

Cat Predation and Suburban Lizards: A 22 Year Study at a Suburban Australian Property

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Abstract: From observations conducted in a suburban property in Perth, Western Australia, over 22 years, it appears that a single pet cat may have exterminated a population (est. 40-50 animals) of the lizard *Ctenotus fallens* over two years, but with the greatest impact in just the first few months. *C. fallens* did not begin to recolonise the site until six years after the cat had moved away. The observations support the hypothesis that extinctions of wildlife in suburbia following the introduction of cats can be swift. They also suggest that *C. fallens* is a suitable species for reintroduction experiments into suburban Perth, comparing the success of reintroductions at sites where cats are confined with those where cats roam freely.

Keywords: Pet cat, urban wildlife, local extinction.

INTRODUCTION

Both feral (*i.e.*, living independently of people) and pet (living in close association with a household) domestic cats *Felis catus* (see [1] for definitions of categories of cat populations) kill lizards and other small vertebrates [2-4]. Small native vertebrates sometimes coexist with feral cats, but there is also strong experimental and correlative evidence that feral cats may cause declines or local extinctions of prey on islands [5-7] and continents [8-10].

The effects of pet cats are more contentious [4, 11, 12]. They occur at densities often exceeding 100/km² [13] and live in landscapes where native environments are fragmented, confining surviving non-volant native wildlife to what are effectively islands. It is well-documented that pet cats prey on wildlife [14-20]. Whether or not this predation causes population declines in native species in urban landscapes is difficult to demonstrate [1, 21], although some studies showed an impact [22, 23]. One reason for this difficulty is that investigating such an impact requires information on the native wildlife before the arrival of pet cats, and observations as the predators become established. This paper reports such *ad hoc*, descriptive observations for an Australian lizard and, based on them, suggests an experimental protocol for testing the impact of predation by pet cats on this species in suburbia.

METHODS

Study Area

Observations were made in a suburban garden in Kingsley, a northern suburb of Perth in south-western

Western Australia (31° 48' 12"S, 115° 49' 03"E). The garden (hereafter referred to as "the property") lies on the northern Swan Coastal Plain. The original native vegetation was a woodland of eucalypts (Myrtaceae) and banksias (Proteaceae) over a shrubby understorey on deep sand. The garden had been part of a farm cleared for agriculture early in the 20th century, and the 2 100m² lot was purchased in 1989 during an urban subdivision of the farm. It had thus been cleared some 60 -70 years previously, lay about 300m from remnant native vegetation around a lake and, when purchased, supported grassy weeds. All surrounding properties were similar or had been cleared even of weeds for house construction and the establishment of conventional (*i.e.*, lawn and exotic garden bed) gardens. On the property, however, house construction was confined to *c.* 300m² and the weeds were gradually replaced by native trees and shrubs over the following 20 years.

Fauna Observations

Wildlife on the property was observed between 1989 and 2012 on a weekly "bird day" when all bird species seen on that day were recorded and notes were made on reptiles and other fauna, including exotic species such as pet cats. These observations took place over 6 – 8 hours on each "bird day", and were conducted by one or two people, commonly between the hours of 08:00 and 17:00. Incursions into the yard by cats during these observations were noted, and the presence of cats was also recorded whenever they were seen or heard during other activities at the property at any time of the day or night. People always chased away any cats they encountered, as did the one or three pet dogs on the property.

RESULTS

Pet Cats

Pet cats were occasional visitors to the garden from 1989, with cats seen approximately 2-3 times per month. With no

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pet cats on adjoining properties, and from one to three resident dogs, visits from cats were infrequent and short. This changed in winter 2002 when an adjoining property was sold and two mature cats moved in. Despite being chased away repeatedly by the people or dogs on the property, one was subsequently seen on the property daily and, judging from the behaviour of the dogs, most nights as well. It was regularly observed hunting. This cat left the neighbourhood in 2006 and the status of cats on the property then reverted to occasional, short visits from cats living at least several properties away.

Reptile Fauna

Fourteen reptile species were observed on the property over the 22 years from 1989 to 2012 (Table 1). These can be classed as:

- Occasional visitors (*Pogona minor*, *Varanus gouldii*, *Pseudonaja nuchalis* and possibly *Tiliqua rugosa*, although the latter may now be resident);
- Present at the time the property was purchased and persisted; therefore were living on the site when the environment consisted entirely of weeds (*Christinus marmoratus*, *Cryptoblepharus buchani*, *Hemiergis quadrilineata*, *Lerista elegans*, *Lerista praepecta* and *Menetia greyii*);
- Present at the time the property was purchased but declined and disappeared in the early 2000s, with this decline coinciding exactly with the arrival of a pet cat (*Ctenotus fallens*);
- Colonised the property (most likely source being native vegetation about 300m to the west), presumably in response to the development of the garden which created a complex and more or less natural environment of native vegetation with leaf-litter and variable cover (*Acritoscincus trilineatum*, *Morethia obscura*). However, this colonisation also occurred subsequent to the disappearance of *C. fallens*, suggesting a possible interaction between these species; and
- Possibly present in very low numbers long-term, or a recent colonist at low numbers (*Aprasia repens*).

