Possum control and bird recovery in an urban landscape, New Zealand

Lilidh Johnstone MacLeod[1,2*], Rod Dickson[3], Campbell Leckie[3], Brent M. Stephenson[4] & Alistair S. Glen[1]

[1]*Landcare Research, Private Bag 92170, Auckland 1142, New Zealand*
[2]*Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, Glasgow, UK*
[3]*Hawke's Bay Regional Council, 159 Dalton St, Napier 4110, New Zealand*
[4]*Eco-Vista: Photography & Research Ltd, PO Box 157, Bay View, Napier 4149, New Zealand*

SUMMARY

In New Zealand invasive brushtail possums *Trichosurus vulpecula* reduce nesting success of native birds and compete with them for food. As an urban biodiversity initiative, intensive possum control was carried out in a residential area on Napier Hill, North Island. Bird species were monitored using five-minute point counts, conducted once before the possum control programme and then annually for a further five years afterwards. Significant increases in the relative abundance of bellbird *Anthornis melanura* and tui *Prosthemadera novaeseelandiae* were attributed to an increase in food supply due to reduced competiton from possums. Kereru *Hemiphaga novaeseelandiae* numbers remained relatively stable and a significant decline was recorded in the relative abundance of silvereyes *Zosterops lateralis.* Management of possum populations will be continued to try to further improve native bird abundance on Napier Hill.

BACKGROUND

The brushtail possums *Trichosurus vulpecula* is a non-native invasive species in New Zealand, and poses a threat to the survival of many native bird species (Innes *et al.* 2010). Possums are arboreal and prey on bird eggs and chicks (Brown *et al.* 1993). Due to their omnivorous diet they are also thought to compete with native bird species such as tui *Prosthemadera novaeseelandiae* and kereru *Hemiphaga novaeseelandiae* for fruits and flowers (Cowan 1990). Significant increases in native bird numbers have been recorded where intensive management has reduced possum populations to low densities on offshore islands and in native forest (Saunders & Norton 2001, Spurr & Anderson 2004).

In recent years there have been increased efforts to restore native biodiversity in New Zealand towns and cities through control of non-native mammal species. On the outskirts of Wellington City the Zealandia-Karori sanctuary was created by constructing an 8.6 km mammal-proof fence around an area of regenerating forest. The eradication of possums and 13 other mammal species from within the reserve benefitted resident tui populations and allowed the reintroduction and establishment of several native birds, some of which had been absent from the mainland for over 100 years (Empson & Fastier 2013). The Greater Wellington Regional Council carried out intensive possum control on the 800 ha suburban Miramar Peninsula, and reported an increase in the abundance of tui which were found breeding in the area after two years of control (Bell 2008).

Native birds are evidently valued by people. In a survey in the Waikato region 97% of respondents said they enjoyed having them in their area; when asked what birds they enjoyed hearing and seeing most, the tui was the most common answer (Kaval & Roskruge 2008). One of three honeyeaters endemic to New Zealand, tui feed mainly on nectar and insects (Craig *et al.* 1981) and in winter, when food is scarce, will travel over 15 km a day to visit nectar sources (Bergquist 1985). Easily identified by the white feather tufts on its throat and its loud complex song, the tui is an iconic native bird which has been used as a flagship species for many biodiversity recovery programmes (Southgate 2007).

The urban environment is increasing rapidly worldwide, and threatens native biodiversity via altered natural habitats, decreased connectivity between remnant native habitats and the introduction of non-native invasive plant and animal species (McKinney 2002). Community-based efforts to conserve native species within cities could have a significant impact on reversing declines in urban biodiversity (McDonnell & Hahs 2013). In 2009 the Hawke's Bay Regional Council began an intensive possum control programme in an urban area, Napier Hill, as part of the Hawke's Bay Urban Biodiversity initiative. This programme aimed to engage the urban community in pest control for conservation and to increase native biodiversity in the area.

ACTION

The Napier Hill Possum Control Area is a 282 ha mixture of residential properties and public land in Napier, Hawke's Bay, New Zealand (39°29'S, 176°54'E), with over 2,700 residents. Napier Hill is heavily vegetated, primarily by introduced trees and scrub, and with some native plant species still present. Despite suspected high densities of invasive possums and rats *Rattus* spp., native bird species such as bellbird *Anthornis melanura*, tui and kereru persisted in the area before pest control commenced.

