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Density and pair fidelity in a translocated population of North Island robin (*Petroica longipes*)

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Abstract The North Island robin (*Petroica longipes*) was introduced to the Zealandia - Karori Sanctuary in 2001. The sanctuary is a mainland island (225 ha) in Wellington that is free from all mammalian predators except mice (*Mus musculus*), and enclosed by a predator-proof fence. During 2001 and 2002 a total of 76 robins were translocated from Kapiti I to the sanctuary. To assess changes in this population since its introduction, I surveyed and mapped territories of robins in a 37 ha section of the sanctuary in 2008. Density has continued to increase, from 0.7 robins/ha in 2003 to 2.5 robins/ha in 2008. This density is higher than other mainland sites. Of 46 adult robins seen within the study area at the start of the 2004-05 breeding season, at least 17 remained within the area in 2008, close to their 2004 territories. These included 4 robins from the original transfer. In all cases where both partners from 2004 were seen in the study area in 2008, the pair bond remained intact. My survey confirms continued increase in this introduced population and high pair fidelity.

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Keywords North Island robin; *Petroica longipes;* density; Karori; territory; abundance, reintroduction

INTRODUCTION

The range and abundance of the North I robin (*Petroica longipes*) (Fig. 1) and South I robin (*P. australis*) has greatly declined since European arrival, largely due to loss of habitat and predation (Powlesland 1997). The main predators of robins and their nests are introduced mammal species, for example stoats (*Mustela erminea*) and ship rats (*Rattus rattus*; Flack 1973). Robins do not appear to show a natural fear of introduced predators in areas where they have been eliminated, but have probably learnt to recognize mammalian predators on the mainland where they co-occur (Maloney & McLean 1995). Despite this ability, it is likely that introduced predators nevertheless limit the density of robins in remaining forested areas.

The conservation of native birds in New Zealand has traditionally focused on the translocation of individuals to predator-free offshore islands. However, more recently attempts have been made to create "mainland" islands by removing introduced predators in an area and erecting a pest-proof fence to prevent reinvasion. The Zealandia – Karori Sanctuary is a 225 ha mainland island that is enclosed by a predator-proof fence (Small 2004). Thirteen introduced mammals have been eliminated from the sanctuary (Karori Wildlife Sanctuary Trust 2000). Although mice (*Mus musculus*) have continued to reinvade (Karori Wildlife Sanctuary Trust 2000), small reinvasions of other mammals, such as weasels

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Fig. 1. Photo of North Island robin (*Petroica longipes)* foraging in leaf litter at Zealandia-Karori Sanctuary, Wellington.

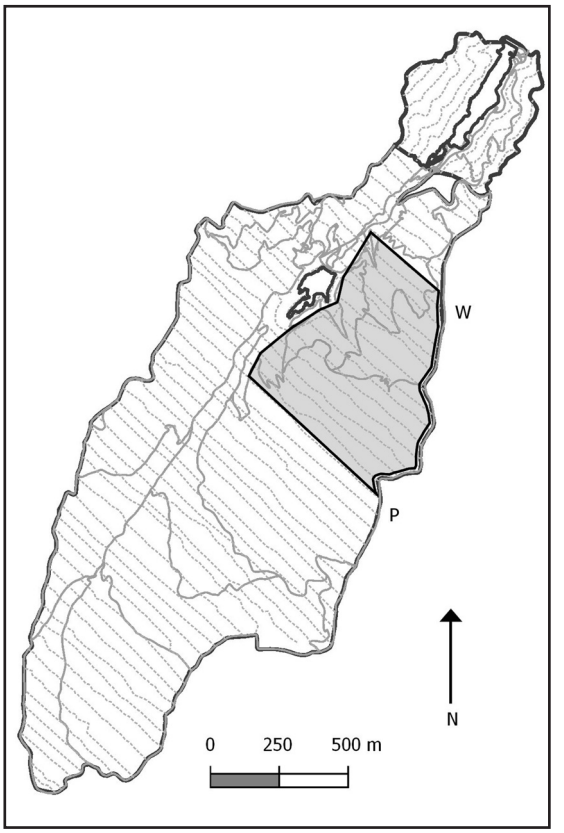

Fig. 2. Map of Zealandia - Karori Sanctuary. Dotted lines, transects; grey shaded section, approximate study area. Map created from data provided by Karori Sanctuary Trust 2008.

