SHORT NOTE

Juveniles in mainland populations of kiwi

Anecdotal reports, historical records, and surveys suggest that kiwi (*Apteryx* spp.) are declining on the New Zealand mainland, even in areas still covered in native forest. Little is known about the causes of their demise, except that feral dogs are definitely responsible in some instances (Taborsky 1988). McLennan & Potter (1992) speculated that predation by cats and stoats on juveniles is probably also contributing to the decline because chicks that successfully fledge seldom reappear as breeding adults (McLennan 1988).

Colbourne (1992) reported that his dog Tess made 101 captures of Little Spotted Kiwi (*Apteryx owenii*) on Kapiti Island between 1986 and 1990, involving 36 juveniles (judged by weight and bill length) and 51 adults. He did not know whether Tess detected young and adult kiwi in direct proportion to their abundance, so could not use the sample to determine the age structure of the Kapiti population or the productivity of adults.

The intention here is to compare Colbourne's sample from Kapiti Island with one obtained with dogs on the mainland. We have assumed that biases, if any, affect both samples in the same way. There are no viable populations of Little Spotted Kiwi left on the mainland, so the comparison necessarily involves different species.

Locations and years: We sampled North Island Brown Kiwi (*Apteryx australis mantelli*) at two sites in Hawke's Bay (Waitere and Haliburtons) from 1983 to 1986 and in the Paerata Reserve at Tangiteroria, Northland, from 1985 to 1991. There were about 50 pairs of kiwi in the 210 ha Paerata Reserve (Potter 1989), whereas the two Hawke's Bay sites contained small and sparse populations (McLennan *et al.* 1987).

Our samples of Great Spotted Kiwi (*A. haastii*) were obtained mainly from Kahurangi Point and Saxon River, in northwest Nelson, between 1986 and 1990. Despite a 700 m difference in altitude between the two areas, both contained about three or four pairs of kiwi per square kilometre (McLennan & McCann, unpub.). We also caught a few Great Spotted Kiwi in Westland (near the Otira Gorge), in the Paparoa Ranges, and in other parts of northwest Nelson.

Samples: Our sampling procedure followed that of Colbourne (1992), that is, using trained dogs to find the birds in their daytime shelters. We searched more-or-less randomly, letting the dogs dictate the direction of travel, so adults and juvenile alike were probably encountered (but not necessarily detected) in proportion to their abundance. In all we used six dogs, varying in skill and experience, although two of them (Belle and Jess) found 62% of the birds.

We also used dogs to find active kiwi at night, to compare with the sample obtained by day. To avoid biasing the sample towards adults, we confined this nocturnal sample to birds located during random searching, and excluded those that we deliberately attracted by playing simulated kiwi calls.

Definition of juveniles: A bird was classified as juvenile if the product of its body weight (kg) and bill length (cm) was less than 16.2 for Brown Kiwi

and 16.0 for Great Spotted Kiwi. These threshold values were derived from the smallest sexually mature male of each species in our samples (Appendix 1). We confirmed that these males were sexually mature by radio-tracking them during at least one breeding season, and by remeasuring them after 5 or 6 months to determine whether they were still growing. We also calculated threshold values for females (24.8 and 27.6 respectively), but never used them. We could not sex the juveniles that we did find, and by chance they all happened to be smaller than the threshold for males.

RESULTS

Number of juvenile and adult kiwi found by dogs on the mainland

In all, the dogs located 76 kiwi, some more than once. At Tangiteroria the dogs made 48 captures of 26 kiwi, only one of them a juvenile. Its weight (1000 g) and bill length (74 mm) indicated that it was probably 5-6 months old. It was found in late March in a small depression under a clump of toetoe (*Cortaderia* sp.) The dogs also caught two small adults which could have been mistaken for large juveniles. Both birds, though, had partners, and their bills did not increase in length over the following five months.

In Hawke's Bay the dogs made six captures, involving four adults and one juvenile. The juvenile was not weighed or measured, but it was about half the size of an adult male.

The story was much the same in the South Island, where the dogs made 52 captures of 45 Great Spotted Kiwi. They found a chick, about a week old, still in the nest with an adult, but no independent juveniles.

On the basis of Colbourne's figures for Kapiti, we expected about 30 independent juveniles in our sample of mainland kiwis, significantly more ($\chi^2 = 43.5, P = <0.0001$) than the two we found.

