Breeding biology of North Island robins (*Petroica australis longipes*) in Pureora Forest Park

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Abstract Breeding of North Island robins was monitored at two sites in Pureora Forest Park, central North Island, during the 1996/97 and 1997/98 breeding seasons. A total of 146 nests was found. First clutches were laid in September-October (mean: 20 September) and last clutches in November-January (mean: 17 December). Pairs had time to rear three broods during the breeding season (September-March), although most reared only two. Nest materials and nest location are described: mean nest height was 5.3 m (range 1.0 - 13.6). Mean clutch size was 2.60 (clutches of 2 or 3). Monthly mean clutch size increased from September to November, then decreased. The breeding biology of the North Island subspecies of robin at Pureora was similar to that of the South Island robin at Kaikoura. Nesting success improved dramatically after brushtail possums were poisoned by aerially distributed 1080 (sodium monofluoroacetate) baits, because mammalian predators were also poisoned. Robins are easy to monitor, and predation is a common cause of nest failure, so the species is potentially a valuable indicator of predator activity.

INTRODUCTION

The North Island robin (*Petroica australis longipes*) is particularly suitable for detailed studies of breeding biology because it can be trained to approach people for a food reward, can be readily captured and fitted with colour bands for individual recognition, and its nests can be found and closely monitored with little chance of desertion (Powlesland 1997). Despite these attributes, Brown's (1997a) account of the impacts of predators on nesting success is the only published study of the breeding biology of this subspecies. General accounts of the North Island robin's breeding biology, or aspects of it, were given by Wilkinson & Wilkinson (1952), Turbott (1961), and St Paul (1976).

The poisoning of brushtail possum (*Trichosurus vulpecula*) populations has implications for robin populations, both as a cost (poisoned robins) and a benefit (reduced predator populations, particularly of possums and rodents). Over the past 30 years, there have been increasing efforts to reduce possum populations, because possums damage indigenous forest ecosystems (Atkinson *et al.* 1995), and because they are a vector of bovine tuberculosis to cattle and deer (Livingstone 1994). Currently, the most common method of control involves aerial broadcasting of baits containing sodium monofluoroacetate (compound 1080) (hereafter referred to as poison operations), which can reduce possum populations by more than 90% (Eason *et al.* 1993). Populations of other predatory mammals, such as the ship rat (*Rattus rattus*), are also markedly reduced by such poison operations (Innes *et al.* 1995), and stoat (*Mustela*

erminea) populations may be reduced too (Murphy *et al.* 1999).

North Island robins have been found dead after poison operations (Spurr & Powlesland 1997). To quantify the costs and benefits of poison operations to robins, Powlesland *et al.* (1999) monitored the nesting success of individually marked birds in Pureora Forest Park, central North Island, during 1995-98. In the course of this research, we obtained data on several aspects of the breeding biology of *P. a. longipes* and we report these here because very little such information is available.

STUDY AREAS AND METHODS

Study areas

We studied the breeding of North Island robins during the 1996/97 and 1997/98 breeding seasons in two study areas within Pureora Forest Park, central North Island (see fig. 1, Powlesland *et al.* 1999). The Tahae study area (c. 100 ha) is unlogged forest within the Waipapa Ecological Area, bordered by Fletcher's Road, the Waipapa River and a scrub and swamp area called Taparoa Clearing (Leathwick 1987). It is relatively flat, at 520-540 m a.s.l. A poison operation was carried out over 37,500 ha, including the Tahae study area, in September 1996.

The Waimanoa study area (c. 300 ha) is bordered by Waimanoa, Link, and Swamp Roads. The forest block is on rolling country at 700-740 m a.s.l.; only about 100 of the 300 ha were used during the study. A poison operation was carried out in September 1997 over 8,577 ha, which included the Waimanoa study area. The vegetation types of the two study areas were similar, and descriptions of the main canopy tree species in each are given in Knegtmans & Powlesland (1999).

Capture and marking robins

Adult North Island robins were captured in mist nets or electronically operated clap traps. Before trying to capture robins, they were fed mealworm (*Tenebrio molitor*) larvae, and at the same time were conditioned to appear for food when we tapped the lid of the mealworm container. Each robin was captured only after it regularly approached us for mealworms. While fledgling and juvenile robins could often be fed beside the trap the first time it was presented, adults were initially wary of the trap and so had to be fed near it several times before they could be reliably trapped. Those robins that would not feed at the clap trap were

fed near a mist net and then startled into it, or attracted into it using taped song. Each robin was fitted with a unique combination of a numbered metal leg band and two or three coloured plastic leg bands (size B butt bands). Most nestlings were banded with an individual combination when 10-15 days old.

