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# Status of little spotted kiwi (*Apteryx owenii*) on Tiritiri Matangi Island in April 2017

Hugh A. Robertson, Natasha B. Coad, Rogan M. Colbourne and James R. Fraser



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# Status of little spotted kiwi (*Apteryx owenii*) on Tiritiri Matangi Island in April 2017

Hugh A. Robertson<sup>1</sup>, Natasha B. Coad<sup>2</sup>, Rogan M. Colbourne<sup>1</sup> and James R. Fraser<sup>2</sup>

<sup>1</sup> Department of Conservation, PO Box 10-420, Wellington 6143, New Zealand.  
hrobertson@doc.govt.nz

<sup>2</sup> With a Nose for Conservation, Elgin, Takamatua Valley Road, RD1, Akaroa 7581, New Zealand

## Abstract

The little spotted kiwi (*Apteryx owenii*) is the second rarest kiwi species in New Zealand, making the monitoring of its population essential. We caught 31 little spotted kiwi (28 adults, 2 subadults and 1 juvenile) on Tiritiri Matangi Island between 17 and 30 April 2017, including 3 of the 14 founders introduced from Kapiti Island in the mid-1990s and 9 island-bred birds that had been banded during 5-yearly monitoring visits between 1997 and 2012. Based on the locations of captures, radio-tagged birds, sightings and the projected origins of calls heard, we estimated that there were at least 25 pairs and a total population of 60–80 kiwi on Tiritiri Matangi Island. This represents a decline from the 2012 estimate of 80–100 birds, possibly due to the severe drought that was experienced in early 2013. However, the birds were generally in good to excellent condition and were heavier than their conspecifics on Kapiti Island at that time of year. At the end of our survey, 10 adult females were transferred to Shakespear Open Sanctuary at the tip of the adjacent Whangaparaoa Peninsula and 10 new adult females were introduced from Kapiti Island in an attempt to increase the genetic diversity of the Tiritiri Matangi Island population. However, the maximum of 24 founders is still below the 40 founders that is usually recommended. Therefore, we recommend that at least 10 additional kiwi are transferred to Tiritiri Matangi Island to improve the genetic resilience of the population to challenges such as diseases or environmental perturbations, and that 5-yearly monitoring and annual call counts are continued.

Keywords: little spotted kiwi, *Apteryx owenii*, population dynamics, territory mapping, drought, genetic rescue.

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# 1. Introduction

The little spotted kiwi (*Apteryx owenii*) was probably the most common kiwi species in New Zealand in the mid-1800s. However, this species had almost completely disappeared from the mainland by the mid-1900s and is now the second rarest of the five kiwi species (Heather & Robertson 2015). Fortuitously, five birds that had been collected in South Westland in 1912 were established on Kapiti Island (Colbourne & Robertson 2004; Ramstad et al. 2013) and the new population flourished to reach c. 1200 birds by 2008 (Holzapfel et al. 2008), despite the small founder population and potential for inbreeding. In 2013, the total population of the species stood at c. 1700 birds, which were distributed across seven offshore islands (Taranga (Hen) Island, Tiritiri Matangi Island, Motuihe Island/ Te Motu-a-Ihenga, Red Mercury Island (Whakau), Kapiti Island, Long Island and Chalky Island) and one predator-free mainland site (Zealandia, Wellington) (Heather & Robertson 2015). Since 2013, a new island population has been established on Anchor Island and a second mainland site is being established at Cape Sanctuary, and the species is currently classified as 'At Risk - Recovering' under the New Zealand Threat Classification System (Robertson et al. 2017).

In July 1993, five pairs of little spotted kiwi were transferred from Kapiti Island to Tiritiri Matangi Island; however, one of the males died shortly after being released due to transmitter entanglement and another male died in a flood in August 1994. Since neither of these males bred while on the island, the initial founder population was a maximum of three males and five females (Colbourne & Robertson 1997). An additional two pairs and two males were introduced from Kapiti Island in July 1995, bringing the founding population up to a maximum of seven males and seven females (Colbourne & Robertson 1997).

