

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 0 ± 10 m intervals along the transect line.

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. Young 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 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, I stopped for 3 to 5 minutes, moving an area of leaf litter 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 clapped and whistled 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 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 banded robins, while banding was undertaken on other transects. All banding during the study was done on robins when banded and pair status were recorded. Mealworms (*Tenebrio molitor* larvae) were used as a food reward. Previous records of unbanded birds at the same location were not considered as separate individuals.

Mapping of approximate territories

At every 2nd numbered point along the transects. This allowed the location of each robin territory to be mapped. 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 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 first robin. If 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 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
~ 2± µf "S #αµ "±µi	17	34	34
~ 2± µf "S #αµ "S ^a	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 "±S ¶²©«" ¶. S ¼µi α µ±S ° µ¶ | µ¶¶- "S µ¶ «α¹ ±^a a territory on the edge of the study area.

Data analysis

Approximate area in hectares covered by the ¶. µ¹ ¼° µ¶¶ S " µf ± S ¥¼«" ° µ² a µ²° S/ f& ' «" 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

· · ¶¶ S- µ±. ±S- S, α µ² ¥±¶¶ ° µi 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 ° « µi µ² ¥± ° µ¶¶ S- µi S ¶¶° ° µ¹ ², ¶¶ 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

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 absence of introduced predators and competitors combined with high suitability of the habitat. Although density is still lower than that found on to determine if density continues to increase, or if it has now reached a plateau and further increases are

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