden was semi-isolated, being surrounded on three sides by grassland, and on the fourth by mature pines with little undergrowth. Hence, most of the kills except rabbits (*O. cunicularis*), were made in the garden. Allowing for the missing rodents would reduce the percentage of birds killed from 33.4% to 11.9%. Analysis of cat diet from droppings avoids this problem, and showed only 12% contained birds, forming 4.5% of their diet by weight (being smaller), in the Orongorongo Valley, 20 km east of Wellington (Fitzgerald & Karl 1979). Scat and stomach content analyses do not account for prey not eaten; but for feral cats, one expects these would be few. Interestingly, in the 1980s, when fewer cats were present, the frequency of occurrence of rats and birds in the diet remained as in the 1970s (Efford et al. 2006), but the frequency of rabbits doubled, although the number of rabbits present had not changed (Gibb & Fitzgerald 1998). Recent comparison of cat diets on Adriatic islands illustrate this effect, and warn that different management strategies will be needed to control feral and house cats (Lanszki et al. 2016).

Current government-approved proposals to exterminate all introduced predators in New Zealand by 2050 (Owens 2017) risk a return to the major rabbit problems of 1870–1950 unless rabbits are removed first. At present, as in our study area, cats hold most New Zealand rabbit populations in a 'predator pit', except in Central Otago (Flux 1999). Removing cats before the rabbits on Macquarie Island was a 24-million-dollar illustration of this mistake (Bergstrom et al. 2009). For a general review of invasive predator management see Doherty & Ritchie (2017).

Two important factors influencing what a cat brings home are birds killed after striking windows (reviewed by Bracey et al. 2016) – mammals are not affected – and road-kills that cats retrieve (Slater 2002; Flux 2017). The first probably increased the number of bird kills attributed to my cats, but could not be measured. The second was insignificant; the cats had access to 150 m of dead-end road serving four houses, on which I recorded only a few hedgehogs (*Erinaceus europaeus*, Linnaeus, 1758) and brushtail possums (*T. Vulpecula*) as road-kills, neither of which were ever brought in by the cats. Remarkably, no estimates of cat predation appear to allow for these factors, although studies of bird-strike on windows and road-kills assess the numbers removed by scavengers at 5 and 12−16 times the ground count (Bracey et al. 2016; Slater 2002). If these scavengers are house cats (which are the most likely to pick up dead birds below their own windows, and on the street outside) they need to be subtracted from the kills attributed to cats. As an example, a comprehensive review of human-related bird mortality in Canada (Calvert et al. 2013) makes no allowance for this, despite one of the contributors stating, 'Some animals brought home and assumed to have been killed by pet cats may have been killed by other means, e.g., collisions with cars or buildings' (Blancher 2013). Had these been allowed for, on my calculation, his estimate of 225 (105−348) million birds killed by cats could be reduced to 110 (45−175) million, assuming most scavenging was by cats, and that they brought back one in three items.

4. CONCLUSION

The prey selected by cats closely reflects the relative abundance of the species available [e.g., blackbird (*T. merula*), song thrush (*T. philomelos*)], modified by taste [(rabbits (*O. cuniculus*)], prey behaviour [dunnocks (*P. modularis*)], and some unexplained aversion [house sparrows (*P. domesticus*)]. That individual cats differ widely in the quantity of prey caught is already well established, but this did not seem to influence prey selection. The difficulty of finding dead rodents compared to birds underestimates the real value of cats in predator control, and bringing back birds killed by cars and windows gives cats a worse reputation than they deserve.

Acknowledgements: This work was not supported by any funding agency.

Many thanks to Mike Fitzgerald for his long interest in our successive cats' diets, and frequent discussions on ecological problems; his perceptive comments on an early draft were especially valuable. Bob Brockie and an anonymous referee made many useful suggestions to improve and clarify the text. My late wife Meg, to whom this paper is dedicated, and family members Doug, Ian, and Sonia Flux helped find kills, as did the gardener, Kevin Priest; and Peng You (Cat 1) and Tigger (Cat 2) provided all the data.

REFERENCES

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

Bergstrom, D.M., Lucieer, A., Kiefer, K., Wasley, J., Belbin, L., Pedersen, T.K. & Chown, S.L. (2009) Indirect effects of invasive species removal devastate World Heritage island. Journal of Applied Ecology, 46, 73–81.

Blancher, P. (2013) Estimated number of birds killed by house cats (*Felis catus*) in Canada. Avian Conservation and Ecology, 8(2), 3. http://dx.doi.org/10.5751/ACE-00557-080203

Bracey, A.M., Etterson, M.A., Niemi, G.J. & Green, R.F. (2016) Variation in bird-window collision mortality and scavenging rates within an urban landscape. The Wilson Journal of Ornithology, 128, 355–367.

Bradt, G.W. (1949) Farm cat as predator. Michigan Conservation, 18, 23–25.

Brockie, B. (2001) When cats away the rats will play. The Dominion, Wellington, 22 October 2001.

Calvert, A.M., Bishop, C.A., Elliot, R.D., Krebs, E.A., Kydd, T.M., Machtans, C.S. & Robertson, G.J. (2013) A synthesis of human-related avian mortality in Canada. Avian Conservation and Ecology, 8(2), 11. http://dx.doi.org/10.5751/ACE-00581-080211

Churcher, P.B. & Lawton, J.H. (1987) Predation by domestic cats in an English village. Journal of Zoology, 212, 439–455. http://dx.doi.org/10.1111/j.1469-7998.tb02915.x

Doherty, T.S., Glen, A.S., Nimmo, D.G., Ritchie, E.G. & Dickman, C.R. (2016) Invasive predators and global biodiversity loss. Proceedings of the National Academy of Sciences, 113, 11261–11265.