Only one of the original pairs from Kapiti Island remained together on Tiritiri Matangi Island, with the others forming new pairs or remaining solitary until after the second release (Girardet 2000). Breeding was first detected in 1994/95, when all three of the original founder males nested. The population then grew rapidly from an estimated 20–35 birds in May 1997 to 60–70 birds in July 2007, roughly doubling every 5 years, but the growth slowed to an estimated 80–100 birds in July 2012 (Table 1).

Because the little spotted kiwi passed through a severe bottleneck (the five individuals introduced to Kapiti Island in 1912 (Colbourne & Robertson 2004; Ramstad et al. 2013)), it has the lowest genetic diversity of the five kiwi species and among the lowest recorded genetic diversity of all birds (Jamieson et al. 2006; Ramstad et al. 2013). Examination of 14 microsatellite loci isolated from kiwi showed that the little spotted kiwi had fewer alleles per locus than the other four kiwi species (mean = 2.4 v. 2.7–3.9) and much lower heterozygosity (mean = 0.38 v. 0.58–0.71) (Ramstad et al. 2010). Genetic diversity has also been lost in the process of establishing each of the new translocated populations. For example, samples taken from island-bred birds on Tiritiri Matangi Island up to 2012 showed a 12% loss of alleles per locus and a 4% loss of

Table 1. Captures, recaptures and estimated population sizes of little spotted kiwi (*Apteryx owenii*) on Tiritiri Matangi Island between 1993 and 2012. The estimated population was based on the number of birds captured, and others seen or heard.

DATE	FOUNDERS RELEASED	FOUNDERS RECAPTURED	ISLAND-BRED BIRDS CAPTURED	ISLAND-BRED BIRDS RECAPTURED	TOTAL CAPTURED	ESTIMATED POPULATION
July 1993	10					10
July 1995	6					15–20
May 1997		6	5		11	20–25
July 2002		4	8	3	15	30–40
July 2007		7	14	6	27	60–70
July 2012		4	17	11	32	80–100

heterozygosity relative to the Kapiti Island population (Ramstad et al. 2013), which means that the kiwi here are likely to be less able to survive new challenges, such as exposure to a novel disease or environmental change. The founding population on Tiritiri Matangi was a maximum of 14 breeding birds, which is well below the usual recommended 40 unrelated founders for kiwi populations (Weiser et al. 2013). Therefore, the addition of new birds to the island would help to increase the genetic diversity of the population as long as they are assimilated into the breeding population.

Here, we report on the results of a survey conducted in 2017, which aimed to determine whether the little spotted kiwi population on Tiritiri Matangi Island had continued to grow. In addition, 10 females were radio-tagged in anticipation of their transfer to nearby Shakespear Open Sanctuary in order to create space for 10 new females to be introduced from Kapiti Island.

## 2. Methods

We assessed the population size of little spotted kiwi on Tiritiri Matangi Island between 17 and 30 April 2017, as part of the long-term 5-yearly monitoring programme that was established under the Kiwi Recovery Programme. We were assisted at various stages by the two local DOC rangers, a rotating team of 13 volunteers from the Supporters of Tiritiri Matangi Inc., four members of the Shakespear Open Sanctuary Society Inc. and one DOC volunteer.

On the first 2 nights, we listened for calls for 1 hour per night from listening stations that gave good coverage of the island. During this time, we recorded the time, direction and distance of both male and female kiwi calls. Once the call counts were finished, and on all other nights, recorded calls were played to attract kiwi, and any birds that approached the 'intruder' were caught by hand or in hand-nets. We also used a certified kiwi dog, Jade, to indicate the presence of kiwi near tracks or any birds that were cautiously approaching the recorded calls, which we also attempted to catch by hand.

