

**An Assessment of the Potential Threats to Indigenous
Biodiversity Posed by Cats (*Felis catus*) in Urban Environments**

Chris Jones

Landcare Research
PO Box 40, Lincoln 7640
New Zealand

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PREPARED FOR:
Hawke's Bay Regional Council
Private Bag 6006
Napier

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Reviewed by:

Approved for release by:



Bruce Warburton
Scientist
Landcare Research

Andrea Byrom
Science Team Leader
Wildlife Ecology and Epidemiology

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Summary

Project and Client

As a result of an increased community awareness of issues surrounding biodiversity conservation in urban areas, Hawke's Bay Regional Council identified a need for better understanding of the potential benefits and impacts of any planned urban pest management programmes aimed at reducing the biodiversity impacts of cats. In December 2007, Landcare Research was engaged under Envirolink Small Advice Grant HBRC54 to review the potential biodiversity impacts of cats in urban areas.

Objectives

- To review scientific and other literature on the potential impacts of cats on urban biodiversity and to provide science advice as to the likely ecological costs and benefits of an urban pest management programme aimed at reducing these impacts.

Main Findings and Conclusions

- Cats in urban areas occur in much higher densities than in naturally regulated feral populations. This is primarily due to subsidised feeding by pet owners or, in the case of strays, the availability of waste and rubbish dumps.
- Although the average predation pressure per individual cat is likely to be low due to supplementary feeding, the cumulative effects of the artificially high cat densities in urban areas is likely to lead to high levels of offtake of susceptible prey. There is overseas evidence that this has led to the local extinction of small prey populations.
- New Zealand studies of cat predation in urban areas show similar trends to overseas studies: small rodents are most frequently caught, followed by roughly equal numbers of small birds and reptiles. These studies rely on pet owners' observations and are likely to under-represent both total kill and the relative frequency of smaller prey items such as small lizards and invertebrates.
- Cat predation may have a relatively greater impact in newer suburban developments nearer to unmodified natural areas. In longer-established suburbs any prey species exist in spite of cat predation. The likelihood of successful reinvasion of these areas by native species following any cat control programme would depend on other factors such as the availability of suitable habitat.
- The removal of cats from an area may lead to unexpected secondary effects such as changes in the local bird community structure due to interspecific competition, or increased predation pressure on some prey species from smaller predators such as rats that were previously controlled in some way by cats. The potential for these effects should be considered on a case-by-case basis.
- The characteristics of many New Zealand fauna (small size, terrestrial foraging or breeding habit, isolated in native habitat fragments) make many species vulnerable to cat predation. It would therefore be prudent to apply the Environmental Precautionary Principle to cat management in urban areas.

Recommendations

- The Environmental Precautionary Principle should be applied to prevent further damage from cat predation to surviving native fauna in urban areas.

- Priority should be given to applying this principle to outer suburbs or newer developments near or adjacent to native habitats.
- Legislative controls on cat activities have been imposed in a number of Australian communities for up to a decade. The details and effects of these measures in mitigating impacts on native biodiversity should be explored as part of a separate study before any local legislation is imposed. The results of such a study would be of value to many local and regional authorities across New Zealand.
- If controls on cats are imposed in urban areas, it is vital that a set of key indicator prey species should be identified and monitored, starting *in advance* of cat controls, so that any effects of the management actions can be quantified and used to guide further management.

1. Introduction

As a result of an increased community awareness of issues surrounding biodiversity conservation in urban areas, Hawke's Bay Regional Council identified a need for better understanding of the potential benefits and impacts of any planned urban pest management programmes aimed at reducing the biodiversity impacts of cats. In December 2007, Landcare Research was engaged under Envirolink Small Advice Grant HBRC54 to review the potential biodiversity impacts of cats in urban areas.

2. Background

Domestic cats (*Felis catus*) were introduced into New Zealand by early European colonists and feral populations were first noted in the mid-nineteenth century. Today, cats are the most common domestic pet in New Zealand and fulfil an important social role as household companions for many people. Urban areas may also support significant numbers of stray animals, which may focus their activities around food resources such as rubbish dumps or cereal stores where rodents may be abundant. Feral cat populations are established throughout New Zealand's three main islands and on 17 smaller islands (Gillies & Fitzgerald 2005). The current Hawke's Bay Regional Pest Management Strategy classifies cats as Site Specific Animal Pests, which means that management programmes will only be put in place in specific sites and under specific criteria based on predictions of pest impacts. While much emphasis has been placed on understanding and mitigating the biodiversity impacts of feral cats in rural areas, there are clear information gaps regarding these issues in urban environments.

