

Kiwi (*Apteryx* spp.) on offshore New Zealand islands

Populations, translocations and identification
of potential release sites

DOC RESEARCH & DEVELOPMENT SERIES 208

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Published by
Department of Conservation
PO Box 10-420
Wellington, New Zealand

DOC Research & Development Series is a published record of scientific research carried out, or advice given, by Department of Conservation staff or external contractors funded by DOC. It comprises reports and short communications that are peer-reviewed.

Individual contributions to the series are first released on the departmental website in pdf form. Hardcopy is printed, bound, and distributed at regular intervals. Titles are also listed in our catalogue on the website, refer <http://www.doc.govt.nz> under Publications, then Science and research.

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ISSN 1176-8886

ISBN 0-478-22686-1

This report was prepared for publication by Science & Technical Publishing Section; editing by Helen O'Leary and Lynette Clelland and layout by Lynette Clelland. Publication was approved by the Chief Scientist (Research, Development & Improvement Division), Department of Conservation, Wellington, New Zealand.

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ABSTRACT

At least five species and six taxa of kiwi (*Apteryx* spp.) are recognised at present. All taxa are currently listed as threatened. Since the 1890s, translocation of kiwi populations to the offshore islands of New Zealand has been used in the conservation of the genus. This report identifies and reviews offshore (and lake-bound) islands where kiwi occur naturally, together with islands to which kiwi have been translocated. Brief, descriptive histories of populations and translocations are provided. At least 28 offshore islands (excluding Stewart Island) currently support populations of kiwi. A number of islands, nominated by DOC conservancies, which might be suitable for future translocations, are also listed. The criteria for this list of potential islands include: lack of predators; sufficient size (at least 100 ha); presence of suitable habitat; legal protection; and absence of conflicting conservation values. Before recommendations as to which species should be translocated (and to which islands) can be made, consultation with other interested parties and detailed investigations of the islands' suitability will be required.

Keywords: Kiwi, *Apteryx* spp., offshore islands, conservation, translocation, New Zealand.

© May 2005, New Zealand Department of Conservation. This paper may be cited as:
Colbourne, R. 2005: Kiwi (*Apteryx* spp.) on offshore New Zealand islands: populations,
translocations and identification of potential release sites. *DOC Research & Development
Series 208*. Department of Conservation, Wellington. 24 p.

1. Introduction

All six recognised taxa of kiwi (*Apteryx* spp.) are currently threatened (Robertson 2003). Under the New Zealand Threat Classification system, Okarito brown kiwi / rowi (*A. mantelli* 'Okarito') and Haast tokoeka (*A. australis* 'Haast') are classified as 'Nationally critical'; North Island brown kiwi (*A. mantelli*) as 'Seriously declining'; great spotted kiwi / roroa (*A. haastii*) and southern tokoeka (*A. australis*) as 'Gradually declining'; and little spotted kiwi (*A. owenii*) as 'Range restricted' (Hitchmough 2002).

The fate of kiwi (*Apteryx* spp.) was already being contemplated more than a hundred years ago. The following communication by Sir Walter Buller to the Wellington Philosophical Society in October 1891 (Buller 1905) encapsulates much of our present-day concern about the plight of the kiwi:

'I have ascertained that since this time last year *Apteryx owenii* has bred, at intervals of about seven weeks or so, no less than five times, if not six. If this be the case there ought to be no difficulty in perpetuating the species, if the surrounding conditions are favourable. Whatever its fecundity may be, however, a wing-less species stands no chance whatever in the face of stoats, ferrets and weasels, of which some thousands have lately been introduced by the Government and turned loose in all parts of the country, in the hope of suppressing the rabbits. The only chance now of saving the various species of apterous birds is in their complete isolation. If Lord Onslow's proposal to set apart Little Barrier Island in the North, and Resolution Island in the South as inviolable preserves, stocking them from time to time with all the desirable species and placing them under the strictest protection, be carried out, then we may hope to be able to save from extinction some, if not all, of these interesting forms. Failing that their final extirpation is not far distant, and the student of the future will have nothing left to him but the dried specimens in European and colonial museums, and such memoirs of the indigenous species as the industry or opportunities of present observers may have furnished'.

A programme of translocating kiwi and other species to offshore island reserves, undertaken by the New Zealand Department of Lands and Survey, gathered momentum from the late 1890s to about 1915. However, after a series of setbacks, especially the arrival of stoats on Resolution I. (Hill & Hill 1987), that momentum waned. Further releases were periodic and often involved a few birds at a time. In the meantime, however, Buller's predictions of kiwi disappearing forever were, sadly, proving correct.

In the early 1980s, islands were being assessed as potential release sites for the smallest species of kiwi (*A. owenii*, little spotted kiwi; Moed & Meads 1987). By this time, *A. owenii* had all but disappeared from the mainland and significant populations persisted at only two sites: Kapiti and D'Urville Is. (Jolly & Colbourne 1991). In the 1980s, little was known of the genetic make-up of the other species of kiwi, with all brown kiwi in the South Island being lumped together as *Apteryx australis*. *Apteryx owenii* was therefore regarded as the rarest variety of kiwi. The smaller size of *A. owenii* also motivated their transfer to offshore Islands, as it was felt the larger kiwi species could cope with most

predators. Of the more than seven hundred islands around New Zealand, nine were thought worthy of investigation as potential transfer sites (Jolly & Colbourne 1991) and only five islands (all < 500 ha) were identified as potentially suitable. The criteria of Jolly & Colbourne (1991) for selecting islands were as follows:

- Lack of predators: Islands with mustelids, dogs and cats, which are probably the main predators of kiwi, were not suitable. Islands with feral pigs and weka were also excluded as pigs are capable of digging up kiwi from their burrows and are often hunted with dogs, and on Kapiti I. Jolly (1989) found that wekas are persistent predators of kiwi eggs.
- Reserve status: There must be adequate long-term protection of the habitat of a suitable island, either through reserve status or legal restriction in the title deed.
- Forested habitat with good soil depth: An island must provide a forest environment in which kiwi can forage for fruit, and a soil which is both sufficiently moist and developed to support their invertebrate food, and also sufficiently deep for them to burrow into.
- Abundant ground invertebrate fauna: Moeed & Meads (1984, 1987) estimated the abundance of invertebrates on Kapiti I. in order to derive a baseline index to use, in comparison with other islands, as an indicator of an adequate invertebrate food supply.
- Presence of surface water: The presence of surface water in streams or swamps was used as an indication that invertebrates, particularly worms, could be near the surface in damp soil and available to kiwi even in drought conditions.
- Adequate size: From initial island visits, it was found that islands < 150 ha had little suitable habitat and were prone to drought. They were also highly vulnerable to catastrophes such as fire or storms which could devastate a much greater proportion of the available habitat than would be likely on larger islands (Pimm et al. 1988).
- Lack of conflicting conservation values: Islands with a high level of endemism, particularly in their invertebrate, amphibian, or reptilian fauna, were excluded.