The reptile species present and the changes (if any) to their status on the property were largely predictable. Thus, large species visited the property occasionally (there were populations 300m to the west), a suite of small species, mostly skinks, was resident and has remained so, and are the species widespread in Perth gardens [24], while two species colonised the property, probably in response to the development of an environment suitable for them (but they were only able to colonise because of nearby populations). The unexpected observation was the initial presence of *C. fallens*, a species uncommon in Perth gardens, and its persistence then abrupt decline coinciding with the arrival of one pet cat on a neighbouring property in winter 2002.

Prior to the arrival of this one pet cat, the population of *C. fallens* on the property was estimated at 40-50 individuals. This was based upon the frequency and regularity with which animals could be seen during short walks around the garden. For example, there were commonly three animals

near the front verandah, a further two animals along a 5m path leading from the verandah, and four or five along a 20m path leading from the back door. These were present at the same time, so account for about 10 animals seen in less than a quarter of the garden. In spring, it was normal to encounter up to 10 lizards on these two walks several times a day.

In the spring/summer (2002/2003) following the winter 2002 arrival of the pet cat, only two *C. fallens* were seen, one with a missing tail that might indicate a narrow escape from a predator. This was a massive change in abundance given that in all previous spring/summer periods *C. fallens* was abundant (Table 1). It is unlikely to be related to climate because winter conditions in 2002 were usual. No hatchling *C. fallens* were observed in late summer/autumn 2003, which was also unprecedented.

Given the apparent disappearance of *C. fallens* by early 2003, observation times for lizard sightings in spring 2003 and summer 2003/2004 were intensified to approximately 15 hours/week (the regular bird day but with supplementary observations throughout the week), but no *C. fallens* were observed. Smaller skinks were still present. *C. fallens* also appeared absent in spring 2004 and summer 2004/2005, but on 7th March 2005 a single hatchling was observed. This was the last sighting of the species on the property despite ongoing regular surveillance until March 2012, when two individuals were detected. Although the pet cat and its owners moved from the neighbourhood in autumn 2006, it appears that by this time *C. fallens* had been extirpated on the property.

DISCUSSION

The reptile fauna of the northern Swan Coastal Plain includes over 60 species [25], although about 25-30 species are likely to occur at any one site. Therefore, the property supports about a third of its original reptile fauna as residents and about half if visitors are included. These species persisted in the area despite clearing, agriculture and urbanisation, and all species except *C. fallens* survived through a four year period of effective residence by one pet cat.

That the cat was responsible for the extirpation of *C. fallens* on the property seems extremely likely but is only circumstantial, because while the cat was seen hunting regularly night and day, it was never actually observed to catch a *C. fallens*. However, there was no abrupt change in the garden's environment at the time of the decline of *C. fallens*, and the resident dogs were all trained to leave wildlife alone. There was no change in the abundance of natural predators in the garden; the predatory birds *Dacelo novaeguineae*, *Gymnorhina tibicen*, *Corvus coronoides* and *Cracticus torquatus* are all occasional to regular visitors, although the *D. novaeguineae* and *C. torquatus* only began visiting the garden regularly in 2009 – after the initial crash in *C. fallens* numbers. Vegetation succession is unlikely as a cause, given that *C. fallens* appeared to have recolonised the property by 2012 after an absence of over six years. The same is true of the possibility that *C. fallens* was outcompeted by the colonists *A. trilineatum* and *M. obscura*.

Bamford [3], in a dissection of a single feral cat, found 12 lizards in the animal's stomach, of which seven were *C. fallens* and the rest were similar-sized geckoes and

Table 1. Reptile Fauna Observed on the Kingsley Property. The Status and Population Trends of Each Species on the Property are Indicated. Snout-vent Lengths for Each Species in mm, shown in Parentheses, are Taken from [31] or, if not given there, from [32]. Common Names are Taken from [33] or, if not Given there, from [32]