Monitoring robins

We checked each pair at least once a week. If the female was attracted, we found the nest by following her back to it. If the male was attracted, he would usually go to the vicinity of the nest with mealworms and feed his mate, and we then followed her to the nest. We checked each nest about every third day to determine its contents and fate. Since nesting attempts failed during egg-laying and early incubation, it is possible that a few nestings went undetected. Therefore, the results should be regarded as an index of nesting success.

Fledglings were difficult to locate for the first few days after leaving the nest. Invariably they were well concealed in thick vegetation, and remained stationary with the parents unwilling to feed them while we were nearby. These factors, combined with nest checks at three-day intervals, meant nesting success had to be determined once the fledglings became mobile, about a week after leaving the nest.

Statistical analyses

The computer package SigmaStat was used for performing *t*-tests, Mann-Whitney Rank Sum tests and χ^2 tests to compare various data sets. Where the *t*-test was inappropriate because the data were not normally distributed, the Mann-Whitney Rank Sum test was used to test for significance.

RESULTS

Breeding season

The combined data for both study areas (*n*=4) gave a mean date for laying first clutches in the 1996/97 season of 27 September (Table 1). In 1997/98, the mean date of first clutches for Tahae (22 September) was slightly later than that for Waimanoa (15 September), but not significantly so (Mann-Whitney Rank Sum test, *P*=0.083). Combining all data from both study areas and seasons (Table 1), the mean date that first clutches were laid was 20 September, the earliest clutch being started on 9 September and the latest on 16 October.

Table 1 Mean and range of egg-laying dates[1] of first eggs in first clutches of North Island robins in Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons.

	Mean	Earliest	Latest	SD	n
1996/97					
Tahae &					
Waimanoa	27 Sep	24 Sep	3 Oct	4.3	4
1997/98					
Tahae	22 Sep	13 Sep	16 Oct	9.9	9
Waimanoa	15 Sep	9 Sep	28 Sep	6.4	8
Overall	20 Sep	9 Sep	16 Oct	8.8	21

[1]When a laying date was unknown it was estimated from the date of hatching or chick age, allowing 19 days for incubation.

Table 2 Mean and range of egg laying dates[1] of first eggs in last clutches of North Island robins in Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons.

	Mean	Earliest	Latest	SD	n
1996/97					
Tahae	11 Dec	22 Nov	17 Dec	9.8	6
Waimanoa	31 Dec	8 Dec	25 Jan	14.7	7
1997/98					
Tahae	13 Dec	3 Nov	2 Jan	18.2	14
Waimanoa	27 Dec	7 Nov	27 Jan	22.8	8
Overall	17 Dec	3 Nov	27 Jan	18.9	35

[1]When a laying date was unknown it was estimated from the date of hatching or chick age, allowing 19 days for incubation.

The mean date that last clutches were laid was earlier at Tahae (11 December) than Waimanoa (31 December) in 1996/97 (t=2.85, df=11, P=0.016) (Table 2). The mean date of last clutches was also earlier at Tahae (13 December) than Waimanoa (27 December) in 1997/98, but the difference was not significant (t=1.36, df=20, P=0.19). Combining all data, the mean date that last clutches were laid was 17 December, the earliest being 3 November and the latest, 27 January.

Since incubation and nestling-rearing lasted about 19 and 21 days respectively (see below), and fledglings are fed for at least 21 days before becoming independent (Powlesland 1983), some successful last nesting attempts would not have been completed until late March. The robin breeding season at Pureora Forest Park therefore extended for seven months, from early September until late March.

Nest building

Nests were built by the female alone, with the male bringing her food two to three times per hour. The nests varied little in composition, except for the types of coarse materials (such as a few twigs or pieces of bark bound with cobwebs) used to form the base. The bulk of each nest was mainly mosses, but the lining was invariably of tree fern (*Dicksonia* and *Cyathea* spp.) scales collected from the bases of fronds.