Further research into the needs of all kiwi species in the last 15 years has, however, led to a relaxing of some of these criteria. *Apteryx owenii* (little spotted kiwi) have been introduced into areas with weka—Karori Wildlife Sanctuary in Wellington, for example—and have bred successfully (R. Empson, Karori Sanctuary Trust, pers. comm. 2004). Similarly, North Island brown kiwi (*A. mantelli*) have been introduced onto islands without forest. Research in the Whangarei Kiwi Sanctuary has shown that some birds have territories exclusively in farmland, and will also breed there. (H. Robertson, DOC, pers. comm. 1999). Releases of kiwi onto Mana, Motuora and Limestone Is have shown that pasture and clumps of gorse or manuka are entirely suitable (author, pers. obs. 2004). Islands without surface water need not be ruled out. So long as invertebrates are abundant, kiwi can source sufficient water through eating them (author, pers. obs. 2004). Many kiwi on Kapiti, Hen and Red Mercury Is monitored by telemetry over summers did not abandon or move out of their territories in spite of no surface water or even damp spots being present for

more than 3 months at a time (author pers. obs. 2004). Motuara I. was originally judged unsuitable for a transfer of kiwi because of dry summer conditions (Moeed & Meads 1987); however, with the first transfer of Okarito brown kiwi chicks to Motuara in 1997, as part of Operation Nest Egg (ONE), the birds were recorded in very good condition after the driest summer recorded in Marlborough in over 50 years (L. Adams, DOC, pers. comm. 1998). Since the mid-1980s, improved methods of control enabled pests to be eradicated from larger islands. Eradication of rats from 200-ha islands has progressed to eradication on islands of about 2000 ha (e.g. Kapiti I.) and, latterly, if the Campbell I. eradication is successful, to more than 10 000 ha.

Since the first period of releases of little spotted kiwi in the 1980s, DNA analysis has shown much more differentiation of kiwi than was originally recognised. Five species of kiwi have been identified, and considerable variations in populations are now recognised (Burbidge et al. 2003). This means that the few islands suitable for translocations now become even fewer per species if all taxa of kiwi are to be represented on them. As a result, priorities will have to be assigned with respect to which species are transferred where.

Kiwi are generally soil feeders. Their three most important food items are Scarabaeid larvae, cicada nymphs and earthworms. These usually contribute about 76% of their diet (Kleinpaste & Colbourne 1983). Kiwi also eat some surface-dwelling invertebrate species and some fruit. Large territories are necessary to provide sufficient food. Territories range in size from 2–3 ha per pair for little spotted kiwi and some North Island brown kiwi populations in Northland, up to and sometimes exceeding 100 ha for a pair of Okarito brown kiwi (rowi, *A. mantelli* Okarito) and tokoeka (*A. australis*).

2. Methods

A list of islands with existing populations of kiwi was assembled from data held by kiwi call scheme records, interviews with people who have worked or lived on these islands, and by reviewing distribution lists of animals in journals, books and other publications.

In addition, each Department of Conservation (DOC) conservancy was asked to list all islands with potential for kiwi translocations in their area. The main criteria were that islands be > 100 ha in area and outside natural stoat invasion distance, i.e. 1200 m or more from the nearest mainland coastline (Taylor & Tilley 1984); the mainland being defined as the three main islands of New Zealand. The author did this task for Northland and Auckland conservancies.

Some of the islands identified had stoats on them at the time of the survey, but were included because stoats could be eradicated permanently (the islands are outside stoat swimming distance). Great Barrier Island was also included on the list, although there may be conflicting conservation values here. The Poor Knights Is and Great I. in the Three Kings Group were not included because of highly endemic fauna and flora. Any island added to the list by the author is

labelled as such in Table 1. The author also removed some islands on Southland Conservancy's list (i.e. Resolution, Secretary, Long, Indian, Ulva Is), as these already have tokoeka populations. Some islands on the list are closer to the mainland than 1200 m, but are included on the basis that continual management could control stoats, at least in the short term.

The sizes of islands were obtained from Taylor (1989).

3. Results

Figure 1 shows the current or historically known presence of kiwi populations on offshore (and lake-bound) islands. Islands are listed roughly from north to south in Section 3.1.

3.1 ISLANDS WITH KIWI NATURALLY PRESENT OR KNOWN FROM TRANSLOCATIONS

Motukawanui

Motukawanui or Great Cavalli I. (35°00'S, 173°56'E) has an area of 380 ha. Moeed & Meads (1987) surveyed this island in 1983 to determine whether it had suitable habitat for little spotted kiwi. They recommended against translocation because of sparse invertebrate food; however, the survey was very brief and covered only a few sites. Instead, the island was later chosen as an experimental site to determine whether captive-bred North Island brown kiwi could cope with the transition back to the wild (as there were no predators or resident kiwi on the island to complicate the experiment). Ten juveniles, sourced from eggs or young chicks collected from Northland and hatched and reared in captivity, were released on the island in May 1995 and monitored by radio telemetry. One juvenile died when its transmitter became entangled in *Muelenbeckia complexa* vines, but the other nine juveniles were alive and calling after two years. Growth rates were at least as high as those of mainland kiwi chicks (author, pers. obs. 2004). Two other chicks, rescued as eggs and hatched at Whangarei Native Bird Rescue Centre, were released in 1997. Five nests from two pairs have been found with eggs present, but the success of those was not followed (author, pers. obs. 2004). In December 2002, a fire burned 10 ha of the island. Subsequently, a charred nest with two kiwi eggs was found. In 2002, a 1-year-old kiwi was caught, thus confirming successful breeding (S. McManus, DOC, pers. comm. 2002). Motukawanui is being used as a refuge for North Island brown kiwi rescued as eggs throughout Northland, protecting the genetic diversity of all the Northland stock. Because the translocated kiwi were hatched from eggs in incubators, and any young chicks found in the wild were treated with anthelmintics in captivity, they lack the endoparasites and ectoparasites that mainland kiwi possess. A survey in 2004 confirmed more breeding and estimated the population as 50-60 individuals (author, pers. obs. 2004).