Control: Initial possum control took place between February and May 2009. Residents were given a choice of control methods for their properties, with bait stations the most popular, although a few opted for Timms kill traps. Kilmore® and Sentry® bait stations were erected by a pest control contractor on trees 1-2 m above ground and baited with Pestoff® brodifacoum (0.02g/kg) pellets with a layer of RatAbate® diphacinone (0.05g/kg) paste on top to kill rats and stop them from clearing bait stations before possums could feed from them. Although rats were poisoned, their numbers were probably not reduced

* To whom correspondence should be addressed: 1100028M@student.gla.ac.uk

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significantly because the distance between bait stations was large relative to rat home range size (Taylor & Thomas 1989). In total 480 bait stations were set up across public land and 363 residential properties, at a distance of 100-200 m apart. Bait stations were refilled by a pest control contractor at two week intervals three times in the first year and twice between March and April of the second and third years. Since the last baiting of all 480 stations in 2011, stations on Napier City Council parkland have been refilled annually, and residents have taken over responsibility for refilling stations on their property with Pestoff® brodifacoum, which is subsidised by Hawke's Bay Regional Council. However, the frequency of refilling bait stations on residential properties has not been recorded. The effect of poisoning on possum numbers was not measured.

Monitoring: Bird populations were monitored annually between 28 November and 27 January from 2009 to 2014 with the exception of 2013. The first count was conducted in January 2009, before possum control was carried out. The five-minute point count method (Dawson & Bull 1975) was used to determine the presence and relative abundance of bird species at 26 count stations. The original method described by Dawson & Bull (1975) was designed to monitor birds in forests and therefore slight modifications were necessary for selecting count stations in an urban area. Some neighbouring stations were less than the recommended 200 m apart; however, such stations were spaced so that they sampled different areas of woody vegetation. We assumed that the higher levels of background urban noise would reduce the distance over which birds could be heard calling and thus counting the same individuals from two neighbouring sites less than 200 m apart was unlikely. Not all counting stations were located within woody vegetation but all were located where recorders could listen into these habitats. The areas of woody vegetation were smaller than recommended by Dawson & Bull (1975), though they were the largest possible in the area. Global Positioning System locations were recorded for all count stations and, where possible, trees were marked with tags to ensure the repeat counts were conducted at the same site.

At each count station three independent counts were carried out by an experienced ornithologist (BMS). Counts took place between 07:00 h and 18:00 h to avoid dawn and dusk when calling rates of species change dramatically over a short period of time (Spurr & Powlesland 2000). Counts were repeated on two more days within 10 days of the first count. Counts at the same station were conducted at different times of the day: once in the morning (08:00 h-12:30 h), once in the afternoon (13:00 h-17:30 h) and once at a time of day that differed as much as possible from the other two counts.

For each count the observer recorded the date, start time, precipitation, external noise levels and the number of observations for each species. Individual birds were recorded as either seen or heard, with data combined for analysis. No counts were conducted during heavy rain or high winds as these conditions can change the behaviour and therefore the conspicuousness of bird species (Spurr & Powlesland 2000).

The mean of the three counts was calculated for each site. Data for each species were analysed separately. As the data were not normally distributed, a non-parametric Wilcoxon Signed-rank test was used to determine whether the median of the 26 count sites differed significantly between the first and last year of sampling. As there was no control area in this investigation, data were compared to national trends from the New Zealand Garden Bird Survey between 2007 and 2014 (Manaaki Whenua – Lancare Research 2014).

CONSEQUENCES

Native species: There was a highly significant increase in the number of bellbirds recorded between January 2009 and December 2014 ($W = 24.5$, d.f. = 26, $p < 0.001$). The mean number of individuals recorded at each count site doubled from 0.33 in January 2009 to 0.67 in January 2010, after just one year of possum control. The population remained stable from January 2011 to December 2011 before increasing between December 2011 and December 2014 (Figure 1a).

Although more gradual, the number of tui recorded increased steadily and significantly over the six year monitoring period ($W = 15.5$, d.f. = 26, $p < 0.001$) (Figure 1b). National population trends for both tui and bellbird were were stable during this time (Manaaki Whenua – Lancare Research 2014). Fantails *Rhipidura fuliginosa* also increased in relative abundance between January 2009 and December 2014 ($W = 42.5$, d.f. = 26, $p < 0.05$) whereas no significant change in fantail numbers was recorded nationally (Manaaki Whenua – Lancare Research 2014).