Most of the captured birds were radio-tagged with an 11-g Sirtrack transmitter that was temporarily attached using a single baby identification bracelet. However, seven paired males had their transmitters attached more permanently with electrical tape so they could be monitored after their partners had been transferred to Shakespear Open Sanctuary. All of the captured birds were aged, measured, weighed, and their body condition was scored following the methods of Robertson & Colbourne (2017). All new birds (except for the 500 g juvenile) were banded.

During the day, we tracked the radio-tagged birds to their daytime dens to plot their home ranges more accurately and to determine whether they were with a partner. We also used certified kiwi dogs (Breeze, Cara, Duke, Jade and Peg) during the day to search for new birds or to pin-point the location of radio-tagged birds.

We plotted the approximate day time and night time locations of all radio-tagged birds, and then combined this information with the locations of other birds that were heard calling, seen or caught but not radio-tagged to determine the number and approximate locations of territories on the island.

### 3. Results

We caught a total of 31 little spotted kiwi on Tiritiri Matangi Island, which included 17 adult males, 11 adult females, 2 subadults and 1 juvenile from the 2016/17 season. Three of these birds (one male and two females) were among the original founders brought to the island in the mid-1990s, nine (six males and three females) were island-bred birds that had been banded between 1997 and 2012, and 19 were new birds (Table 2).

The majority of captures (21/31) were made at night; however, four birds were found by dogs during the daytime and six were found with their radio-tagged partners. This last method of encounter, which particularly improved the capture rate of females late in the survey, was higher than usual because we spent longer on the island than during previous visits and so we had more opportunities to find birds sharing a daytime site.

Table 2. Characteristics of the 31 little spotted kiwi (*Apteryx owenii*) caught on Tiritiri Matangi Island in April 2017. Condition was scored as moderate (M) good (G), very good (VG), or combinations in between, following Robertson & Colbourne (2017). \* = transferred to Shakespear Open Sanctuary. † = Radio-tagged for monitoring after its partner had been transferred to Shakespear Open Sanctuary.

BAND	FIRST CAUGHT	AGE	SEX	DATE	EAST	NORTH	BILL (mm)	WEIGHT (g)	CONDITION	PARTNER
O-19815	2007	Adult	Male	19/4/17	1769077	5948231	69.4	1380	VG	
O-19907	1995	Adult	Male†	18/4/17	1768664	5947863	69.0	1125	M	O-32687
O-20484	1997	Adult	Male	22/4/17	1769540	5947660	64.1	1600	VG	
O-20864	1995	Adult	Female*	26/4/17	1769111	5946984	88.2	1570	M	O-21337
O-21322	2017	Adult	Male†	18/4/17	1769321	5947145	67.2	1170	G	O-32030
O-21323	2017	Adult	Male	18/4/17	1769248	5947866	69.7	1330	VG	
O-21326	2017	Subadult	Male	19/4/17	1768474	5948279	65.0	1000	MG	
O-21327	2017	Adult	Male	19/4/17	1768881	5948286	67.5	1240	MG	
O-21335	2017	Subadult	Male	21/4/17	1769805	5946861	66.2	1100	G	
O-21336	2017	Adult	Male	23/4/17	1768589	5947860	70.2	1290	VG	
O-21337	2017	Adult	Male	24/4/17	1769201	5946924	72.4	1230	MG	O-20864
O-28506	2012	Adult	Male	19/4/17	1769549	5947120	66.7	1400	VG	
O-28508	2012	Adult	Female*	22/4/17	1769061	5947447	83.2	1580	G	O-31452
O-30501	2017	Adult	Male†	22/4/17	1768567	5948376	72.3	1440	VG	O-30512
O-30502	2017	Adult	Female*	22/4/17	1768458	5948653	84.3	1560	VG	
O-30511	2017	Adult	Male†	25/4/17	1769023	5947959	65.2	1300	MG	O-32180
O-30512	2017	Adult	Female*	27/4/17	1768497	5948387	84.3	1820	VG	O-30501
O-31434	2002	Adult	Male	18/4/17	1768260	5948050	69.1	1070	M	
O-31451	2002	Adult	Male†	21/4/17	1768356	5948455	73.2	1190	G	O-31453
O-31452	2002	Adult	Male†	24/4/17	1769169	5947288	66.0	1390	VG	O-28508
O-31453	2002	Adult	Female*	18/4/17	1768380	5948275	83.3	1890	VG	O-31451
O-32030	2012	Adult	Female*	17/4/17	1769086	5947138	84.0	1420	MG	O-21322
O-32175	2017	Adult	Male	20/4/17	1769693	5947299	66.3	1130	G	
O-32177	2017	Adult	Male	22/4/17	1769605	5947145	66.6	1300	VG	
O-32178	2017	Adult	Male†	23/4/17	1769796	5946888	66.9	1070	M	O-32179
O-32179	2017	Adult	Female*	23/4/17	1769796	5946888	84.7	1510	G	O-32178
O-32180	2017	Adult	Female*	23/4/17	1769095	5948058	84.8	1570	MG	O-30511
O-32687	1995	Adult	Female*	18/4/17	1768814	5947790	86.9	1450	M	O-19907
R-63951	2017	Adult	Female	18/4/17	1768440	5948150	84.9	1840	VG	
R-63952	2017	Adult	Female*	22/4/17	1768269	5948656	81.1	1520	G	
nil	2017	Juvenile	Unknown	19/4/17	1769494	5947036	44.6	500	M	