TABLE 1. POTENTIAL ISLAND TRANSLOCATION SITES FOR KIWI (*Apteryx* spp.) AROUND NEW ZEALAND.

CONSERVANCY	ISLAND	SIZE (ha)	DISTANCE FROM LAND (m)	COORDINATES	INTERMEDIATE ISLANDS?†	LAND STATUS	KIWI PREDATORS	NOTES
Northland	Stephenson*	123	3200	34°58'S, 173°47'E	No	Maori	None?	
	Lady Alice*	155	10200	35°53'S, 174°43'E	No	Crown	None	
	Whatupuke	101	10200	35°53'S, 174°44'E	No	Crown	None	
Auckland	Great Barrier*	27761	17000	36°10'S, 175°25'E	No	Crown / private	Dogs, pigs? cats	
	Kaikoura*	535	100	36°10'S, 175°18'E	No	Crown		
	Rakitu*	328	2500	36°07'S, 175°29'E	No	Crown		Weka introduced
	Rangitoto*	2321	1600	36°47'S, 174°51'E	No	Crown	Stoat	
	Motutapu*	1560	3100	36°47'S, 174°54'E	No	Crown	Stoat	Grassland Farmed
	Motuihe*	195	1200	36°49'S, 174°56'E	No	Crown		
Waikato	Pakihī*	114	1200	36°55'S, 175°10'E	Yes	Private	Stoat	
	Curvier	195	2200	36°26'S, 175°46'E	No	Crown	None	
Bay of Plenty	Great Mercury	1860	5500	36°37'S, 175°47'E	No	Private	Cats	
	Slipper	247	2600	37°02'S, 175°56'E	No	Private		
	Tuhua	1277	25000	37°17'S, 176°15'E	No	Iwi freehold	None	
	Mokoia	143	2200	38°03'S, 176°16'E	No	Iwi freehold	None	
Wellington	Motuhora	153	7100	37°52'S, 176°58'E	No	Maori		Four Bay of Plenty brown kiwi released
	Motiti*	690	8600	37°38'S, 176°25'E	No	Maori / freehold	Cats, dogs	Farmed
	Mana	217	4000	41°05'S, 174°47'E	No	Crown	None	Has a lone hybrid kiwi
Nelson	Blumine	380	500	41°10'S, 174°15'E	No	Crown	Stoats, pigs	May be managed in future
	Chetwode*	242	2500	39°54'S, 174°04'E	No	Crown	None	
Otago	Pigeon	140	1200	44°55'S, 168°25'E	No	Crown	Dogs	Recreational island: dogs, fire
Southland (Fiordland)	Pomona	220	500	45°30'S, 167°28'E	No	National Park	Stoats	
	Doubtful 1	137	150	45°44'S, 167°43'E	Yes	National Park	Stoats	Tokoeka released 2002
	Doubtful 3	130	150	45°44'S, 167°42'E	Yes	National Park	Stoats	
	Bauza	480	700	45°47'S, 166°52'E	Yes	National Park	Stoats	Kiwi may be present already?
	Breaksea	170	1150	45°36'S, 166°38'E	No	National Park	None	
	Anchor	1525	800	45°45'S, 166°32'E	Yes	National Park	Stoats	Stoat eradication. Kiwi present?
	Cooper	1780	500	45°42'S, 166°51'E	No	National Park	Stoats	Kiwi may be present already?
	Chalky	514	1100	46°02'S, 166°31'E	Yes	National Park	None	Predators managed for kakapo

Table 1 continued.

CONSERVANCY	ISLAND	SIZE (ha)	DISTANCE FROM LAND (m)	COORDINATES	INTERMEDIATE ISLANDS?†	LAND STATUS	KIWI PREDATORS	NOTES
(Stewart I.)	Passage	167	1100	46°01'S, 166°31'E	Yes	National Park	None	
	Coal	1163	500	46°05'S, 166°41'E	Yes	National Park	Stoats	
	Rarotoka	98	7000	46°28'S, 167°48'E	No	Maori	None	
	Ruapuke	1525	11000	46°46'S, 168°30'E	No	Iwi freehold	Cats, dogs	
	Whenua Hou	1396	3000	46°45'S, 167°39'E	No	Nature Reserve	None	
	Bench	121	2600	46°55'S, 168°16'E	No	Nature Reserve	None	
	Pearl	512	250	47°13'S, 167°42'E	No	Scenic Reserve	None	
	Anchorage	150	250	47°14'S, 167°40'E	No	Scenic Reserve	None	
	Noble	173	250	47°15'S, 167°39'E	No	Scenic Reserve	None	
	Putauhinau	141	1500	47°13'S, 167°23'E	No	Maori	None	
	Big South Cape	939	1500	47°14'S, 167°24'E	Yes	Iwi freehold	None	

* Islands added by R. Colbourne to list suggested by DOC Conservancies. Note that R. Colbourne provided lists for Northland and Auckland Conservancies.

† Intermediate islands occur between the island in question and the mainland and could, if close enough, provide 'stepping stones' for stoats to colonise from.