(Mustela nivalis) have been successfully controlled (Karori Reservoir Wildlife Sanctuary Trust 2008). A number of native bird species have now been introduced, including the North I robin (Karori Wildlife Sanctuary Trust 2001, 2006). In 2001 and 2002, a total of 76 North I robins were translocated from Kapiti I to Karori (Small 2004). The robins dispersed with 59% settling within the sanctuary (Small 2004). By 2003, the density of robins reached ~0.7 birds/ha. Monitoring of breeding success was continued until the end of the 2004-05 breeding season but further density calculations were not carried out.

The density of robins on islands where mammalian predators are absent is typically higher than that in areas of mainland New Zealand where mammalian predators are present (Flack 1976). Although the Karori sanctuary is free from mammalian predators, it is not a true island and robins can easily disperse outside the sanctuary (Small 2004). When robins were introduced it was assumed that robin density was unlikely to reach those of offshore islands where dispersal is more difficult, but would be higher than in mainland areas where introduced predators and competitors are present but controlled (R. Empson 2009, *pers. comm*.). However, the density at which this might occur is unknown.

The aim of this study was to estimate the current density of robins at the sanctuary and compare this with previous values for Karori and other mainland and island sites. A second aim was to search for robins that were previously banded and to assess fidelity to both territories and mates.

MATERIALS AND METHODS

Study area and species

The study was carried out at the Zealandia - Karori Sanctuary in Wellington, New Zealand (41°18′S, 174°44′E). The area surrounds a water reservoir and access was made through a series of transects that cross the area. The area I searched was bounded by transects labelled P to W, and was bordered on the east by a fence and on the west by a path

following the lake edge (Fig. 2). Fifteen transects spaced at approximately 50 m intervals cross the study area. Each transect was marked by points at ~25 m intervals, and coded for ready identification of location.

The North I robin principally eats invertebrates (Powlesland 1997). It is generally coloured grey or black with a whitish front. Males are slightly darker than females (Higgins & Peter 2002); however, males do not obtain their typical black plumage until they are over a year old (Armstrong 2001, Powlesland 2002), and young males may be similar in appearance to females. Robins often investigate noises and humans within their territory. They can be taught to return to an observer making a certain noise within their territory for a food reward (Powlesland 1997). I used the tameness and close approach of the birds to confirm their identification and to map territories. The breeding season of robins at the sanctuary lasts from around Sep until Feb or Mar (Karori Sanctuary Trust, *unpubl. data*).

Surveys

Surveys of the sanctuary were carried out between mid-Jul 2008 and late Oct 2008 by repeatedly walking along transect lines, mapping, and if possible, identifying each robin observed. Surveys were generally conducted on 1 to 3 days per week, with 2 or 3 transects surveyed per day.

On each transect, at every second numbered point, attempts were made to attract robins by stopping for 3 to 5 minutes, moving an area of leaf litter aside to uncover invertebrates and sitting while clapping then whistling. If a robin was seen, its band combination or 'unbanded' was recorded, otherwise 'none seen' was noted. Other information was also recorded including date, start time, end time, weather, and location (i.e. transect name and point number). At points where robins were seen, immediately prior to leaving, a further area of leaf litter was moved aside while whistling and clapping quietly, to encourage the robin to return on next hearing the sound within its territory. Robins could be heard calling from a distance greater than 25 m, I did not record robins unless seen.

Points on a transect were surveyed alternately. For example, if odd numbered points were surveyed on a visit, then even numbered points were surveyed on the next visit. Overall, transects W to T were surveyed 4 times, odd numbered points and even numbered points on these transects were both surveyed twice each. Transects ST to P were surveyed 3 times, and odd numbered points on these transects were surveyed twice and even numbered points once. Where possible, I determined robin pairs by noting pair bonds, such as one adult feeding another.

Band colours and banding

Robins were banded with 3 coloured bands and a metal band (2 bands per leg). However, only a small proportion of robins at the sanctuary were banded. Between 2002 and 2005 banding was carried out on all robins within the study area to facilitate monitoring, but by the beginning of this study the majority of robins were unbanded. I first surveyed transects with the highest number of banded robins, while banding was undertaken on other transects. All banding during the study period was carried out by Annette Harvey. During banding, mealworms (*Tenebrio molitor* larvae) were used to attract robins into a clap trap. Locations of robins when banded and pair status were recorded by Annette Harvey. When new robins were colour-banded, previous records of unbanded birds at the same location were not considered as separate individuals.