3. Objective

- To review scientific and other literature on the potential impacts of cats on urban biodiversity and to provide science advice as to the likely ecological costs and benefits of an urban pest management programme aimed at reducing these impacts.

4. Review

4.1 Cats as predators

Cats are carnivores and, as such, are very capable hunters of small prey typically of body mass ≤ 100 g (Dickman 1996). Most research on their diet and behaviour in New Zealand has focused on the threats posed to native wildlife from feral cat populations. A range of studies of feral cat diets, both from within New Zealand and overseas, have drawn the same

qualitative conclusions: cats are primarily predators of small mammals, particularly rodents and juvenile rabbits (*Oryctolagus cuniculus*). In spite of this apparent preference for small mammals, cats are opportunistic predators and other small animals will be preyed upon where available. Birds are also frequently taken, as are small reptiles and invertebrates, although the relative proportions of each prey type will vary according to local availability.

In New Zealand, feral cats have been associated with the complete local extinctions of native birds, particularly on islands (Buller 1905; Fitzgerald & Veitch 1985; Veitch 2001) and with declines in native lizard populations (Stack 1874; Thomson 1922). If local populations of their main prey decline through control or disease, cats may increase their predation on native species (Norbury 2001).

Feral cat populations are commonly controlled in areas of high conservation value and have been completely eradicated from a number of New Zealand's islands. While benefits to native wildlife have often resulted from these actions (summarised in Dickman 1996), the fact that other predators (primarily mustelids) were present and were eradicated or controlled along with cats makes it difficult to determine the benefits accrued from cat control alone (Saunders 2000). The biodiversity benefits of cat control may be offset to some extent if smaller predators are also present in a system. For example, Imber et al. (2003) noted that continued predation by kiore (*Rattus exulans*) following the eradication of cats from Little Barrier Island prevented recovery of the island's Cook's petrel (*Pterodroma cookii*) population.

4.2 Cats in urban environments

Measures of cat numbers

The numbers of cats in urban environments have been described in two main ways. Firstly, the percentages of households owning at least one cat have been recorded as part of surveys of cat predation trends. The results from New Zealand and overseas show similar rates of cat ownership with local rates towards the higher end of the range: Bristol, UK, 28% (Baker et al. 2005); various, USA, 27–35% (Ash & Adams 2003; Kays & DeWan 2004); Dunedin, 35% (Van Heezik, unpubl. data), Auckland, 41% (Becker 1993 unpubl., cited in Gillies & Clout 2003). The densities of pet cats that spend some time outdoors in urban areas have been estimated by various means and in each case the estimates have been significantly higher than feral populations, which generally exist at ≤ 5 cats km⁻² (Table 1). Estimates of the local densities of stray cats are generally similarly high (Table 1). Densities of cats have been shown to increase with housing densities (Haskell et al. 2001) and to decline along an urban to rural land-use gradient (Lepczyk et al. 2003).

Home range

While true feral cats must range widely to obtain sufficient food, leading to estimates of home range sizes typically in hundreds of hectares (summarised in Gillies & Fitzgerald 2005), cats in urban areas typically range over much smaller areas of ≤ 5 ha (Morgan 2002; Kays & DeWan 2004; Van Heezik unpubl. data) with a small core area maintained as exclusive.

Table 1 Estimated densities of owned free-ranging and stray cats in urban areas

Location	Density (cats km ⁻²)	Source
<i>Owned, free-ranging cats</i>		
Bristol, UK	229	Baker et al. (2005)
SE Michigan, USA	343	Lepczyk et al. (2003)
Dunedin	223	Van Heezik (unpubl.)
<i>Stray cats</i>		
Portsmouth Docks, UK	200	Dards (1981)
Brooklyn, New York, USA	488	Haspel & Calhoon (1989)
Yarralumba, NSW, Australia	90	Wilson et al. (1994)

Predatory behaviour

As direct observation of kills is rare, estimates of predators' killing behaviour are commonly derived from studying their diets, which, in turn, are estimated from analysing gut or faecal samples. There are obvious drawbacks in applying either of these methods to urban cats resulting from their status as pets: gut sampling involves killing an animal first and urban cats commonly hide their droppings, the contents of which are likely to be dominated by pet food. Accordingly, most studies of the predatory behaviour of urban cats have been based on owner surveys wherein records are kept of prey deposited by the cats at their homes. The results of a range of these studies are summarised in Table 2.

