

Changes in bird numbers on Tiritiri Matangi Island, New Zealand, over the period of rat eradication

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Abstract Tiritiri Matangi is 25 km north of Auckland City in the Hauraki Gulf, New Zealand. Most of its forest cover was removed during many centuries of Maori and European occupation and farming. Some areas of extant forest canopy remained. Farming ceased in 1971. Since 1984 some 300,000 native trees have been planted. Twenty-seven species of native bird are naturally present and breeding on the island. Twenty-two exotic species introduced to mainland New Zealand have found their way to the island. Nine species of native bird have been translocated to the island. Data from bird counting transects within extant forest areas in spring are considered. The data from a three-year period before eradication of Pacific rats (*Rattus exulans*) in September 1993 are compared to a three-year period following rat eradication, with a three-year settling period between. A number of significant changes are recorded with both increases and decreases in bird numbers. These are attributed to the direct impact of the rats or changes in forest composition following rat removal, or the data are confused by conservation management action beyond the immediate count areas.

INTRODUCTION

Tiritiri Matangi is a low-lying 220 ha island lying 4 km off the Whangaparaoa Peninsula and 25 km north of Auckland City in the Hauraki Gulf, New Zealand. It is a Scientific Reserve under the Reserves Act 1977, and is open to public visitation.

Maori occupied the island prior to the arrival of Europeans in New Zealand, and from at least 1841 it was grazed by domestic animals. A lighthouse was established on the south-eastern end in 1865. The Crown withdrew the grazing lease in 1971, and management of the island was then taken up by the Hauraki Gulf Maritime Park Board. At that time it was proposed that, apart from the Lighthouse Reserve area, native vegetation be allowed to regenerate naturally.

In 1979 a programme of planting to enhance regeneration was proposed, with a plan which called for the planting of most of the island while leaving selected areas to regenerate naturally (Department of Lands and Survey 1982) (Fig. 1). In the period 1984 to 1993 more than 280,000 native trees were planted, increasing the proportion of non-grassland vegetation from 6% to 60% of the island's area (Galbraith and Hayson 1995). Some 20,000 trees have been planted since 1993, but planting has now ceased.

The Pacific rat or kiore (*Rattus exulans*) is presumed to have been on the island at the time of first European contact but was removed in an operation during September 1993 (Veitch 2002). Cats (*Felis catus*), rabbits (*Oryctolagus cuniculus*) and goats (*Capra hircus*) were reported as having feral populations that were subsequently removed (Dept. of Lands and Survey 1982, Moller and Craig 1987). Cats were probably never established as a feral population and the occurrence referred to by the Dept of Lands and Survey (1982), and later quoted by Moller and Craig (1987), related to domestic cats owned by a lighthouse keeper (A. Wright pers. comm.). Rabbits which

were at one time plentiful had disappeared by 1908 (Dept of Lands and Survey 1982). The goat population was small and was removed by the lighthouse keepers. This work was under way in 1961 (A. Wright pers. comm.) and no goats were present in 1971 (R. Walter pers. comm.).

Seventy-seven bird species have been recorded on or within sight of the island (B. Walter pers. comm.). Of these, 22

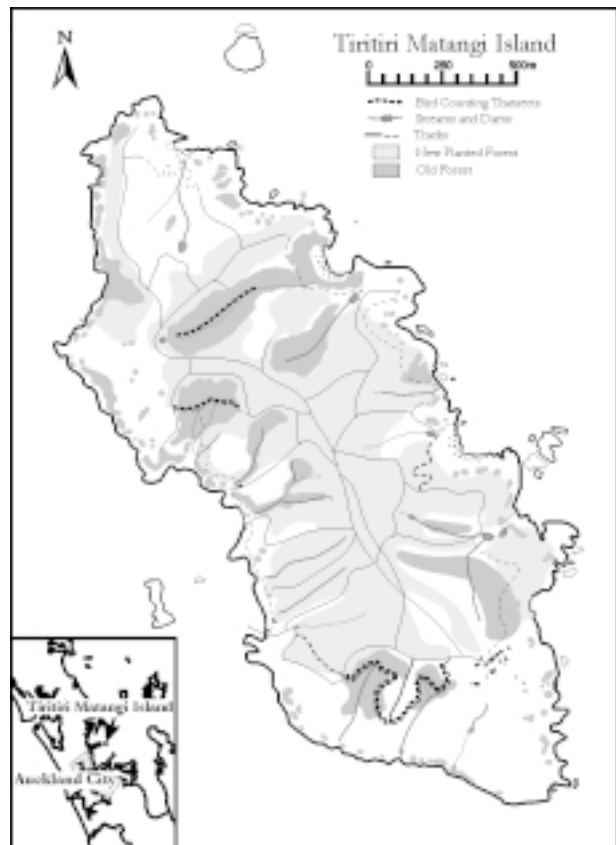


Fig. 1 Tiritiri Matangi Island showing forest areas and the bird counting transects.

are species which have been introduced to New Zealand and have found their own way to the island; nine are native birds which have been translocated to the island; 19 are native birds which are not known to breed on the island and 27 are native birds which are naturally present and breeding on the island.