A plot of the radio-telemetry locations was combined with the capture sites of birds that were not radio-tagged, sightings and the projected locations of calling birds to give an overall picture of the distribution and number of birds on the island (Fig. 1). There were at least 25 pairs, as well as two apparently unpaired adult males, two subadults and one juvenile on the island in April 2017. Based on our experience that some adults (particularly females) and most juveniles and subadults will have gone undetected, we estimated a total population of 60–80 birds on the island in April 2017.

All of the birds we caught were considered to be in ‘Moderate’ to ‘Very Good’ condition based on the amount of fat covering the ribs and backbone. The mean weight of the 11 adult females was  $1612 \pm 162$  g, with a maximum weight of 1890 g, while that of the 17 adult males was  $1274 \pm 143$  g, with a maximum weight of 1600 g.

## 4. Discussion

The population of little spotted kiwi on Tiritiri Matangi Island is clearly very well established based on the strong population growth from the 14 founder birds that were released in 1993 and 1995 to an estimated 80–100 birds in July 2012. However, the population appears to have declined, or at best stabilised, in the last 5 years.

Carrying capacity is an often-quoted concept but is very difficult to measure in the real world. A site may be sufficiently productive to sustain and grow a kiwi population for many years, during

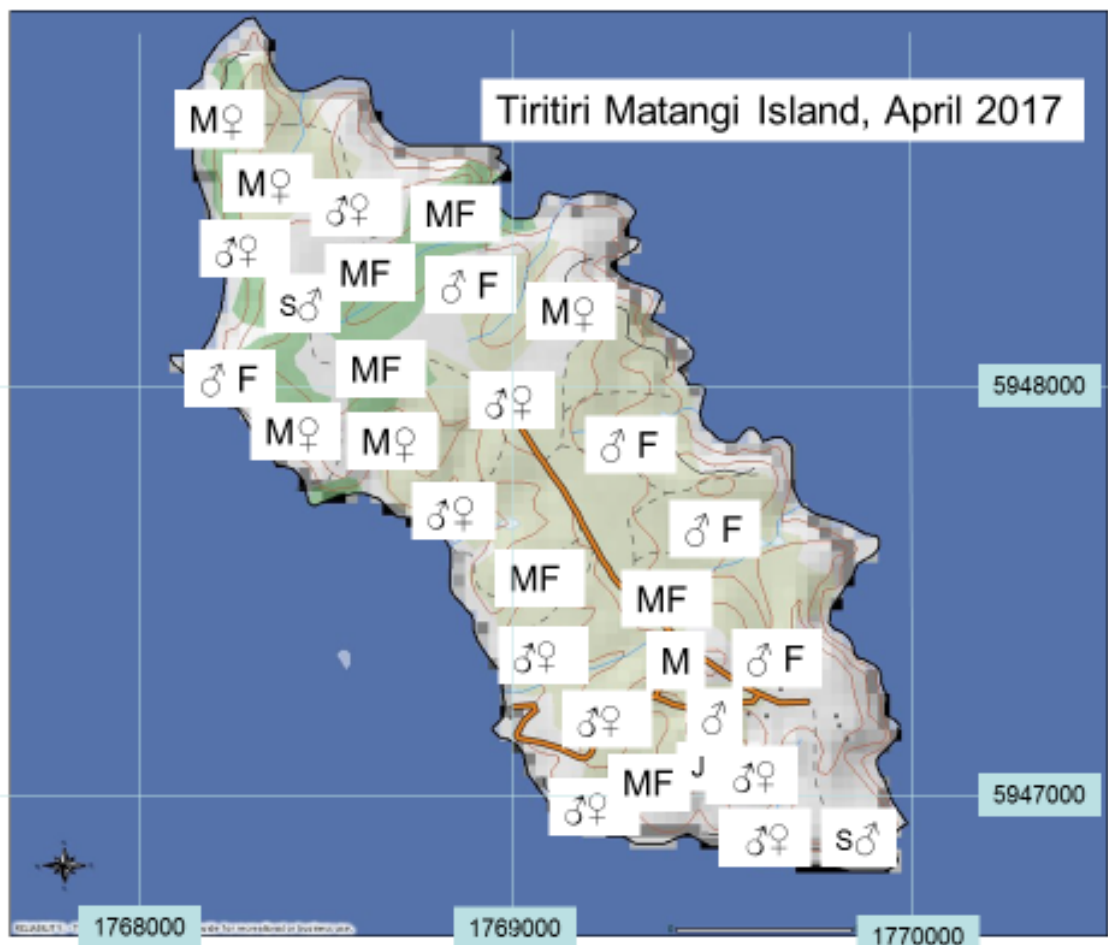


Figure 1. Map of Tiritiri Matangi Island showing the locations of little spotted kiwi (*Apteryx owenii*) in April 2017. ♂ = adult male caught; ♀ = adult female caught; M = male heard; F = female heard; S♂ = subadult male; J = juvenile.