Nest site

Five types of nest sites were distinguished: on trunks or in trunk forks (35.6%, n=146 nests, combined data from both study areas and seasons); on trunk-branch junctions (34.2%); epiphytes next to trunks (15.1%); and at the central (n=11%), or outer portion of branches (4.1%). Nest sites were covered in epiphytes, such as mosses, lichens and filmy ferns, which meant that nests were well camouflaged.

Two nesting attempts (1.4% of 146) involved females re-using nests that they had built and successfully fledged broods from during the previous season.

The 146 nests were fairly evenly distributed through three forest strata. These were within the shaded canopy (uppermost storey of tree crowns) (30.8%), upper understorey (shaded plant crowns below the canopy and above 2 m high) (39.7%), and lower understorey (plants 0.3-2.0 m high) (29.5%). The main tree species or physical type in which the nests were situated, or on which epiphytes were growing that contained nests, were: tawa (*Beilschmiedia tawa*) (24.0%, n=146), tree ferns (*Dicksonia* and *Cyathea* spp.) (19.2%), dead trunks (10.3%), mahoe (*Melicytus ramiflorus*) (9.6%), *Coprosma* spp. and totara (*Podocarpus totara*) (4.1% each), and miro (*Prumnopitys ferruginea*), kamahi (*Weinmannia racemosa*), pigeonwood (*Hedycarya arborea*), and tanekaha (*Phyllocladus trichomanoides*) (3.4% each). Of those on dead trunks, one nest was in a cavity and five were on broken-off stumps.

Nest height

The mean height for all 146 nests was 5.3 m, with the highest nest at 13.6 m and the lowest at 1.0 m. The mean nest heights at Tahae for the 1996/97 and 1997/98 seasons were not significantly different (Mann-Whitney Rank Sum test, P=0.07), nor were the mean nest heights at Waimanoa for the two seasons significantly different (Mann-Whitney Rank Sum test, P=0.18) (Table 3).

Combining data for the two seasons, the mean nest heights at the two sites were not significantly different (Mann-Whitney Rank Sum test, P=0.56).

Distance between nests

The distance between consecutive nests of each pair was measured to determine whether pairs that had failed nesting attempts as a result of predation built their next nest further away than those that were successful, as was investigated for the fantail (*Rhipidura fuliginosa*) (McLean 1980). Data from the two seasons and study areas were combined. Pairs whose nests failed as a result of predation re-nested a mean of 60 m away (range=12-160, SD=31.4), whereas those that fledged young renested a mean of 44 m away (range: 5-117, SD=30.3) (Table 4). The difference is almost significant (t=1.98, df=70, P=0.0512).

Eggs

On all five occasions when nest contents were checked during egg-laying, the interval between successive eggs was one day. The white, ovoid eggs were marked with brown and purplish-brown blotches and spots over the entire shell, but concentrated at the larger end.

Seventeen eggs were retrieved from 11 nests following predation or abandonment. The mean (± SD) length and maximum breadth of these eggs were 24.7 ± 0.6 mm and 18.4 ± 0.4 mm. The extremes in length were 24.0 x 17.7 mm and 26.2 x 17.8 mm, and those in width were 17.5 x 24.4 mm and 19.0 x 24.8 mm.

Clutch size

Data from only those nests inspected at least twice during incubation were included in calculations for mean clutch size (Table 5). Clutches consisted of two or three eggs (n=78), with an overall mean of 2.60 eggs. The monthly mean clutch size for the combined data varied through the breeding season; 2.18 eggs in September (n=17), 2.42 in October (n=12), 2.93 in November (n=27), 2.76 in December (n=17) and 2.20 in January (n=5) (Kruskal-Wallis test = 31.25, df=4, P<0.001). Mean clutch size did not differ significantly between the two study areas in either 1996/97 (Mann-Whitney Rank Sum test, P=0.34), or in 1997/98 (Mann-Whitney Rank Sum test, P=0.40). Also, it did not differ significantly between the two breeding seasons for the two study areas combined (Mann-Whitney Rank Sum test, P=0.52).

Table 3 Mean, maximum and minimum heights (m) of North Island robin nests in the Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons.

	Mean	Max.	Min.	SD	n
Tahae					
1996/97	4.3	10.2	1.2	3.06	17
1997/98	5.8	13.6	1.0	3.23	65
Waimanoa					
1996-97	5.5	12.0	1.8	2.96	33
1997/98	4.6	10.5	1.3	2.59	31
Overall	5.3	13.6	1.0	3.05	146

Table 4 Mean distance (m) between nesting attempts of North Island robins (Tahae and Waimanoa combined) depending on whether the previous nest was successful (fledged at least one nestling) or failed as a result of predation.