No significant changes were found in the relative abundance of kereru and grey warbler *Gerygone igata* either in our study or nationally (Manaaki Whenua – Lancare Research 2014). Welcome swallow *Hirundo neoxena* showed no change in relative abundance during our survey despite increasing in national abundance over the same time period (Manaaki Whenua – Lancare Research 2014). Kingfisher *Halcyon sancta* also remained stable in number during surveys, although national population trend data were not available for this species. Silvereye *Zosterops lateralis* declined in relative abundance between January 2009 and December 2014 ($W = 262$, d.f. = 26, $p < 0.001$) (Figure 1c) at our study site, and also nationally (Manaaki Whenua – Lancare Research 2014).

Non-native species: Apart from the goldfinch *Carduelis carduelis*, which declined ($W = 288.5$, d.f. = 26, $p < 0.001$), and the greenfinch *Carduelis. chloris*, which increased in number ($W = 46$, d.f. = 26, $p < 0.01$), the relative abundances of non-native species between January 2009 and December 2014 showed no consistent trend across years at our study sites. In January 2011 there was a drop in the relative abundances of song thrush *Turdus philomelos*, blackbird *Turdus merula*, chaffinch *Fringilla coelebs*, and starling *Sturnus vulgaris* but numbers of these species increased in subsequent years. House sparrow *Passer domesticus* increased in the year after possum control but returned to pre-treatment levels the following year and remained stable thereafter. There was no change in the relative abundances of either common myna *Acridotheres tristis* or dunnock *Prunella modularis*. Nationally, blackbird and song thrush populations declined but all other non-native species populations were stable (Manaaki Whenua – Lancare Research 2014).

DISCUSSION

Possums feed on the buds, flowers and fruits of plants and can suppress fruiting in some native plant species (Cowan 1990, Cowan & Waddington 1990). After the eradication of possums on Rangitoto, an island in the Hauraki Gulf by Auckland, North Island, the number of tui increased. This was attributed to increased nectar availability, as predators (ship rats *Rattus rattus*, cats *Felis catus* and stoats *Mustela erminea*) were still present (Spurr & Anderson 2004). For this reason it is concluded that the rapid increase in bellbirds and the more gradual increase

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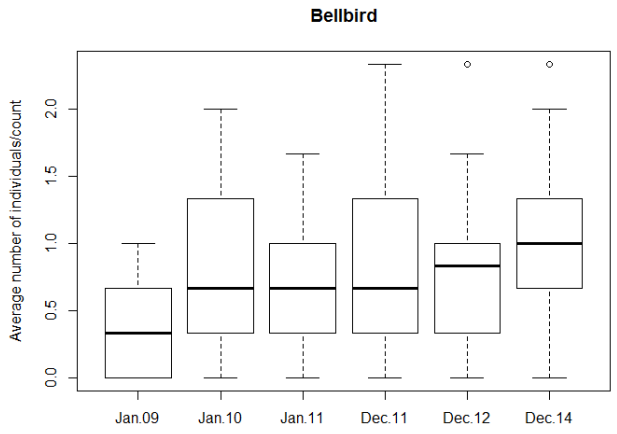
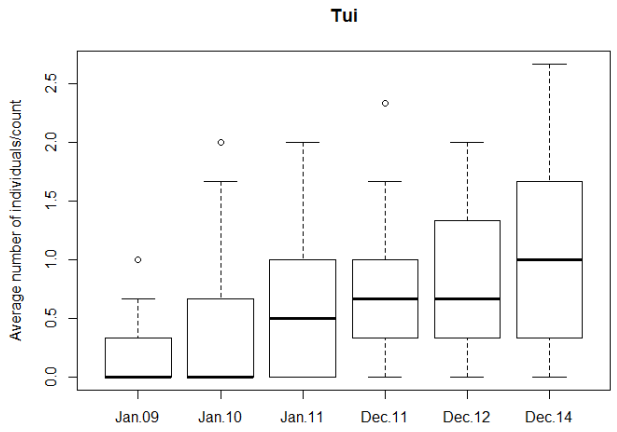
a)



b)



c)