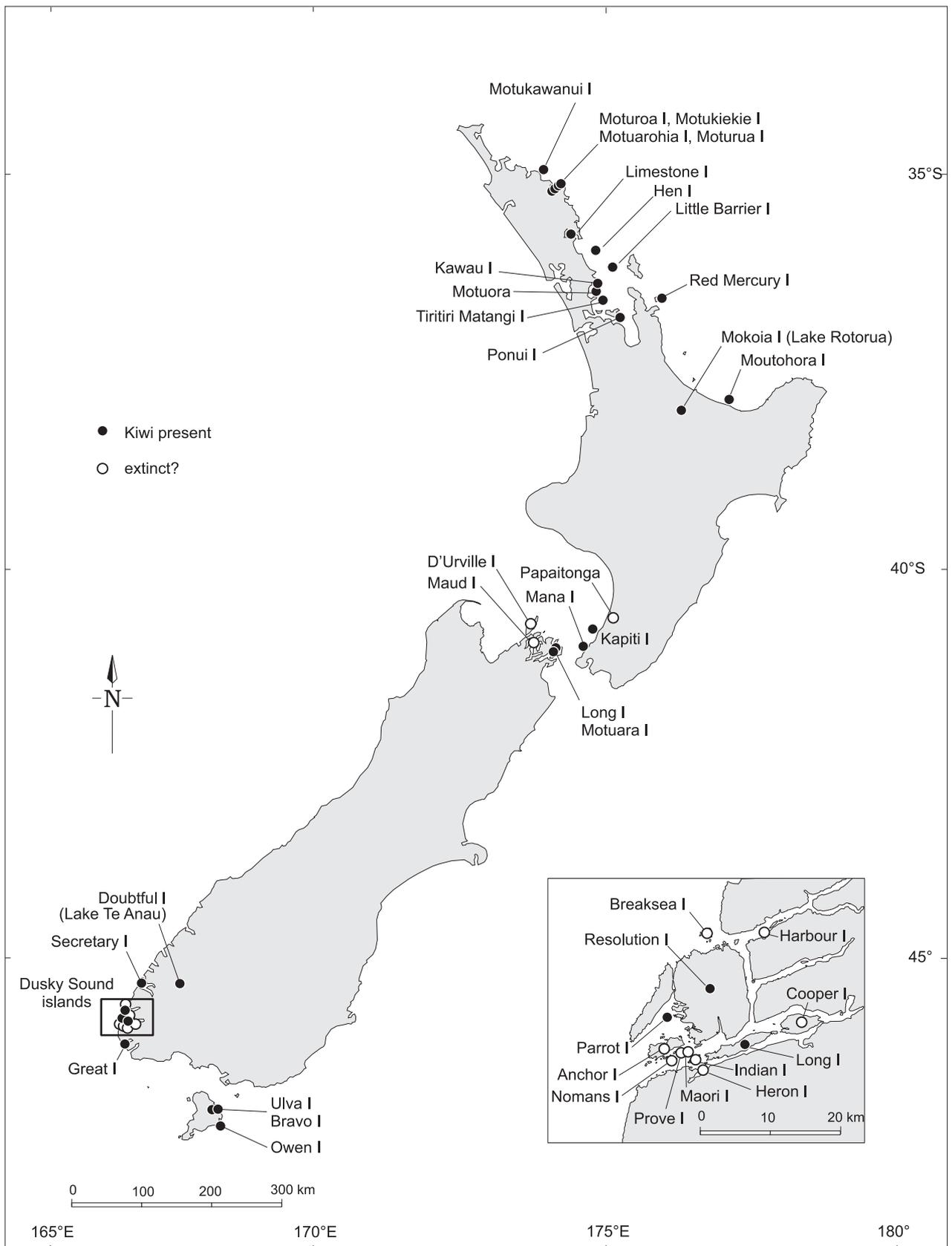


Figure 1. Present distribution of kiwi (*Apteryx* spp.) on offshore and lake-bound islands, and islands where kiwi are now presumed extinct (or status is unknown because of a lack of recent surveys). Inset shows Dusky Sound islands in detail.

Moturoa

Moturoa I. (35°14'S, 174°05'E) has an area of 157 ha. The island is privately owned but gazetted as a Wildlife Refuge. Six North Island brown kiwi from Waitangi Forest were introduced by the New Zealand Wildlife Service in 1982 and a single bird from a nearby location two to three years later (P. Asquith, local resident, pers. comm. 2003). Around 1992, a survey by local Forest and Bird members recorded 15 different kiwi calling and estimated the population to be about 20–25. The birds are currently heard and seen regularly, and are found all over the island (P. Asquith, pers. comm. 2003).

Moturua

Moturua I. (35°13'S, 174°11'E) has an area of 163 ha. An unknown number of North Island brown kiwi were released in the mid-1980s from birds salvaged from areas in the Bay of Islands catchment being cleared for forestry (S. Anderson, DOC, pers. comm. 2003). While the island has stoats, kiwi are still seen and heard at night (S. Anderson, pers. comm. 2003).

Motukiekie

Motukiekie (35°13'S, 174°12'E) has an area of 34 ha. North Island brown kiwi were possibly translocated to this island at the same time as they were put onto Moturua (mid-1980s) and are still present in small numbers (R. Pierce, Wildlands Consultants, pers. comm. 2003). Stoats are present. John Gardiner, Area Manager for DOC Whangarei, does not recall kiwi being translocated to Motukiekie.

Motuarohia

Motuarohia I. (35°14'S, 174°09'E) has an area of 66 ha. A few kiwi (species not specified) were moved onto this island in the mid-1980s after rescue from local Bay of Island forests about to be logged (J. Gardiner, DOC, pers. comm. 2003).

Limestone

Limestone or Matakohe I. (35°47'S, 174°21'E) has an area of 38 ha and lies within Whangarei Harbour. While the island is close enough to the mainland at Onerahi for stoats to swim to it, a programme of pest control by the Friends of Limestone Island Restoration Society has reduced mustelids to very low numbers. North Island brown kiwi eggs sourced within 40 km of Whangarei City are hatched at Whangarei Native Bird Recovery Centre (under ONE) and released onto Limestone I. with the purpose of later helping to re-populate Bream Head. Two adults were initially put on the island in April 2001 to see if the habitat was suitable. Because they remained in good condition, six chicks were then transferred. Four of those were moved to Bream Head once they weighed at least 1200 g, the size at which most young kiwi are safe from stoats. The growth rates of island kiwi were at least as good as those of North Island brown kiwi on the nearby mainland. A further 10 chicks were introduced in 2002. In addition, an 8-year-old ONE female which had been used in Rabbit Calicivirus Disease trials in 1995, and was later held at Whangarei Museum for 6 years, was released on the island in 2002.