	Successful			Failed		
	Mean	SD	n	Mean	SD	n
1996/97	41	34	8	65	36	17
1997/98	46	29	16	57	29	31
Overall	44	30	24	60	31	48

Table 5 Mean size of North Island robin clutches in the Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons, and in total.

	Mean	SD	n
1996/97			
Tahae 2.50	0.54	8	
Waimanoa	2.75	0.45	16
1997/98			
Tahae 2.52	0.51	31	
Waimanoa	2.65	0.49	23
Overall 2.60	0.49	78	

Incubation

Only female robins incubated. Their mates took food to them throughout the day, but the frequency of food presentations was not quantified. Incubation lasted 18 (n=2 clutches) or 20 days (n=2).

Of 127 eggs not preyed upon in 49 nesting attempts from both study areas and seasons, 113 hatched (89%). At least seven of the 14 unhatched eggs were infertile, including two (4.1%) complete clutches, and one egg contained a partly-developed embryo.

Table 6 North Island robin nesting success in the Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons.

	Aerial poisoning[1]	Number of pairs	Number of nests	Nesting success[2]	Mean no. of fledglings pair[1]
1996/97					
Tahae	Yes	7	18	72%	3.7
Waimanoa	No	14	35	11%	0.4
1997/98					
Tahae	No	23	67	30%	1.5
Waimanoa	Yes	10	30	67%	3.8

[1]Aerial 1080 possum poisoning operations were carried out just before the start of robin nesting (Powlesland *et al*. 1999).
[2]Proportion of nesting attempts that resulted in at least one fledgling surviving at least the first week after leaving the nest.

Nestling rearing

Only females brooded nestlings. While the frequency of their visits was not quantified, males were occasionally seen feeding their mates when nestlings were present, but generally once nestlings were more than five days old, males fed all prey to them. The nestling period was determined for two broods at 20 and 22 days.

Of 46 banded nestlings not preyed upon from 21 nesting attempts from both study areas and seasons, at least 41 (89.1%) survived for at least one week after leaving the nest. Since no chicks were found dead in nests (unless killed by predators), it is assumed that the five young that disappeared did so soon after leaving the nest. This is because fledglings are not known to become independent until at least three weeks of age (Powlesland 1983), once able to fly competently (7-10 days after fledging) they are inquisitive of people, and, as with the adults, they were then invariably seen whenever the territory was checked. Thus it is unlikely that any fledgling 1-3 weeks out of the nest would have gone undetected during our frequent visits to its parents' territory.

Nesting success

Robin nesting success, as a proportion of nests found that fledged chicks or as the mean number of fledglings per pair, differed considerably depending on whether or not the study area had been subjected to a poison operation just before the nesting season (Table 6, Powlesland *et al*. 1999). The Waimanoa robins had very low nesting success (11%, 0.4 fledglings pair[1]) during the 1996/97 season when no poison operation occurred beforehand and populations of predatory mammals remained unchecked. In contrast, when a poison operation was carried out just before the start of the breeding season

(Tahae in 1996/97, Waimanoa 1997/98), robin nesting success was high (72% and 67%, 3.7 and 3.8 fledglings pair[1], respectively). Robins at Tahae during the 1997/98 season, one year after a poison operation, had moderate nesting success (30%, 1.5 fledglings pair[1]). The greatest productivity per pair was during the 1997/98 season at Waimanoa when two pairs each reared three broods.

Nesting effort

Most pairs nested two (22.0%, $n=41$), three (46.3%) or four times (24.4%) each season (Table 7). Even though the mean nesting effort at Waimanoa (no predator poisoning) (3.5 nests pair[1] season[1]) was nearly one greater than that at Tahae (poison operation just before the breeding season) (2.6) during the 1996/97 season, the difference was not significant (Mann-Whitney Rank Sum test, $P=0.07$). Overall for the two seasons, the mean number of nests per pair per season was 3.1.

Retention of pair bonds

Over the two breeding seasons, of 53 pairs present in September at the start of the breeding season, 37 (69.8%) of the pair bonds remained intact seven months later when breeding had finished (Table 8). Pair bonds were broken because either males disappeared (9.4%), females disappeared (7.5%), females were known to be killed or injured during nest predations (5.7%), or females deserted their partners to pair with bachelors elsewhere in the study areas (7.5%). Of the four females that changed mates, two left their partners rearing fledglings, and the other two left following failed nesting attempts.