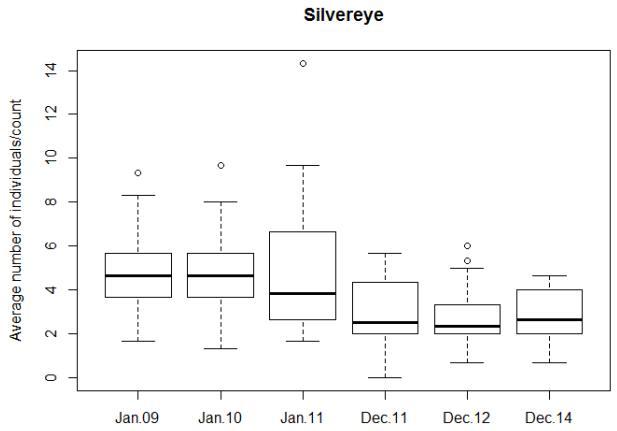


Figure 1. Mean number of individuals of a) bellbirds, b) tui and c) silvereye seen and heard during five-minute point counts at 26 stations on Napier Hill, Hawke's Bay, New Zealand. For each species, the boxplots show the minimum, lower quartile, median, upper quartile and maximum values for the mean number of individuals/count at 26 stations from 2009 – 2014. Data points outwith the minimum and maximum are outliers removed from the analysis. These are identified in R as data points which are 1.5 times the interquartile range above the upper quartile or below the lower quartile. Possum control started in February 2009.

in tui recorded at Napier Hill were likely to be due to an increase in food availability attracting more individuals to the area. In contrast, bellbird and tui populations remained stable between 2007 and 2014 across the whole of New Zealand (Manaaki Whenua – Lancare Research, 2014). Nectar and fruit make up a large proportion of the diet of these two bird species (Craig *et al.* 1981) making them important pollinators for several native plant species (Anderson 2003). The increased abundance of these birds and the assumed decrease in browsing by possums could therefore have a positive impact upon the native vegetation on Napier Hill.

Kereru are important seed dispersers, especially for plants with large fruit (Clout & Hay 1989). Baber *et al* (2009) suggested that, along with tui, kereru could be used as an indicator species for successful mammalian pest control in New Zealand. In a study conducted in Motatau Forest, Northland, possums were documented preying on the eggs of kereru. In an effort to restore the kereru population, poisoning for mammalian pests was carried out and both the abundance and nest success of kereru increased significantly within the first two years of mammal control (Innes *et al.* 2004). Fruit, along with leaves, makes up the majority of the kereru diet. If possum control resulted in higher fruit availability we would expect an increase in the number of kereru as seen in previous studies (Innes *et al.* 2004, Baber *et al.* 2009), but in our study the population remained stable. In November 2009 a resident found a kereru fledgling, presumably having been tipped out of a tree during high winds; this was the first evidence of kereru breeding in the area in 30 years.

There are several possible explanations for the lack of increase in kereru following possum control. Many studies have documented rats predating on both the eggs and newly hatched chicks (Innes *et al.* 2004). Kereru may be more susceptible to rat predation than tui and bellbirds and without targeted rat control on Napier Hill increases may not be seen. Another possiblility is that the number of individuals recorded was too low to detect a change over time. Alternatively, Napier Hill may not provide sufficient habitat to support an increase in kereru numbers. However, the discovery of a fledgling was encouraging as it showed kereru were breeding in the area. We hypothesize that kereru may respond more gradually and that continued control of possums could allow for a stable breeding population to establish in the area.

The Manaaki Whenua – Landcare Research Garden Bird Survey (2014) showed that between 2007 and 2014 there has been a decline in the number of silvereye recorded nationally and so the decline in this species recorded during our survey is more likely to be reflecting national population trends.

There is also strong evidence that the Regional Council's aim of engaging the local community in pest control conservation has been achieved. Feedback from residents of the area has been extremely positive. Many report seeing and hearing more native birds and note an increase in fruit and flowers in their gardens. This study would have benefitted considerably from rigorous monitoring of fruit and flowers and it is suggested here that this be included in future possum control studies. Hawke's Bay Regional Council has received many positive comments from residents and the local press (Hamlin 2009). Residents have also become actively involved in the programme by refilling baiting stations themselves, the cost of which is subsidised by the council. This is vital in the continuation of the programme.

As there was no non-treatment area for comparison in this study, the possibility that changes in species relative abundance were unrelated to the pest control cannot be discounted. Other

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factors, such as harsh winter conditions or changes in the abundance or timing of fruiting and flowering plant species, could explain the changes in the abundances recorded in this study. However, the comparison between our data and national trends and previous findings that possum control has led to the recovery of native bird species in other areas (Spurr & Anderson 2004, Bell 2008), mean that we consider this to be the most likely explanation for changes in bird numbers at Napier Hill.

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