Mapping of approximate territories

A GPS was used to determine the location of at least every 2nd numbered point along the transects. This allowed the location of each robin territory to be mapped. The program Quantum GIS (an open source geographic information system) was then used to combine position of numbered points with other previously mapped features including track-logs of transects. Points which were not estimated using the GPS were placed halfway between the neighbouring GPS estimated points on the map. The GPS locations were accurate to approximately 5 m. Approximate robin territories were then mapped by drawing lines to enclose the area around points where apparent territory-holders had been seen. Territories were mapped for robin pairs where possible, or for individual birds where partners were unknown. Where a robin was seen only once at a point which was greater than 50 m from all other sightings of that robin or its partner, the point was not included as part of the territory.

In many cases ownership of an area was uncertain. If 2 robins, which were not a known pair, were seen together and one successfully chased the other away (i.e. the 2nd robin did not return), or one robin left immediately after seeing the other, it was assumed that the area was within the territory of the robin that remained. However, if ownership of the territory was unclear, or different robins were seen on different occasions, then the point was regarded as a territory boundary and on the map the area around the point was split between the neighbouring territories. In a few cases it was unknown whether a robin was resident in the area, however the area where it was seen is referred to as its territory in my estimates of population size. Eleven of the 39 'single' robins were seen just once;

Table 1. Summary of North I robins recorded in study area. Total number of individuals estimated from census of known pairs, probable pairs, and single birds. Estimated maximum values are the total population size if all single robins were actually paired with unobserved individuals.

Territory type	Total number of territories	Total number of individuals	Approximate number of individuals in study area
Confirmed Pair – centre	17	34	34
Confirmed Pair – edge	12	24	12
Probable Pair – centre	7	14	14
Probable Pair – edge	2	4	2
Unknown, poss. single – centre	25	25 (50 if all paired)	25 (to 50)
Unknown, poss. single – edge	14	14 (28 if all paired)	7 (to 14)
Total	77	115 (to 154)	94 (to 126)

9 of these were seen in the centre of the study area and 2 on the edge. One male was seen at opposite ends of the study area and was classified as having a territory on the edge of the study area.

Data analysis

Approximate area in hectares covered by the survey was determined by the program QGIS. The territories of robins on the borders of the study area probably continued outside the study area. It was assumed that on average about half of the territory of these robins was within the study area. Therefore the number of individuals within the study area was calculated as the total number of individuals seen minus half of the individuals whose territories bordered the study area. Robin density was calculated as the number of individuals within the study area divided by area.

RESULTS

At least 115 different individual robins were recorded, including 112 banded robins and at least 3 robins which were unbanded. The locations of robins and their approximate territories are mapped in Fig. 3. Twenty-nine known pairs, 9 probable pairs and 39 robins whose pairing status was unknown were seen within the survey area (Table 1). The majority of the single robins were thought (or known) to have partners, although the identity of the partner was not established. Assuming that no robins went undetected and half of each border territory was within the study area, the density within the 37 ha area was calculated to be ~2.5 robins per hectare. A lower density limit of 2.3 can be calculated by assuming that robins seen only once did not live within the study area. Alternatively, assuming all unpaired robins actually had undetected partners gives an upper density estimate of 3.4 robins per hectare.

Ninety two of the 115 robins (80%) observed were either aged < 3.5 years at the time of the study, or had moved from outside the study area. This is known because, at the start of the study, these robins were either unbanded, or had a band combination which indicated banding in 2007 or 2008. Twenty-four robins (table 2) were aged at least 3.5 years by summer 2008 (one of these disappeared during the study).

At the beginning of the 2004-05 breeding season there had been 46 adult robins within the study area (45 banded and one unbanded), of these 17 were seen in 2008. This gives a 4-year minimum survival rate of around 37%, or annual minimum survival rate of around 78% for adult robins. The actual survival rate may have been greater as some individuals might have gone unnoticed during the 2008 study or moved out of the study area. Fourteen robins had remained within 50 m of their previous location (table 2) while the other 3 were within 150 m of their 2004 location. In addition, seven chicks from 2004-05 were seen in 2008. Of the adults, 2 female robins from the original 2001 transfer were still present, as were a pair from the 2002 transfer. Overall, at least 4 pairs monitored in 2004 remained together in Oct 2008. In all cases where robin pairs differed from 2004, previous partners were not seen during the 2008 study.

DISCUSSION

The number of robins within the study area (115 individuals) has more than doubled since late

Table 2. Mate and territory fidelity in the North I robin at the Karori-Zealandia Sanctuary. Comparison of Oct 2008 locations and partners for the 24 North I robins within the study area that were aged 3.5 years or greater with their locations and partners during the 2004-05 breeding season (2004-05 information: Karori Sanctuary Trust, *unpubl. data*). Not applicable indicates robins that were chicks in 2004/05 season.