Hen

Hen or Taranga I. (35°58'S, 174°43'E) has an area of 484 ha. Thirty-eight little spotted kiwi from Kapiti I. were transferred to Hen I. in May 1988 and June 1989—a total of 16 males, 14 females and six juveniles (Jolly & Colbourne 1991). A survey in February–March 1995 revealed 44 individuals and an estimated population of 50 birds (Colbourne & Robertson 1997). This equates to a population growth rate of about 4% per annum (and an estimated population in 2002 of 70 individuals). If Hen I. has a similar carrying capacity to Kapiti I. (one pair/3 ha), it could be expected to maintain a population of about 160 pairs.

Little Barrier

Little Barrier I. or Hauturu (36°12'S, 175°03'E) has an area of 3083 ha. This island has a substantial population of North Island brown kiwi, possibly numbering 240–300 pairs (author pers. obs. based on an average territory size of 10–12.5 ha/pair). A call listening survey in 2002 confirmed that kiwi were still widespread throughout the island from the flats at the DOC headquarters up to the summit (K. Baird, consultant, pers. comm. 2003). Data from the Kiwi Call Scheme (a database administered by DOC) have given a maximum call rate of 24 calls/h. Oliver (1930) stated that pure white kiwi were occasionally observed on Little Barrier, and noted that a live albino taken from the Taupo region was released on the island in 1913.

There is debate as to whether brown kiwi occurred naturally on the island or not. Dieffenbach (1841) said that local Maori told him that kiwi were present. Hamilton (1961) wrote that North Island brown kiwi were liberated 'some time before 1903' and again in about 1919, the present stock probably being descendants of the latter importation of 16 birds. Layard (1863), who visited Little Barrier in 1862, remarked: 'It is said that the kiwi exists in large numbers on this lonely island, but we did not see any tracks'. Hutton (1868) wrote: 'It will be noticed that Kiwi (*Apteryx mantelli*) does not appear in this list; and, notwithstanding current reports, I am inclined to think that it is either very rare or else does not exist on the island. I was accompanied by a very good dog, but we neither heard nor saw a Kiwi during the whole time we were on the island. I am also informed by Mr Barstow, of the Bay of Islands, that in 1842 Captain Wood, of H.M.S. "Tortoise", spent three or four days on the Little Barrier with the express object of catching Kiwis, but did not see one.' In 1868, Captain F.W. Hutton reported 'Sir George Grey told me that he also spent a day or two on the south-west side of the island (Little Barrier Island), looking for Kiwis, but found none'. Buller (1873) stated that T. Kirk had 'lately' collected several on the island. Reischek (1887b) included the North Island brown kiwi in his list but, in the absence of any additional evidence, this would appear to be based upon the earlier statements of Layard and Buller.

No kiwi were seen during the long period that the Shakespears lived on the island (1897–1910). Based on the analysis of blood samples (Herbert & Daugherty 1994), it appears that the North Island brown kiwi taken to Little Barrier I. originated from Taranaki. However, a haplotype unique to Little Barrier I. (H. Robertson, pers. comm. 2002) supports the argument that some were already present. The presence of a species of kiwi feather lice unknown

outside of the island also adds to the latter speculation (Palma 1991). (Palma collected lice from kiwi throughout the North Island but did not have samples from Coromandel or Hawkes Bay).

Oliver (1922) stated that 19 great spotted kiwi were sent to the island in 1915 from Gouland Downs, northwest Nelson. At the time of Oliver's visit in 1921, information from the caretaker, Mr Nelson, suggested that these birds had become established. Oliver noted that Mr Nelson once 'separated a brown kiwi and a Haast's (great spotted) kiwi from fighting'. Dr R.A. Falla found feathers of the great spotted kiwi during a visit in January 1928, but the species has not been recorded since (Hamilton 1961).

Kawau

Kawau I. (36°20'S, 174°50'E) has an area of 2050 ha. It is not known whether kiwi occurred on Kawau naturally. They may have all been released by Governor Grey who owned the island from 1862–1888. Grey introduced many exotic species, including kookaburra, wallaby, zebra, as well as some native species such as weka. There are references to some kiwi obtained by Frederick Manning and carefully preserved by Grey on a small headland on the southwest- or south-facing side of the island. Letters from Manning to Grey held in the Grey collection at the Auckland Library indicate that they were introduced around 1863/4 (R. Hall pers. comm.). Kawau I. is moderately populated by people and has stoats, cats and dogs as part of the current animal community. A recent survey (2002) of the island (K. Baird, pers. comm. 2003) revealed the presence of North Island brown kiwi at all six listening sites and a total population of 30–40 birds.

Motuora

Motuora I. (36°30'S, 174°47'E) has an area of 85.5 ha. Four North island brown kiwi chicks from the greater Whangarei area were first released onto Motuora I. in October 1999. These were sourced as eggs and chicks, and hatched or reared at Auckland Zoo, as part of ONE (Grzelewski 2000). Motuora I. is being used as a creche to hold kiwi, in the absence of mustelids, until they are large enough to be returned to where they came from in either Bream Head or the Whangarei area. There is no history of rodents or other small mammals on Motuora I. The island is grazed by cattle to keep kikuyu grass under control, while the Friends of Motuora Society restore native forest in fenced-off sections. In 1999, most of the island was farmland, gorse, a shelter-belt of old pines and small enclaves of scrub. Five more kiwi chicks were released in 1999 and monitored. Two died after being caught in vines, so transmitters were removed. Until then, the birds were gaining weight at above the average rate for mainland chicks of the same age. A total of 57 North Island brown kiwi were released onto the island until 7 May 2002, including one captive-bred North Island brown kiwi from Northland stock. Since 1999, three kiwi are known to have died, and 21 birds have been released back onto the mainland (author, pers. obs. 2003). One male was found on a nest with an egg, indicating that breeding has been attempted (author, pers. obs. 2004). A breeding population is to be left on the island and their offspring will be removed as well as the ONE subadults (author, pers. comm. 2004).