The studies outlined in Table 2 and others permit some generalisations to be made about the predatory behaviour of urban pet cats. Local variations in offtake depending on the type and amount of prey available will be superimposed on these patterns.

- In all studies, rodents (mice, juvenile rats) are the most frequently observed prey type, with birds and small reptiles making up smaller, but significant proportions of the observations. Invertebrates are also reported as prey. Predation appears to be opportunistic and to reflect availability.
- Seasonal patterns in prey returns reflect variations in availability throughout the year. Rodents are most commonly returned in autumn and winter, whereas lizards are most likely to be observed as prey in spring and summer.
- There is marked variation in predatory behaviour between individual cats, with most kill-frequency data being positively skewed. This means that a small number of cats return with disproportionately more prey than others.
- For birds, smaller ground-nesting or foraging species and nestlings are most at risk.
- Higher densities of cats in urban areas lead to greater total predation pressure than in less developed rural areas.
- Greater proportions of native (rather than introduced) prey are taken with increasing proximity of owners' suburbs to natural habitat boundaries.

Table 2 Summary of studies of urban pet cat prey returns based on owners' observations

Location	Results	Source
Bristol, UK	Mice and other small rodents most frequently observed; small birds, especially sparrows also common. Fewer reptiles, amphibians, invertebrates.	Baker et al. (2005)
Nationwide, UK	Mice and other small rodents most frequently observed; small birds, especially sparrows also common. Fewer reptiles, amphibians, invertebrates.	Woods et al. (2003)
S. California, USA	Small mammals predominate; roughly equal numbers of small birds and lizards.	Crooks & Soulé (1999)
Canberra, Australia	Mostly (65%) small mammals (mice, juvenile rats). Birds (27%) of a wide range of species including 41 native species, also native reptiles.	Barratt (1997)
Perth, Australia	Mainly small mammals, followed by equal numbers of birds (including 11 native species) and reptiles (all native)	Calver et al. (2007)
Auckland: fully urban and urban-forest edge	Sparrows, silvereyes, bellbirds and thrushes most commonly taken birds in both areas, but relative proportion of natives higher in forest-edge site; invertebrates (primarily crickets) most common prey in urban area; rodents most common at forest edge, also increased numbers of native lizards and wētā.	Gillies & Clout (2003)
Dunedin	Small rodents most frequently observed; birds (including silvereyes, fantails, and bellbirds) next most common, followed by native skinks and invertebrates.	Van Heezik unpubl. data

The findings described above and any inferences drawn from them with regard to potential impacts of cats in urban areas are based on two fundamental assumptions. The first is that cat owners' reporting is accurate and unbiased. This is unlikely to be the case, as non-experts are likely to misidentify prey remains, and under-reporting, so as not to portray their pets in a bad light, is likely to be common. Furthermore, a significant proportion of owners surveyed in all studies report that their cats never kill wildlife. This is also likely to be a source of error. The second major assumption is that owners' observations accurately reflect what is killed and in the same proportions, i.e. that cats bring home everything that they kill. Again, this is unlikely: Turner and Meister (1988) found that smaller animals are more likely to be eaten at the point of capture, with larger prey, such as rodents, being more likely to be taken home. Some studies have attempted to quantify this bias: George (1974) estimated that around 50% of kills are taken home and Kays and DeWan (2004) suggest that around two-thirds of kills would be left or consumed *in situ*.