Response	Number of robins		
	Was Oct 2008 territory within 50 m of 2004-05 territory?	Was 2004-05 partner seen in 2008 study?	Was 2008 partner the same as in the 2004-05 season?
Yes	14	8	8
No	3	9	6
Unknown	0	0	3
Not applicable	7	7	7

2004, when 46 individuals (22 pairs) were known to be within the same approximate area (Karori Sanctuary Trust, unpubl. data). The density of ~2.5 robins/ha in 2008 has increased from 2003 when a density of 0.7 robins/ha was calculated (Small 2004). This difference in density at the level of the entire reserve is actually greater than the numbers indicate as I estimated density as the number of robins divided by area. However, at the time of Small's (2004) study, robins had not yet colonised the entire sanctuary and density was defined as number of individuals inhabiting territories divided by the sum of the territory sizes (i.e. uninhabited areas were excluded from the density result). Thus, not only have robins colonised greater areas of the Karori Sanctuary since their introduction, they have also increased in density in the area first colonised.

Densities of robin populations on mammal-free islands can remain stable with low population change over several years and these islands generally have higher densities and smaller territories than at comparable mainland sites (Flack 1976). For example, density value in several recent studies of robin populations on mammal-free islands ranges from around 3.8 to 10 robins per hectare (Armstrong et al. 2000, Byrne 1999, Mackintosh & Briskie 2005). Whereas, at the mainland site of Kaikoura, calculated density was 0.15 robins/ha (1998) (Byrne 1999, Mackintosh & Briskie 2005). At the mainland site of Otamatuna, Northern Te Urewera, after 3 years predator management, density was found to be 0.7 robins/ha minimum (predator management caused a density increase of 30.6%) (Beaven & Rutson 2000). At around 2.5 robins/ha, the density of robins at Karori in 2008 is higher than other mainland sites but still lower than many values for robins on mammal-free islands. The higher density is probably due to the absence of introduced predators. It is less clear why density of robins at Karori is lower than on islands, but it seems likely that this is affected by the ease with which robins can leave the sanctuary. Robins were only introduced to the sanctuary in 2001 and some areas near occupied territories remain vacant (Fig. 3). These appear suitable for colonisation, so it is possible that density will continue to increase.

My observations suggest that territory size of robins has also decreased since 2003. Territory size in my survey averaged ~0.5 ha, which is smaller than mean territory size of 2.9 ha in Mar 2003 (Small 2004). There were few robin territories close to the eastern fence in the 2008 survey (Fig. 3) Areas very close to the fence (< 50 metres) often lacked canopy cover, which may explain the absence of robins (Flack 1973). Near to the fence there also appeared to be a higher proportion of non-native forest and drier ground than in areas further west. However, robins are known to hold territories in a variety of forest types, including introduced (Flack 1973). Therefore this may not be the cause of the uninhabited sections. Another possible cause is the survey method. Moving leaf litter to uncover invertebrates was probably less attractive to robins in areas close to the fence where pine needles covered the ground and this method did not uncover large numbers of invertebrates. Finally, robins with territories on the fenceline may forage outside the reserve so are at greater risk of predation (R. Empson 2009, pers. comm.).

During the study 38 known or probable robin pairs were recorded. The majority of the other 39 robins were also believed (or known) to have partners. Many robins were seen calling to unidentified partners while holding food in their beak, then disappearing in the direction of the responding bird. Due to time limitations the identity of partners could not always be established, however the number of unpaired birds is probably much lower than shown on the map and number of pairs much higher. If all 39 possibly single robins were in fact paired with individuals who had