Tiritiri Matangi

Tiritiri Matangi I. (36°36'S, 174°57'E) has an area of 218 ha. Five pairs of little spotted kiwi were transferred from the Okupe Valley at the northern end of Kapiti I. to Tiritiri Matangi I. on 4 July 1993. Two males later died, one through drowning and the other through transmitter entanglement. A further two pairs and two replacement males were sent to Tiritiri Matangi I. on 15 July 1995. Colbourne & Robertson (1997) estimated a population of 20–25 birds on the island, giving a population growth rate of c. 11% per annum. A resurvey in May 2002 estimated a population of about 50 individuals. (H. Robertson, pers. comm. 2003). At a stocking rate similar to Kapiti I., the Tiritiri Matangi I. population could reach and stabilise at about 70 pairs. Among the birds captured in May 2002 were the heaviest female and male little spotted kiwi ever recorded (female 2040 g; male 1540 g). This indicates an abundant food supply on the island.

Ponui

Ponui I. (36°50'S, 175°10'E) has an area of 1770 ha. North Island brown kiwi were introduced to Ponui by the New Zealand Wildlife Service following a request from the island's owners. Six birds originating from Little Barrier I. were released in June 1964, followed by a further eight kiwi from Waipoua (Northland) later the same year (D. Merton, DOC, pers. comm. 2003). Miles & Castro (1999) organised a survey in which a total of 1502 kiwi calls were heard during 49 h of listening. This gave a mean call rate of 30.7 calls/h. From the location of kiwi pairs, observers estimated that there were 10 pairs/km² (10 pairs/100 ha). If kiwi were uniformly spread over all of Ponui, that could equate to a population of about 350 adults. The establishment of this dense population is of interest, in that stoats have been seen on the island since 1940. However, stoats don't appear to be common and sightings may have been of males dispersing from elsewhere (J. Miles, DOC, and I. Castro, Massey University, pers. comm. 2003).

Red Mercury

Red Mercury I. (36°37'S, 175°55'E) has an area of 225 ha. Six male and six female little spotted kiwi were transferred to Red Mercury I. from Kapiti I. in July 1983 (Jolly & Colbourne 1991). One of the original birds was killed by a dog during a survey in 1986. A survey in 1996 (Colbourne & Robertson 1997) revealed a population of probably 13 pairs and a minimum of 30 individuals on the island, giving an estimated growth rate of 8% per annum. After rat eradication in 1992, a follow-up survey in April 2001 estimated a minimum of 19–20 pairs (H. Robertson, pers. comm. 2002). Undetected juveniles and chicks would boost that number towards 50–60 individuals. The population was likely to have been 55–65 kiwi in 2002. The island should support c. 70 pairs if a similar stocking rate exists there as on Kapiti I.

Moutohora

Moutohora or Whale I. (37°51'S, 176°58'E) has an area of 172 ha. It is being used by DOC's Bay of Plenty Area Office as a safe breeding area with the objective of cropping offspring for release back to the mainland sources of the

original stock. Two 4-month-old female North Island brown kiwi from Ohope Scenic Reserve were released onto Moutohora on 18 April 2001 (R. Warne, DOC, pers. comm. 2002). They were recovered as a chick and an egg from a nest, incubated and reared at Rainbow Springs as part of ONE. Further releases of kiwi are planned.

Mokoia

Mokoia I. (38°04'S, 176°17'E) has an area of 120 ha and lies in the middle of Lake Rotorua. Four North island brown kiwi from the Bay of Plenty area were released onto the island in 2004. These three male and one female kiwi were hatched and raised at Rainbow Springs Kiwi Centre as part of the ONE programme (B. Evans, DOC, pers. comm. 2004).

Papaitonga

In Lake Papaitonga (40°39'S, 175°15'E), near Levin, there is a small island, about 0.5 ha in area. This was part of the estate of Sir Walter Buller. He released a pair of great spotted kiwi, a pair of little spotted kiwi, and a single North Island brown kiwi there at the turn of the 20th century. He also released three large tuatara (*Sphenodon* spp.) to prevent the kiwi from being molested. The locals apparently had a most 'unaccountable dread' of these guardians and would never willingly step foot on the island (Buller 1905). The island was far too small to maintain kiwi in the long term and the birds presumably died out quickly. There are no kiwi currently present (author, pers. obs. 2004).

Kapiti

Kapiti I. (40°51'S, 174°55'E) has an area of 1970 ha. Before 1900, no kiwi were recorded on Kapiti I., despite it being a major whaling location, produce trading area and farm. Two thousand people once lived on the island. The first known transfer of kiwi to Kapiti I. was of a pair of great spotted kiwi / roroa (*A. baastii*) brought by Richard Henry in July 1908 from Dusky Sound in Fiordland. A.S and Amy Wilkinson (rangers 1924-42) on Kapiti I. gave the following account of kiwi there (Wilkinson & Wilkinson 1952): 'The second introduction was made on October 12, 1912. In the annual report for Scenic Preservation for the year ended March 31, 1913, Mr Phillips Turner, then inspector of Scenic Reserves, says: "All I have to report with regard to our native birds is that I liberated on Kapiti Island sanctuary three night parrots [kakapo (*Strigops habroptilus*)] and five kiwis from the South Island. The birds were in good heart when let go, and should succeed on the island".'

Early in 1925 the Wilkinsons heard several of these kiwi calling and judged them to be little spotted kiwi. The Wilkinsons reported that in 1925, Mr Phillips Turner, a member of the Kapiti Island Advisory Board, then visiting the island, mentioned to them that he had introduced some kiwi from the Wanganui district. This was likely to have been the seven kiwis liberated in October 1923 (Brook 1924). On 10 March 1929 a trapper caught a little spotted kiwi in his trap. On 22 March the same trapper chased after and caught a kiwi near his hut; this bird was a North Island brown kiwi. On 15 September 1931, a sick North Island brown kiwi from Taranaki was released but was found dead 2 days later. In January 1935 the Wilkinsons liberated a North Island brown kiwi sent by

Major R.A. Wilson, of Bulls. They received another North Island bird in November, 1940, caught by a motorist near Taihape, and released it in good health (Wilkinson & Wilkinson 1952).