Gekkonidae		
<i>Christinus marmoratus</i> (70)	Marbled Gecko	May have been present in 1989 but seen regularly by the early 1990s. Has probably increased in abundance due to provision of shelter and development of trees with shedding bark. By 2010, possible to observe several when working in the garden, and eggs found regularly under plant pots.
Agamidae		
<i>Pogona minor</i> (160)	Dwarf Bearded Dragon	A single sub-adult observed once in 2006. Presumably dispersed from remnant native vegetation 300m to the west.
Varanidae		
<i>Varanus gouldii</i> (1600 total length)	Gould's Goanna	Hatchlings settled in garden for a few weeks in autumn 1996 and 1997 but neither persisted
Scincidae		
<i>Acritoscincus trilineata</i> (70)	Western Three-lined Skink	First observed in 2008 but probably resident before this. Seen occasionally subsequently, suggesting the species colonised the garden.
<i>Cryptoblepharus buchananii</i> (50)	Buchanan's Snake-eyed Skink (but widely known as the Fence Skink)	Present in 1989 and common on walls, fences and trees throughout garden subsequently.
<i>Ctenotus fallens</i> (90)	West-coast Laterite Ctenotus	Common in 1989 and remained abundant up to and including summer 2001/2002. Most often observed in spring with juveniles observed in late summer/early autumn, consistent with spring/summer breeding typical of reptiles in the region [34] (Davidge 1980). Usual to see 4-5 animals crossing the path in a 20m walk, and estimated there may have been 50 resident on the property. Only two animals seen all spring/summer 2002/2003, one of these missing its tail which was unusual, and a single hatchling seen March 2005. No further sightings until March 2012, when two individuals were detected.
<i>Hemiergis quadrilineata</i> (55)	Two-toed Earless Skink	Present in 1989 and has remained common.
<i>Menetia greyii</i> (30)	Common Dwarf Skink	Present in 1989 and has remained common.
<i>Lerista elegans</i> (40)	Elegant Slider	Present in 1989 and has remained common.
<i>Lerista praepepita</i> (60)	Blunt-tailed West-coast Slider	Present in 1989 and has remained common.
<i>Morethia obscura</i>	Shrubland Morethia Skink	A single specimen observed in 1994 and then occasionally subsequently, but seen regularly from about 2006.
<i>Tiliqua rugosa</i> (250)	Shingleback (but widely known as the Bobtail in Western Australia)	Regular visitor, presumably animals from remnant native vegetation 300m to west. Some animals probably resident by about 2000.
Elapidae		
<i>Pseudonaja affinis</i> (1500 total length)	Dugite	Occasional visitor from 1989 to 2012.
Pygopodidae		
<i>Aprasia repens</i> (110)	Sedgeland's Worm-lizard	Single individual detected while digging in May 2012. Species may have been present long-term in very low numbers, or colonised from remnant native vegetation 300m to the west.

pygopodids. *C. fallens* may be particularly vulnerable to predation by cats because of its size, whereas smaller lizards persisted. The cat dissected by Bamford [3] was killed (hit by a vehicle) just after sunrise and the stomach contents were

fresh, suggesting the lizards had been eaten at night. This may explain why predation was not observed on the property.

It would appear that a single pet cat exterminated a population (est. 40-50 animals) of *C. fallens* over two years, but with the greatest impact in just the first few months. Extinction was possible because recolonisation opportunities were limited to animals moving 300m from a reserve to the west across roads and open gardens providing very little cover, and where some properties have resident cats. While the evidence is circumstantial and limited to a single prey species, it does indicate a possible impact of pet cats on wildlife populations – a point that has been difficult to demonstrate in the literature despite abundant evidence of pet cats preying on wildlife [12].

The survival of *C. fallens* for over 10 years indicates that this species can be resident in Perth gardens under some conditions and may be a suitable subject for translocation/reintroduction experiments into suburbs where domestic cats are restricted or confined [26, 27]. Combining the suggestions in those papers with the observations in this study and those of Bamford [3], we predict that *C. fallens* should persist in suburbs where pet cats are required to be confined at night. Local councils in Western Australia are empowered to introduce such restrictions and a number already do so, while there are also successful experiences with cat restrictions elsewhere in Australia [28-30]. Therefore, an appropriate experimental design would be to reintroduce *C. fallens* into such suburbs and into other suburbs where no such restrictions are in place. Care should be taken to match the vegetation/ garden design of control and experimental areas to avoid confounding of the predator effect with garden design. Although this design raises the ethical issue that *C. fallens* introduced into areas where cats are unrestricted would be expected to perish, this is an essential part of the experiment. We argue that failure to test the hypothesis rigorously would be a greater evil, and furthermore the most likely source of animals for translocation would be sites being cleared for urban expansion and where animals would otherwise be killed. Disproportionate success of the reintroductions where cats are confined at night compared with sites where they roam freely would support our hypothesis that pet cats are a major factor in the distribution of *C. fallens* in suburban Perth.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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