which time the population would be considered to be below carrying capacity; however, an environmental perturbation may temporarily lower the carrying capacity of the site and result in many deaths. Flightless birds on islands and in fenced sanctuaries will be particularly vulnerable to environmental stochasticity because they are unable to move to alternate sites with better conditions.

Although an undetected disease outbreak may have been the cause of the decline or plateauing of the population, it seems more likely that many birds died during the severe drought that affected the island in early 2013. Unusually, two unbanded island-bred birds were discovered active in daylight, and both subsequently died at Auckland Zoo of complications from severe dehydration. These two birds may have just been the tip of the iceberg and many others likely died without being found.

A MetService automated weather station located 5 km from the island on the tip of Whangaparaoa Peninsula recorded a total of 10.6 mm of rainfall in the first 2 months of 2013, which was less than 10% of the 30-year (1981–2010) average of 124 mm (National Climate Database (CliFlo), National Institute of Water and Atmospheric Research). Furthermore, the first half of March 2013 was also extraordinarily dry, with only 1.0 mm of rain falling before 16 March, and again the overall total of 25.7 mm for March was much lower than the 30-year average of 71.2 mm. This drought in early 2013 followed on from a drier than normal last quarter in 2012 when 159 mm, or <70% of the long-term mean of 242 mm, of rain fell. Although kiwi can obtain all of their water requirements from the invertebrates they eat, this drought may have taken its toll on the population if litter and soil invertebrates became scarce and/or retreated deep into the soil where they were out of reach of kiwi.