This paper reviews the changes in numbers of selected bird species in forest areas which have not been deliberately modified by human activity over the period 1990 to 1998.

METHODS

In 1987 the Ornithological Society of New Zealand (OSNZ) established bird counting transects on Tiritiri Matangi. Data from three transects located in unmanaged forest areas are used in this paper (Fig. 1). The transects were counted in November each year, as close as possible to the 20th of each month. Counters were given the following instruction for counting: "Walk slowly along the transect. Try to keep walking but you may stop to identify a bird. Count each bird within 10 metres of each side of the transect. Record the start and finish time of each count to the nearest minute. Record the average weather experienced during each count. Birds may be recorded as 'seen' or 'heard'". A standard form, with all bird names already entered, was used.

The counts were repeated on two mornings, with a total of six to 10 counts (depending on the number of people participating) being recorded each year. The data shown here are the average number of birds seen and heard for each species for the six to 10 counts on each transect each year.

Two transects were through old pohutukawa (*Metrosideros excelsa*) forest, which at the start of the study period had little understorey, but now has moderately dense understorey. The third transect was through forest dominated by introduced wattle (*Acacia decurrens*) in which native understorey species have increased in variety and density during the study period. There has been no management of these forest areas by humans. A small section of the third transect passed through an area that was grassland at the start of the study and is now planted with native trees.

The planted areas adjacent to these forest areas (Fig. 1) were either predominantly grassland or bracken fern (*Pteridium esculentum*) at the start of the study period, but are now closely planted with native trees varying in height from one to four metres.

Data from the November (austral spring) counts should reflect the resident population, rather than be influenced by the varying abundance of young of the year. We considered the average count recorded for each species, then selected for detailed analysis the five native forest dwelling species which were present before conservation management of the island began, and that have been recorded in the November counts every year. Two of the native

species that were re-introduced to the island before these counts began, and two exotic species which are commonly found in forest areas, are also considered.

Analysis

The bird count data (Table 1) were analysed for significant differences between the 1990-1992 and 1996-1998 periods, using 't' tests.

RESULTS

The native species recorded were (in decreasing order of abundance, post eradication): tui (*Prothemadera novaeseelandiae*), bellbird (korimako) (*Anthornis melanura*), fantail (piwakawaka) (*Rhipidura fuliginosa*), grey warbler (riroriro) (*Gerygone igata*), silvereye (tauhou) (*Zosterops lateralis*), spotless crane (puweto) (*Porzana tabuensis*), kingfisher (kotare) (*Halcyon sancta*), pigeon (kereru) (*Hemiphaga novaeseelandiae*), kaka (*Nestor meridionalis*), long-tailed cuckoo (koekoea) (*Eudynamis taitensis*) and shining cuckoo (pipiwharauoa) (*Chrysococcyx lucidus*),

Seven native species were introduced to the island before or during the study period, so numbers of introduced native species were expected to change. Six of these introduced native species encountered on the three forest transects during the study were (in decreasing order of abundance, post eradication): saddleback (tieke) (*Philesturnus carunculatus*), whitehead (popokatea) (*Mohoua albicilla*), stitchbird (hihi) (*Notiomystis cincta*), red-crowned parakeet (kakariki) (*Cyanoramphus*

Table 1 A comparison of average numbers of birds counted on the three "forest" transects during the three years preceding the rat eradication and three years after rat eradication, with a three-year period between to allow bird species to establish a new equilibrium in the absence of rats.

	1990-1992	1996-1998	% change
Native birds present during all counts:			
Bellbird	8.6 ±3.6	16.3 ±1.2	90.6
Fantail	3.6 ±2.0	3.2 ±1.1	-9.7
Silvereye	3.2 ±2.2	0.6 ±0.5	-81.8
Tui	27.4 ±3.2	30.0 ±4.6	9.5
Grey Warbler	2.0 ±0.2	1.0 ±0.3	-48.3
Native birds introduced before counts began:			
Parakeet	2.1 ±1.5	5.8 ±1.8	178.6
Saddleback	9.9 ±1.8	19.0 ±2.1	91.9
Exotic birds in the forest:			
Chaffinch	1.0 ±0.4	0.7 ±0.3	-36.8
Blackbird	1.7 ±0.1	1.8 ±0.7	5.5

novaezelandiae), robin (toutouwai) (*Petroica australis*), and kokako (*Callaeas cinerea*).

The exotic species recorded were (in decreasing order of abundance, post eradication): brown quail (*Synoicus ypsilophorus*), blackbird (*Turdus merula*), chaffinch (*Fringilla coelebs*), starling (*Sturnus vulgaris*), song thrush (*T. philomelos*), greenfinch (*Carduelis chloris*) and dunnoek (*Prunella modularis*).

While trends are apparent, it can be expected that not all species will change in number at similar rates, and some changes may not be related to rat eradication. Five native species, two introduced native species and two exotic species which were present in the forest throughout the study period, and that were recorded during all counts, are examined below in more detail.