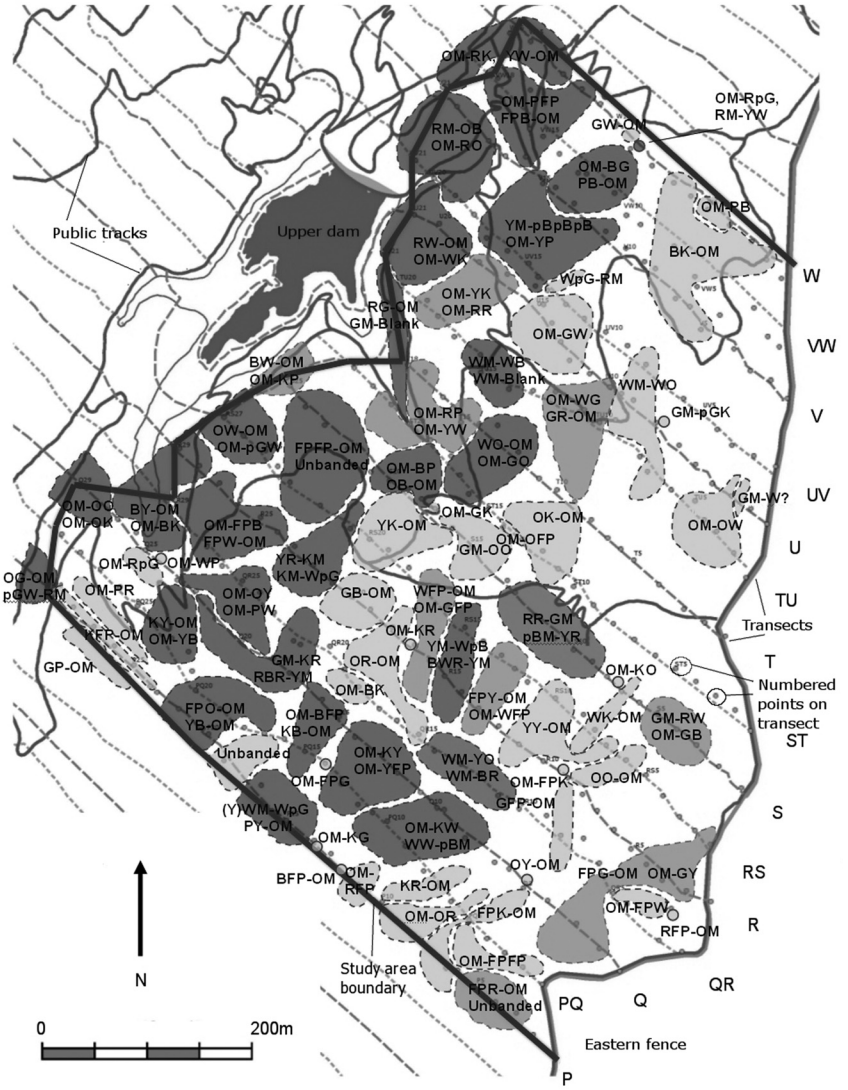

Fig. 3. Approximate spatial distribution of North I robin territories within transects W to P east in Zealandia - Karori Sanctuary, Aug to Nov 2008. Dark grey shading indicates known pairs, mid-grey shading shows probable pairs; light grey shading shows a robin whose partner is unknown or unconfirmed. Small shaded circles indicates robin/s seen only once. The area outside the study area boundary was not systematically surveyed.

remained unseen during the study this would give a density of 3.4 robins/ha. However, many of these robins may be paired with other individuals also shown as single on the map rather than with unseen individuals.

In all cases where both partners from the 2004 study were seen during the 2008 survey, the pair bond was still intact. These results were expected as other studies of North Is robins have found that pair bonds are usually retained unless one of the pair dies (Armstrong *et al*. 2000, Powlesland *et al*. 2000), robin territory boundaries may also be very stable unless neighbouring birds die (Flack 1973). While these results concur with studies showing that adult robins tend to remain in the same territory with the same partner, it is possible that some of the robins from 2004 may have moved out of the study area and have gone unnoticed.

Surveys which attempt to census every individual in a population, such as the one reported here, are seldom successful in obtaining complete coverage. This can be due to a number of factors. For example, trade-offs in time spent on each transect and the area surveyed meant I was only able to visit each point on each transect a few times. If a robin was unable to hear my attempts to attract it, or unwilling to respond during these few visits, it would have been missed in my survey. As territory size was smaller than in previous surveys, it is possible that some territories cross only one or two survey points, and this would further reduce detection based on transect surveys. A few robins

also became wary after banding, which could have reduced detection rates. As the study took place during the breeding season some females may have been on the nest and not detected. Finally, it is also possible that robins seen only once were transient, lived on the edge of the study area or died later in the season. Robins are known to occasionally feed in or pass through neighbouring territories (Flack 1973).

In conclusion, the robin population within the study area increased greatly between 2003 and 2008. 2008 density at the sanctuary was estimated to be more than 3 times higher than in 2003. This density is high for a mainland site and probably reflects the absence of introduced predators and competitors combined with high suitability of the habitat. Although density is still lower than that found on offshore islands, further surveys would be valuable to determine if density continues to increase, or if it has now reached a plateau and further increases are offset by greater dispersal out of the sanctuary.

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