Monogamy was normal for robins during this study. However, one instance of polygyny was observed; a male paired with two females. All three birds had lost their partners early in the season, the females being in

Table 7 Nesting effort (number of nests pair[1] season[1]) of North Island robins in the Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons, and in total.

| | No. of pairs[1] | Number of nests pair[1] season[1] | | | | | |
		1	2	3	4	5	Mean
1996/97							
Tahae	7		3	4			2.6
Waimanoa	6			4	1	1	3.5
1997/98							
Tahae	18	1	5	5	6	1	3.1
Waimanoa	10		1	6	3		3.2
Total	41	1	9	19	10	2	3.1

[1]Includes only those pairs present for the entire season

Table 8 Pair bond retention by North Island robins in the Tahae and Waimanoa study areas, Pureora Forest Park, during the 1996/97 and 1997/98 breeding seasons.

	Pairs start[1]	Present at end[2]	Male disappeared	Female disappeared	Female dead/injured	Female moved
Tahae						
1996/97	7	6				1
1997/98	23	15	4	1	1	2
Waimanoa						
1996/97	12	8		3	1	
1997/98	11	8	1	1		1
Total	53	37	5	5	2	4

[1]Number of pairs present in September when the breeding season started
[2]Number of pairs present in March by which time most pairs had finished breeding

neighbouring territories. The male shifted about 100 m to the females' territories and was seen to present food to both females. The three subsequent nests of one female all failed as a result of predation during incubation, while the other female successfully fledged chicks which the male assisted to feed, from her one nest. Also unusual was a neighbouring bachelor pairing with a female whose mate disappeared during incubation. The female had been incubating for at least 13 days when the bachelor paired with her; he then fed her during the remainder of the incubation period and fed the resultant brood.

DISCUSSION

Breeding season

North Island robins at Pureora started egg-laying in September, as they did on Kapiti Island (Wilkinson & Wilkinson 1952). However, South Island robins (*Petroica*

australis australis) at Kowhai Bush, Kaikoura, started egg-laying a month earlier (Flack 1979; Powlesland 1983). From these examples it would appear that the difference in the timing of the start of nesting is not related just to altitude because both the Kowhai Bush (60-150 m a.s.l.) and Kapiti Island (0-200 m a.s.l.) studies were at a similar altitude. Robins on Outer Chetwode Island, Marlborough, which hold small territories (0.2-0.6 ha pair[1]), had a short breeding season (late August – November). However, when some robins from this island were transferred to nearby Motuara Island, which had had no robins, the transferred birds laid from August to December (Flack 1975). This result suggests that robin population density, possibly in combination with prey availability, influences the start and duration of the nesting season.

The robin breeding season at Pureora extended from early September, when egg-laying began, until late March, when fledglings from late broods were still being fed by

their parents, a seven month period. As a nesting cycle takes about nine weeks (nest-building 2-5 days, pre-lay period 2-7 days, egg-laying 2-3 days, incubation 19 days, nestling-rearing 21 days, re-nesting after fledging a brood c. 2 weeks) (this study; Powlesland 1983), seven months is just sufficient for a pair of robins to rear three broods. Only two pairs at Pureora achieved this feat, both during the 1997/98 season in the Waimanoa study area, when possum and rat populations were at low densities following a poison operation (Powlesland et al. 1999). Most other pairs had at least one failed nesting attempt as a result of predation or, having reared two broods, they did not attempt to rear a third.

Breeding biology

The composition and sites of robin nests at Pureora were much the same as those on Kapiti Island (Wilkinson & Wilkinson 1952) and at Kaikoura (Powlesland 1983). In contrast to tomtits (*Petroica macrocephala*), which place their nests in cavities or thick vegetation for camouflage (Heather & Robertson 1996; Knegtmans & Powlesland 1999), robins relied mainly on epiphytes (mosses, filmy ferns, and lichens) on trunks and branches to camouflage their nests.