Applications of predator-prey theory

A prey species may be categorised as either primary or secondary depending on whether or not it is the main, subsistence prey of the predator in question. This distinction is important as it has implications for the population dynamics of both predator and prey species. Predator populations are likely to fluctuate in response to changes in the availability of their primary prey, such that a decline in prey may lead to a subsequent decline in predator numbers, leading in turn to a reduction in predation pressure on the primary prey, which may allow a recovery of prey numbers. This dynamic link does not occur between predators and a secondary prey which, if rare as a result of other factors such as habitat loss or fragmentation, may be preyed upon to local extinction by a predator population, the numbers of which are sustained by its primary prey. Cats in urban areas are maintained at 'unnaturally' high densities by food supplied by owners or scavenged (effectively the primary prey). Any wild prey, especially those that are rare, but easily accessible may therefore suffer unsustainable levels of predation, or 'hyperpredation' by a high density predator population even if the prey population is declining. Although the absence of the hunger urge is likely to cause well-fed urban cats to hunt less intensively than their feral counterparts, even relatively low individual predation pressure from a dense urban population can drive small, isolated prey populations in urban habitat fragments to extinction (Crooks & Soulé 1999).

The existing community of potential prey species in mature urban areas is the result of a number of factors, of which predation pressure due to cats is only one. For example, the species composition of a local bird community will also have been influenced by the degree of habitat disturbance, modification and regeneration and by interspecific competition. In a mature community the relative effects of these factors would be difficult to disentangle. A removal of or significant reduction in predation pressure on such a community may lead to unpredicted consequences. Some prey species may increase, but competition between prey species may make it very difficult to predict which ones. In an attempt to predict which Australian native species are most at risk from cat predation, and, conversely, which are likely to benefit most from cat controls, Dickman (1996) assigned rank scores to species based on attributes such as body mass, habitat use, behaviour, mobility and fecundity. A similar system could be used in New Zealand as a first step in predicting impacts.

Another potential net negative effect of the removal from a system of a 'higher-order' predator, such as cats, is that due to 'mesopredator release.' This occurs where the predator has some sort of regulatory (either numerical via predation, or behavioural) impact on a

smaller predator, e.g. rats. The removal of the larger predator effectively releases the smaller predator from any suppression, which can, in turn, lead to significant impacts on some prey species (Palomares et al. 1995; Crooks & Soulé 1999).

In urban areas, the product of relatively low individual predation pressure and very high cat densities can lead to a large net offtake from some prey populations. This does not necessarily equate to a significant impact on the population dynamics of any one prey type. The threshold level at which predation acts to cause negative population growth in a prey can only be determined from detailed studies of the demographic parameters (survival, reproduction, population size) of the prey. Likewise, the clear demonstration of a predator's impact on a prey population in isolation from other factors can only be obtained by conducting a robustly designed experiment, which in urban areas would be subject to considerable social, logistical and financial constraints. At the very least, any control of a predator population should be accompanied by monitoring of those prey considered most at risk from its impacts.

The caveats and conditions described above mean that there is little unequivocal evidence of significant negative effects on native species due to predation by cats in an urban environment. This may therefore weaken arguments in favour of implementing legislation imposing control of cats in urban areas. In spite of this, Lilith et al. (2006) recommend adopting the Environmental Precautionary Principle to protect wildlife: *'Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to protect environmental degradation'* (The Intergovernmental Agreement on the Environment, May 1992, quoted in Deville & Harding 1997). Legislation controlling cat activity has been imposed by a number of Australian local and regional authorities over the past decade. Given the susceptibility of many native New Zealand fauna to cat predation, it would be wise to adopt a similar precautionary approach, especially in peri-urban areas close to sites of conservation value.

5. Conclusions

- Cats in urban areas occur in much higher densities than in naturally regulated feral populations. This is primarily due to subsidised feeding by pet owners or, in the case of strays, the availability of waste and rubbish dumps.
- Although the average hunting pressure per individual is likely to be low due this supplementary feeding, the cumulative effects of the artificially high cat densities in urban areas is likely to lead to high levels of offtake of susceptible prey. There is overseas evidence that this has led to the local extinction of small prey populations.
- New Zealand studies of cat predation in urban areas show similar trends to overseas studies: small rodents are most frequently caught, followed by roughly equal numbers of small birds and reptiles. These studies rely on pet owners' observations and are likely to under-represent both total kill and the relative frequency of smaller prey items such as small lizards and invertebrates.
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species following any cat control programme would depend on other factors such as the availability of suitable habitat.

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6. Recommendations

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7. Acknowledgements

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