Measurements of brown kiwi caught on Kapiti I. between 1982 and 2002 give mean bill and weight similar to those of southern tokoeka (*A. australis*) from Fiordland (author, pers. obs. 2000). Physically, they are very similar, with small tarsal scutal scales, small whiskers, proportionally long neck and soft tips to the feathers. No brown kiwi that resemble North Island brown kiwi have been heard or caught on Kapiti I.; however, a blood sample collected in 1990 had a gene sequence unknown in southern or Haast tokoeka (*A. australis* 'Haast'). Charles Daugherty (Victoria University, Wellington) suggested the possibility of hybridisation (Herbert & Daugherty 1994). At the the time of their study, however, few Fiordland birds were sampled, so further genetic research is needed to clarify this. It appears that any 'pure' North Island brown kiwi have died out on Kapiti I.

If all tokoeka on the island originated from the one pair introduced by Richard Henry, that could explain why the population is not very vigorous. After 95 years, tokoeka are still not widespread on Kapiti I., but maintain a stable population of about 50-100 individuals. This could also be a reflection of Kapiti I. having little suitable habitat. Tokoeka are restricted to the moister soil areas close to the cloud zone on the higher parts of the island or along swampy areas. Where they do occur, their territories completely overlap those of little spotted kiwi and both species are known to breed in each other's presence (author, pers. obs. 2004).

Little spotted kiwi maintained a stable population of c. 1000 birds for 15 years on Kapiti I. However, during the last 9 years numbers have increased to c.1200, which may be a reflection of an improvement in the carrying capacity of the island with the reduction of food competition since the removal of rats in 1996 (author, pers. obs. 2004)

Mana

Mana I. (41°05'S, 174°46'E) has an area of 217 ha. In June 1992 a male spotted kiwi was caught at Franz Josef township in the South I. and a blood sample taken. The analysis revealed that the bird was a hybrid between an Okarito brown kiwi (rowi) and a little spotted kiwi (Herbert & Daugherty 1994). If the father of the bird was a little spotted kiwi (as seems likely, on the basis of mitochondrial DNA), it would represent one of the most recent instances of that species surviving on the mainland. It is also possible that the little spotted kiwi contribution came from *A. owenii occidentalis*, a proposed former subspecies of little spotted kiwi (Oliver 1930). Part of the territory of this bird was to be logged for expansion of the Franz Josef township. After consultation, the Kiwi Recovery Group decided to place the bird on Mana I. and to search for any other spotted kiwi on the West Coast. Because no others were found, a female little spotted kiwi from Kapiti I. was placed on Mana I. in June 1994 to try and form a pair bond and ultimately breed with the male. However, the birds occupied different territories and the female eventually disappeared. The male is still heard and occasionally seen (C. Miskelly, DOC, pers. comm. 2005).

D'Urville and Maud

D'Urville I. (40°50'S, 173°50'E) has an area of 15 000 ha. There was a naturally occurring population of little spotted kiwi on D'Urville I., but its numbers had dwindled to about 15 individuals by 1978 and no kiwi have been reported there for the last 16 years (author, pers. obs. 2005). This decline probably came about because of predation by stoats and dogs. In 1980, a New Zealand Wildlife Service survey over most of the island found only three birds. Two males were taken into captivity, but one died. The remaining captive male was sent to Maud I. (41°01'S, 173°53'E) in the Marlborough Sounds to join a female D'Urville kiwi, but this male presumably died, as it was not detected thereafter (B. Cash, DOC, pers. comm. 2003). A stoat was caught on Maud I. so, in July 1982, it was decided to transfer the female to nearby Long I., together with two little spotted kiwi males from Kapiti I. in an attempt to let them breed to preserve any genetic material unique to the D'Urville population. In July 1987, after following up on a report of another adult little spotted kiwi on D'Urville I., the Wildlife Service transferred a male to Long I. (Colbourne & Robertson 1997). The D'Urville Island population of little spotted kiwi is now presumed to be extinct, and none remain on Maud Island (author, pers. comm. 2005).

Long

Long I. (41°08'S, 174°15'E) has an area of 142 ha. (Note that there is also a Long I. in Dusky Sound, Fiordland.) The female little spotted kiwi transferred from D'Urville I. in 1982 bred successfully and raised at least one offspring, a male, found in 1986 (Jolly & Colbourne 1991). After the last D'Urville I. male was transferred to Long I. in 1987, one of the two Kapiti I. males was removed to Otorohanga to give the D'Urville male a better chance of breeding and increasing the size of the D'Urville I. genepool (Colbourne & Robertson 1997). However, the D'Urville I. male set up a territory at the opposite end of the island from the female and, as he could have been an old bird with little breeding time left, a female little spotted kiwi from Kapiti I. was introduced to his territory in July 1989. In March 1995, two new kiwi and the D'Urville I. male were caught. From the monitoring of calls in 1995 it was estimated that a minimum of 10 birds were present on the island. This gives an estimated population growth rate since 1982 of 6% per annum (Colbourne & Robertson 1997) and a minimum population in 2002 of about 20 individuals. If the carrying capacity of Long I. is similar to that of Kapiti I., then a stable population of about 53 pairs could be expected on Long I.

Motuara

Motuara I. (41°05'S, 174°15'E), with an area of 59 ha, is an ONE creche for the rearing of Okarito brown kiwi / rowi (*A. mantelli* 'Okarito') chicks. Fifty-five juveniles were reared on Motuara over 5 years from 1997-2001. Four juveniles disappeared. The island provided enough food for the birds, and all were in good condition when transferred back to Okarito (L. Adams, pers. comm. 2002). The future use of the creche is dependent upon the results of an extensive stoat-trapping experiment to improve the natural survival of juveniles in Okarito forest. Two more chicks were put on the island in early 2003 and 14 in early 2004 (author, pers. obs. 2004).

Secretary

On Secretary (45°01'S, 167°00'E), an 8140-ha island in Doubtful Sound, Fiordland, there is a natural population of southern tokoeka (*A. australis*). A survey during Operation Raleigh in February 1987 recorded a low call rate of about 0.4 calls/h; however, because of heavy rain, most listening was done around the Gut Hut (J. McLennan, Landcare Research, pers. comm. 1987). One tokoeka was caught and a blood sample taken. No surveys for kiwi have been conducted on nearby 480-ha Bauza I. (45°18'S, 166°55'E).