Day and night samples

The dogs made 14 captures at night, involving 11 adult kiwis and one juvenile. The 92 captures during daylight involved 61 adults, one independent juvenile, and one dependent chick. The day and night samples do not differ significantly (Fisher Exact test), showing that the dogs detected adults and juveniles in the same proportion, irrespective of whether the birds were active or in shelters.

DISCUSSION

Independent juvenile kiwi appear to be much more numerous on Kapiti Island (41%) than on the mainland (3%). Juveniles could be more prolific on Kapiti Island because:

1. Little Spotted Kiwi fledge more young each year than do Brown and Great Spotted Kiwi;
2. Little Spotted Kiwi have a longer juvenile phase than do the other species;
3. Dogs find juveniles more easily on Kapiti than on the mainland, perhaps because of some feature of the landscape, or because juvenile Little Spotted Kiwi behave differently from those of the other species; or
4. Juveniles surivie better on Kapiti Island than on the mainland.

There is little to support the first two explanations. All kiwi are long-lived (20+ years) and have low reproductive rates. Jolly (1989) reported that Little Spotted Kiwi on Kapiti Island fledge just 0.08 chicks/pair/year, whereas mainland kiwi fledge about 0.2 - 0.5 chicks/pair/year (McLennan 1988, Potter 1989, McLennan & McCann, unpubl.). It is difficult to reconcile Jolly's measurements with the high incidence of juveniles in Colbourne's sample, but the two studies were undertaken in largely different years and therefore are not strictly comparable. The productivity of Little Spotted Kiwi may have increased since possums were exterminated on Kapiti. It is unlikely, however, that dogs find more juveniles on Kapiti simply because the birds there fledge more young.

Juvenile Little Spotted Kiwi are recognisable as such for their first 18 - 24 months of life (Colbourne 1992). Nothing is known about growth rates of juvenile Brown and Great Spotted Kiwi in the wild, but studies on captive birds suggest that they too take about 24 months to reach adult size (Reid & Williams 1975). The adults of all species also appear to have a similar life expectancy, at least in captivity (Reid & Williams 1975). Differing life histories do not, then, account for the near-absence of juveniles in the mainland sample.

We have no information to either support or deny the third explanation. Dogs work better in some habitats than others, but it is difficult to see why they might focus on juveniles in one area and adults elsewhere. The denning habits of adult North Island Brown Kiwi sometimes vary between areas, both in the sites they select and the frequency with which they use them (McLennan *et al.* 1987, Potter 1989); this in turn could influence how easily dogs find them. For the same reason, juvenile kiwi may have been more detectable on Kapiti Island than on the mainland, although it is unlikely that this alone would account for the large difference between the Kapiti and mainland sample.

The last explanation – that juvenile survival is poorer on the mainland – is the one we favour. The Little Spotted Kiwi on Kapiti Island live with few predators (Weka and Norway rats), in much the same way as all kiwi did before the arrival of humans. The mainland species, on the other hand, now co-exist with rats, cats, mustelids, possums, and (sometimes) feral pigs and feral dogs. Radio-tracking studies show that the adults survive well in the presence of all predators but dogs, but chicks probably do not. They fledge at a weight of just 250-300 g, and are probably too small and slow to defend themselves in their first year of life. The following calculations indicate just how low their survival rates might be.

The number of independent young produced per pair per year can be estimated crudely from the following formula:

$$\text{Productivity} = \frac{\text{no. juveniles}}{\text{no. years to adulthood}} \times \frac{1}{0.5 \times \text{no. of adults}}$$

The calculation makes no allowance for juvenile mortality or the presence of solitary adults and assumes, probably incorrectly, that adults and juveniles were detected in proportion to their abundance. We accept that the estimates could be substantially wrong, but assume for comparative purposes that the

biases are similar in both the Kapiti and mainland samples.

Assuming that juveniles reach adulthood in two years, pairs on Kapiti Island produce 0.7 independent juveniles/year, whereas those on the mainland produce just 0.03. We know that mainland pairs actually *fledge* some 0.4 chicks/pair/year, so some 92% of juveniles apparently die before they reach adulthood. This in turn indicates that mainland pairs would have to breed for 66 years to replace themselves – unlikely, given that kiwi seldom live for more than 30 years in captivity.

We still cannot with certainty attribute the poor survival of mainland juveniles to introduced carnivores, although clearly they are prime suspects. There is no other obvious reason why the Kapiti population should contain more juveniles, especially when the kiwi there are already at a very high density relative to those on the mainland. It is important now to establish whether the population of Brown Kiwi on Little Barrier Island also contains a high proportion of juveniles, since they too live at a high density in the absence of mammalian predators (except kiore). It is already clear, however, that efforts to reverse the decline of kiwi on the mainland should focus on juvenile survival, and the factors that enhance it.