Of the native birds that were present during all counts, the 90.6% increase in bellbird numbers is significant ($P=0.024$) but the 9.5% increase in tui numbers is not statistically significant ($P=0.459$). Fantail decreased slightly in abundance but this change is not statistically significant ($P=0.794$). The apparently-large decrease in abundance of silvereye (-81.8%) is not statistically significant ($P=0.113$) but the lesser decrease in grey warbler (-48.3%) is statistically significant ($P=0.015$).

Two native bird species were introduced to the island before this study began: parakeets in 1973 and saddlebacks in 1984. Following rat eradication, parakeets increased by 178.6% but this is marginally insignificant ($P=0.051$). Numbers in the bush transects remain low with high variation from year to year. When introduced to other locations saddlebacks have reached carrying capacity by the sixth year after liberation (Lovegrove pers. comm., Veitch pers. obs.) and so, on Tiritiri Matangi, they may have reached carrying capacity in 1990. Following rat eradication their numbers increased by 91%, which is highly significant ($P=0.005$).

Two exotic species were recorded in all or nearly all counts: chaffinches and blackbirds. Over the study period the average numbers of both species have declined. The 36.7% decline of chaffinches is not significant ($P=0.286$), nor is the 5.5% increase of blackbirds ($P=0.818$). Total numbers of both species were low throughout the study period.

DISCUSSION

Pacific rats are known to suppress the abundance of native fauna (Atkinson and Moller 1990). Their presence on Tiritiri Matangi may have affected the birds counted in this study in three ways: directly through predation; indirectly through competition for food; indirectly through habitat modification. Endeavouring to separate the impacts of the rats from the less-direct impacts caused by the conservation management work on the island is also difficult.

We have endeavoured to exclude the impacts of conservation management work, other than rat eradication, by using data only from the least-modified habitats. However, the planting of trees adjacent to these relatively-small forest areas may have changed bird numbers within the forest. Direct predation by rats is most likely to affect birds such as saddlebacks and parakeets which nest or roost close to, on or in the ground, or in tree cavities accessible to rats. Competition for food may affect all species that feed on fruit, seeds, or large invertebrates at sites accessible to rats. Since rat eradication there has been a massive increase in abundance of ripe fruits and seeds which were previously eaten by rats before they ripened (Veitch pers. obs.). The forest understorey has become notably more dense, which may provide food for some birds or make the forest too dark for others. C. J. Green (pers. comm.) has shown that terrestrial insects have increased significantly since rat eradication; these insects are a principal food for saddlebacks and blackbirds.

Counting forest birds is an imprecise science. The data shown here is very typical of such counts (e.g. Girardet *et al.* 2001) with variability possibly caused by conspicuousness of species, weather patterns, feeding locations, observer aptitude and other factors. This variability makes year to year comparisons impossible, and the comparison of less than three-year periods to be undesirable. In this study we have compared three-year periods and found some changes to be highly significant, with most of these probably resulting from the eradication of rats.

The increase of bellbirds may be a direct result of increased food. Seasonally the fruit on low-growing shrubs is a significant part of the bellbird diet. Their nests are also accessible to rat predation.

The decrease of silvereyes and grey warblers may be a result of changing forest composition. A similar decline of these species has been noted elsewhere (Diamond & Veitch 1981) following regeneration of forests and forest understorey.

Parakeets depend on fruits and seeds as their major food source. Much of their nesting and roosting on Tiritiri Matangi is in crevices in cliffs as few tree cavities are available. This species can survive predation by Pacific rats, but there is a strong indication here that their numbers have increased dramatically as a result of rat eradication.

Saddlebacks on Tiritiri Matangi have been provided with nest and roost boxes and so are mostly safe from predation, apart from juveniles which are likely to spend the first few nights after fledging on the ground. A major saddleback food source is terrestrial insects, and so this species was expected to benefit from rat eradication.

Chaffinches have previously been reported to decline in areas where forest regeneration has occurred (Diamond and Veitch 1981). A similar decline of blackbird numbers

was expected but this species may be gaining benefit from improved food in nearby open areas.

We consider that the eradication of rats from Tiritiri Matangi has been a significant factor in the changes of bird numbers recorded here. Some species have benefited in the short term, others may benefit more in the longer term and some species have declined as forest composition changes.

ACKNOWLEDGMENTS

We thank the Department of Conservation for providing accommodation and support for this project and the following people who assisted with the counts on Tiritiri Matangi: D. and P. Agnew, G. and J. Arnold, K. Barrow, T. Barton, B. Binning, K. Bond, D. Booth, S. Chamberlin, L. Conningham, L. Duff, N. Dyson, G. Eller, C. Exley, B. and K. Glass, S. Graham, B. Green, K. Haslett, J. and L. Hovard, C. Jowett, R. Orange, N. and R. Peachman, J. Penny, N. Rothwell, J. Simmonds, J. and D. Taylor, C. and P. Thompson, J. Tolley, M. and T. Turner, and T. Woronoski.

We also thank Colin Miskelly and John Craig for their helpful reviews of our manuscript.

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