Doherty, T.S. & Ritchy, E.G. (2017) Stop jumping the gun: a call for evidence-based invasive predator management. Conservation Letters, 10, 15–22.

Efford, M.G., Fitzgerald, B.M., Karl, B.J. & Berben, P.H. (2006) Population dynamics of the ship rat Rattus rattus L. in the Orongorongo Valley, New Zealand. New Zealand Journal of Zoology, 33, 273–297.

Fitzgerald, B.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, 107–126.

Flux, J.E.C. (1999) Status, ecology, and control by predators of rabbits and hares in New Zealand. Proceedings of the Rabbit Control, RCD: Dilemmas and Implications Conference (30-31 March 1999, Wellington, New Zealand), Royal Society of New Zealand Miscellaneous Series, 55, 4–9.

Flux, J.E.C. (2007) Seventeen years of predation by one suburban cat in New Zealand. New Zealand Journal of Zoology, 34, 289–296.

Flux, J. (2017) The deadly road-kill cycle. Ecological Society of New Zealand Newsletter. 159, 2.

Forbush, E.H. (1916) The domestic cat: bird killer, mouser and destroyer of wildlife: means of utilizing and controlling it. Boston: Wright & Potter. 112 pp.

Gaby, M.J. (2014) A report on free-roaming domestic cat activities in urban areas: what do owned free-ranging domestic cats get up to? Research project, School of Geography, Environment and Earth Sciences. Victoria University of Wellington, New Zealand.

Gibb, J.A. & Fitzgerald, B.M. (1998) Dynamics of sparse rabbits (*Oryctolagus cuniculus*), Orongorongo Valley, New Zealand. New Zealand Journal of Zoology, 25, 231–243.

Gillies, C. & Cutler, A. (2001) A trial of the liberator, leap activated, audio visual alarm collar for cats for wildlife protection in Wellington, New Zealand. Unpublished report to The Royal Forest & Bird Protection Society, Wellington, New Zealand. 31 pp.

Gillies, C. & Fitzgerald, B.M. (2005) Feral cat. In: C.M. King (Ed.), The handbook of New Zealand mammals pp. 308–326. Auckland: Oxford University Press.

Kauhala, K., Talvitie, K. & Vuorisalo, T. (2015) Free-ranging house cats in urban and rural areas in the north: Useful rodent killers or harmful bird predators? Folia Zoologica, 64, 45–55.

Kays, R.W. & DeWan A.A. (2004) Ecological impact of inside/outside house cats around a suburban nature preserve. Animal Conservation, 7, 273–283.

King, C.M., Flux, M., Innes, J.G. & Fitzgerald, B.M. (1996) Population biology of small mammals in Pureors Forest Park: 1. Carnivores (*Mustela erminea*, *M. furo, M. nivalis*, and *Felis catus*). New Zealand Journal of Ecology, 20, 241–251.

Krauze-Gryz, D., Gryz, J. & Goszczynski, J. (2012) Predation by domestic cats in rural areas of central Poland: an assessment based on two methods. Journal of Zoology, 288, 260–266.

Linklater, W. (2013) There is never only one cat... Retrieved from http://sciblogs.co.nz/politecol/2013/12/07

Lanszki, J., Kletecki, E., Trocsanyi, B., Muzinic, J., Szeles, G.L. & Purger, J.J. (2016) Feeding habits of house and feral cats (*Felis catus*) on small Adriatic islands (Croatia). North-Western Journal of Zoology, 12, 336–348.

Loss, S.R., Will, T. & Marra, P.P. (2012) Direct human-caused mortality of birds: improving quantification of magnitude and assessment of population impact. Frontiers in Ecology and the Environment, 10, 357–364.

Loyd, K.A., Hernandes, S.M., Carrol, J.P., Abernathy, K.J. & Marshal. G.J. (2013) Quantifying free-roaming domestic cat predation using animal-borne video cameras. Biological Conservation, 160, 183–189.

Marra, P.P. & Santella, C. (2016) Cat wars: the devastating consequences of a cuddly killer. Princeton and Oxford: Princeton University Press. 212 pp.

Medina, F.M., Bonnaud, E., Vidal, E., Tershy, B.R., Zavaleta, E.S., Donlan, C.J. Et al. (2011) A global review of the impacts of invasive cats on island endangered vertebrates. Global Change Biology, 17, 3503–3510. http://doi:10.1111/j.1365-2486.2011.02464.x

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, 47–56.

Mudge, D. (2002) Silence of the fantails. New Zealand Geographic, 55, 70–86.

Owens, B. (2017) The big cull. Nature, 541, 148–150.

Slater, F.M. (2002) An assessment of wildlife road casualties - the potential discrepancy between numbers counted and numbers killed. Web Ecology, 3, 33–42.

Swann, H.K. (1913) A dictionary of English and folk-names of British birds.London: Witherby. 308 pp.

Tschanz, B., Hegglin, D., Gloor, S. & Bontadina, F. (2011) Hunters and non-hunters: skewed predation rate by domestic cats in a rural village. European Journal of Wildlife Research, 57, 597–602.

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