Most aspects of the breeding biology of the North Island robin (this study) and South Island robin (Flack 1979; Powlesland 1983) are much the same. Their eggs are similar in colouration and mean size (*P. a. longipes*: 24.7 x 18.4 mm, *P. a. australis*: 24.9 x 18.6 mm). Clutches of *P. a. longipes* consisted of two or three eggs, while those of *P. a. australis* also included a few of four eggs (2% of 150). The monthly mean clutch size for both subspecies increased to a peak at about the middle of the nesting season and then declined. Although sample sizes were small in this study of *P. a. longipes*, the duration of incubation (19 days) and nestling stages (21 days) recorded were much the same as those of *P. a. australis* (18 and 21 days respectively).

Robin conservation

The nesting success (11% of nesting attempts) and productivity of robins (0.4 fledglings pair⁻¹) at Pureora in the 1996/97 season was low, when there was no control of populations of mammalian predators. Similarly, only 13% of nesting attempts by robins (*n*=54) at Kaharoa, near Rotorua, were successful during the 1993/94 season when predatory mammals were not controlled, and 5 of 12 nesting females disappeared during the season (Brown 1997a). However, there is little information about the

long-term impacts such predation events may have had on mainland robin populations. During the 1970s, nesting success of robins in Kowhai Bush was about 30% annually (Flack 1979; Powlesland 1983). During this same period, censuses indicated that the population declined by 83%, from 94 to 16 adults (Flack 1979; Powlesland 1983), and therefore would have been vulnernable to local extinction, particularly because there were fewer females than males (J.A.D. Flack & B.D. Lloyd pers. comm.). The continued presence of robin populations in the central North Island forests under such predation pressure probably results largely from the species' ability to re-nest several times during a nesting season.

It is possible that exotic plantations adjacent to native forest at Pureora may act as refuges for robins, as some plantation age classes support lower densities of ship rats and stoats than native forest (King et al. 1996). An example where this effect may be operating is reported from Mauritius where a 6 ha mature grove of Japanese red cedar (*Cryptomeria japonica*) is inhabited by many pairs of the threatened Mauritius Fody (*Foudia rubra*) (Safford & Jones 1993). Breeding data for the fody show that the birds have much greater nesting success in the *Cryptomeria* grove than in native habitats. The authors considered the higher success to be a result of reduced predation; the grove of exotic trees offered little to foraging ship rats and macaques (*Macaca fascicularis*) and so was unattractive to these introduced predators of birds eggs and nestlings (Safford & Jones 1993). Whether a similar situation exists at Pureora should be investigated.

Given the high predation rates recorded at robin nests in several widely-separated unmanaged native forests, it is timely that the Ornithological Society of New Zealand has begun another national bird distribution mapping survey, which should indicate whether robin distribution has contracted (or even changed) in the 20 years since data for the first atlas were collected (Bull et al. 1985).

From 1991 to 1999, new populations of North Island robins have been established as a result of transfers to islands free of mammalian predators (Tiritiri Matangi Island (Armstrong 1995), Mokoia Island (Jansen 1993), and Mana Island (Empson & Miskelly 1999)), and to sites on the mainland where mammalian predators are controlled, including Department of Conservation mainland island sites (Trounson Kauri Park, Northland; Wenderholm Regional Park, near Auckland; Kakepuku Historic Reserve, near Otorohanga; Paengaroa Scenic Reserve, near Taihape; Boundary Stream, Hawkes Bay) (Saunders 1999). It is too early to determine whether the

transfers will be successful, but early indications are that most will result in self-sustaining robin populations, so long as intensive predator control is maintained. Because pairs at sites which are largely predator-free are able to rear two, and occasionally three, broods in a season and robins breed at one year of age, populations can increase quickly (c. 30-125% annum^{-1}, Powlesland *et al.* 1999). As a result, while these mainland sites remain substantially predator-free, the long-term conservation of the species on the North Island seems more assured than previously.

Because introduced mammalian predators destroy many robin nests, and robins can be studied readily (Brown 1997a; Powlesland 1997), the species may be a useful indicator of "general predator impacts", both in terms of possible predator impacts on other forest bird species more difficult to monitor, and to quantify the impacts on non-target bird species of management actions to reduce predator populations (Brown 1997b; Powlesland *et al.* 1999). The "health" of a forest block for birds could be assessed by annual censuses of robins (number of birds in a given area, or proportion of paired males versus unpaired males) just before the breeding season, by monitoring nesting success, or both. However, because vulnerability to predators and to management techniques (especially to poison operations for mammal control) will vary between species, the efficacy of such a monitoring programme would need to be tested by measuring their impact on robins and other species simultaneously at the same site.

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