The weights of the captured birds in April 2017 were not significantly different to those taken in July during earlier monitoring work on the island (H. Robertson, unpubl. data), at a time when weights would be expected to be heavier as they approach the breeding season, i.e. females:  $1638 \pm 201$  g,  $n = 28$ ; males:  $1313 \pm 150$  g,  $n = 45$ ; t-test,  $P = 0.70$  and  $P = 0.35$  respectively). The weights were, however, significantly greater than those recorded (H. Robertson & R. Colbourne unpublished data) on Kapiti Island in April (females:  $1340 \pm 114$  g,  $n = 71$ ; males:  $1122 \pm 97$  g,  $n = 89$ ; t-test,  $P < 0.001$  and  $P < 0.001$  respectively). Furthermore, over half of the birds that were captured were in good or very good condition and there was a high proportion of island-bred birds in the population. Therefore, we believe that the little spotted kiwi population on Tiritiri Matangi Island is currently not constrained by carrying capacity and is again in a growth phase. This is likely to continue until the next extreme drought or until resources limit further growth. The population of 60–80 birds on this 225-ha island is still below the carrying capacity of 109 birds that Colbourne & Robertson (1997) predicted based on the density of little spotted kiwi observed on Kapiti Island. As the population nears carrying capacity, we would expect to see a decline in the condition and weights of the birds, as well as a shortening of the breeding season and reduced number of breeding attempts. Although changes in breeding productivity would be difficult to measure in the absence of detailed telemetry work, there is no indication that the condition or weights of the birds has been reduced by the current density of birds on the island.

Tiritiri Matangi Island had a small founder population of a maximum of 14 birds drawn from the Kapiti Island population, which, in turn, is believed to have been derived from only five birds (Colbourne & Robertson 2004; Ramstad et al. 2013). However, the observed population decline is unlikely to have been caused by inbreeding depression as a result of the low genetic variation in the population because a serious loss of genetic variability is unlikely to have yet occurred. Part of our management in 2017 was to introduce ten new females from Kapiti Island to improve the overall genetic diversity of the closed population. Based on the trajectory of population growth up to 2012, we expected that the population in 2017 would be close to the predicted carrying capacity of 109 birds, and so we planned to translocate ten females from Tiritiri Matangi Island to Shakespear Open Sanctuary to help establish a population there while creating opportunities for the new Kapiti females to establish pair-bonds with the territorial males left behind. Given

the observed decline or, at best, stabilisation in the population, these new females will make up a greater proportion of the current population on Tiritiri Matangi Island than anticipated, which should improve the genetic diversity of the population as long as they are integrated into the effective breeding population. To monitor their success, we radio-tagged seven of the ten separated males and two of the new females, and the Supporters of Tiritiri Matangi will follow these birds to determine whether the males maintain their territories and are later found with the new females or with island-bred females.

We recommend that the current 5-yearly monitoring of little spotted kiwi on Tiritiri Matangi Island is continued during this phase of population change, and that the success of the new females is monitored through recaptures and genetic analysis. Changes in the level of genetic diversity in the population as a result of these translocations can also be measured by assessing whether the number of alleles per locus and heterozygosity of island-bred birds have increased compared with the samples obtained during this 2017 survey.

The founding population of up to 24 birds on Tiritiri Matangi Island (14 original founders plus ten new introductions in 2017) remains well below the 40 unrelated founders that is usually recommended (Weiser et al. 2013). Therefore, we recommend that additional birds are transferred from Kapiti Island to Tiritiri Matangi Island, perhaps at the time of the next 5-yearly survey in 2022.

The Kiwi Recovery Plan 2018–2028 (Germano et al. 2018) includes a goal to increase the population of little spotted kiwi by an average of at least 2% per annum, making the continued monitoring of the Tiritiri Matangi Island population essential. From the perspective of all kiwi taxa, it will also be of interest to assess whether the capacity of the island is lower than predicted as a result of severe droughts, especially if such extreme weather events become more frequent with global climate change.

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