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APPENDIX 1 — Weight and bill length of kiwi found by dogs on the mainland. NIB, North Island Brown Kiwi; GSK, Great Spotted Kiwi; A, adult; J, juvenile; C, chick; ?, no measurement taken.

Location	Species	Sex	Weight (g)	Bill Length (mm)	Age Class
Tangiteroria	NIB	F	2600	141	A
Tangiteroria	NIB	F	2380	133	A
Tangiteroria	NIB	F	2720	128	A
Tangiteroria	NIB	M	2200	105	A
Tangiteroria	NIB	M	2380	105	A
Tangiteroria	NIB	F	?	140	A
Tangiteroria	NIB	F	2600	144	A
Tangiteroria	NIB	F	1920	129	A
Tangiteroria	NIB	M	1900	104	A
Tangiteroria	NIB	F	?	128	A
Tangiteroria	NIB	F	2600	132	A
Tangiteroria	NIB	F	2300	120	A
Tangiteroria	NIB	M	1950	96	A
Tangiteroria	NIB	M	2050	97	A
Tangiteroria	NIB	F	2200	121	A
Tangiteroria	NIB	?	1000	74	J
Tangiteroria	NIB	M	2200	101	A
Tangiteroria	NIB	F	3000	132	A
Tangiteroria	NIB	F	3100	146	A
Tangiteroria	NIB	M	2150	102	A
Tangiteroria	NIB	F	2300	135	A
Tangiteroria	NIB	F	2500	123	A
Tangiteroria	NIB	M	1650	98	A
Tangiteroria	NIB	M	2500	102	A
Tangiteroria	NIB	F	2800	139	A
Tangiteroria	NIB	F	3000	129	A
Haliburtons	NIB	F	2560	128	A
Waitere	NIB	F	2200	131	A
Waitere	NIB	?	?	?	J
Waitere	NIB	M	1900	87	A
Waitere	NIB	F	2640	112	A
Heaphy Track	GSK	M	2450	90	A
Heaphy Track	GSK	?	250	41	C
Heaphy Track	GSK	F	3130	117	A
Heaphy Track	GSK	M	2790	99	A
Heaphy Track	GSK	F	3000	114	A
Heaphy Track	GSK	F	3400	132	A
Heaphy Track	GSK	M	2900	98	A
Heaphy Track	GSK	M	2120	99	A
Heaphy Track	GSK	F	3200	114	A
Heaphy Track	GSK	M	2600	102	A
Heaphy Track	GSK	F	3400	116	A
Heaphy Track	GSK	M	2950	98	A
Heaphy Track	GSK	F	3390	126	A
Heaphy Track	GSK	M	2800	94	A
Heaphy Track	GSK	M	3000	99	A
Heaphy Track	GSK	F	3490	117	A

Heaphy Track	GSK	M	2600	103	A
Heaphy Track	GSK	F	4300	134	A
Heaphy Track	GSK	M	2550	98	A
Heaphy Track	GSK	F	4150	127	A
Heaphy Track	GSK	F	3700	128	A
Heaphy Track	GSK	M	2500	99	A
Heaphy Track	GSK	M	?	?	A
Heaphy Track	GSK	F	3000	120	A
Kahurangi	GSK	M	2300	94	A
Kahurangi	GSK	M	2300	83	A
Kahurangi	GSK	M	2120	96	A
Kahurangi	GSK	F	3000	103	A
Kahurangi	GSK	M	1850	95	A
Kahurangi	GSK	F	2850	120	A
Kahurangi	GSK	F	3100	115	A
Kahurangi	GSK	F	3200	115	A
Karamea	GSK	M	2100	96	A
Oparara R.	GSK	F	?	?	A
Boulder Lake	GSK	M	2350	95	A
Ohikanui R.	GSK	M	1950	103	A
Ohikanui R.	GSK	F	2900	132	A
Taramakau R.	GSK	M	2100	87	A
Taramakau R.	GSK	F	3200	128	A
Taramakau R.	GSK	F	3350	129	A
Taramakau R.	GSK	M	2500	103	A
Taramakau R.	GSK	F	2850	129	A
Taramakau R.	GSK	M	2500	99	A
Deception R.	GSK	F	2300	120	A
Deception R.	GSK	M	1800	89	A