Dusky Sound

Before 1897, only two islands in Dusky Sound were known to have kiwi. The first was Resolution I. (45°40'S, 166°40'E), covering 20 860 ha and with a 'plentiful' population of southern tokoeka (previously known as roa, see Hill & Hill 1987). No little spotted kiwi were found on this island in spite of their abundance on the mainland opposite (Hill & Hill 1987). The second island was 1780-ha Cooper I. (45°43'S, 166°51'E), where Richard Henry recorded hearing little spotted kiwi (Henry 1895).

Resolution I. was gazetted as a reserve for the preservation of native flora and fauna in 1891. In 1894, the then new ranger—Richard Henry—provided the first detailed accounts of the wildlife of the area and it was his duty to transfer ground birds from the South Island mainland to Resolution I. and other islands in Dusky Sound. The aim was to establish safe havens for these birds after mustelids were introduced to New Zealand in the 1890s. Between 1897 and 1908, Henry and his assistants moved about 750 ground birds (mostly kakapo, southern tokoeka and little spotted kiwi) within Dusky Sound and shipped about 100 (mostly kakapo and southern tokoeka) elsewhere in New Zealand (Hill & Hill 1987).

It is believed that Henry only gave details for about three-quarters of the collecting trips he made between May 1895 and December 1896 (Hill & Hill 1987). However, by 1887 at least 13 southern tokoeka and 16 little spotted kiwi had been put on 1878-ha Long I. (45°45'S, 166°43'E); five southern tokoeka onto 168-ha Indian I. (45°46'S, 166°36'E); nine southern tokoeka and 26 little spotted kiwi onto Resolution I.; and seven southern tokoeka onto 41-ha Parrot I. (45°42'S, 166°33'E). Most of these birds were from Cascade Harbour. Henry mentioned that sometimes he got up to four southern tokoeka from the one hole; on one occasion he got three similar-sized birds from a burrow. In 1897, Henry liberated two (presumably male) southern tokoeka onto 51-ha Harbour I. (45°36'S, 166°46'E) at the head of the Vancouver Arm of Dusky Sound to keep a previously released female southern tokoeka company.

On Parrot I. at an altitude of about 600 feet, Henry came across a fat male southern tokoeka sitting in a hole hatching (incubating) a large fresh egg—the largest southern tokoeka egg he had ever seen. Also in the nest was a chick judged to be about a fortnight old. He wrote: 'Parrot Id [island] is out in the worst of the wind and I argued that nearly all the insects would be blown off it, but wrong as usual whenever a body goes speculating, for this must be an exceptionally good place for them. For the same reason I did not put roas [southern tokoeka] on Anchor Id but I will do so now because it is a fine big Id and very high which seems to suit roa best' (Hill & Hill 1987). He did not

document any releases. In 1900, stoats were first seen on Resolution I. As an insurance Henry began to put a few ground birds on the southeast side of Anchor I. (45°45'S, 166°32'E) and on 'Maori'¹ I. (45°45'S, 166°33'E), Prove (45°45'S, 166°35'E) I., and Nomans I. (45°46'S, 166°34'E) where they were safely out in the main stream of the sound. In a desperate bid to isolate them from danger, he put birds on the remote islands in Breaksea Sound. At Breaksea I. (45°34'S, 166°38'E), the swell was so great that he had to throw his four southern tokoeka ashore and watched helplessly as one of them ran towards the water and was swept away by a wave. In 1902, Henry made little mention of southern tokoeka and kiwi in his reports, but in 1903 he did state that he had moved seven little spotted kiwi from the north side of Dusky to Cooper I. (Hill & Hill 1987). A reference to kiwi sign found by a Wildlife Service survey in 1979 on 10-ha Heron I. (45°47'S, 166°38'E) at the entrance to Cascade Cove has been found by the author, but no further details were given.

Parrot I. apparently still has a high density of kiwi (M. Willians, DOC, pers. comm. 2002), although no sign was found during a survey by Ian Flux in 2003. Indian I. also has many kiwi (I. Flux, DOC, pers. comm. 2003). Both Resolution (particularly the interior) and Long Is have medium to high densities of southern tokoeka. Anchor I. may also have kiwi, a possible male southern tokoeka was heard at Luncheon Cove (J. Maxwell, DOC, pers. comm. 2002). Kim Morrison identified southern tokoeka on Cooper I. in 1985. There is no reference to Richard Henry having put southern tokoeka on that island so it may be a naturally-occurring population.

Great Island and Preservation Inlet

Little is known of the distribution of kiwi on islands in Preservation Inlet. Reischek (1887a) visited Chalky Sound and recorded southern tokoeka as rare. He did not mention little spotted kiwi. A southern tokoeka was heard in 2002 on Great I. (45°58'S, 166°38'E) (D. Russell, Ngai tahu, pers. comm. 2003). Great I. (723 ha) is separated from the mainland by a channel only 300 m wide, a distance a kiwi could probably swim.

Lake Te Anau

In April-May 2002, nine southern tokoeka from the Murchison Mountains in Fiordland were transferred to Doubtful I. (137 ha) and an unnamed island immediately northwest (26 ha) in Middle Fiord, Lake Te Anau. (45°13'S, 167°43'E). Seven males and two females were released. This was the first of a planned series of transfers to release 3-5 pairs on Doubtful I. and three pairs on the smaller, unnamed, island. The purpose of these transfers was to increase numbers and distribution of kiwi, and to provide an island where people can visit the birds without special authority (D. Russell, pers. comm. 2003). However, the kiwi monitored all lost weight and one died of starvation. None bred in the season following their transfer and four kiwi have since been taken from the islands and returned to where they came from (H. Edmonds, DOC, pers. comm. 2004).

¹ Name used by Richard Henry (Hill & Hill 1987).

Ulva, Bravo and Owen Islands

A population of southern tokoeka lives on 259-ha Ulva I. (46°57'S, 168°08'E), in Patterson Inlet, Stewart I. Currently, there are an estimated 30 individuals (15 banded) descended from birds introduced by locals on possibly 2–3 occasions about 25 years ago (B. Beavan, DOC, pers. comm. 2003). Southern tokoeka have been recorded twice on 22-ha Bravo I. (46°59'S, 168°10'E) in Patterson Inlet (Sanson 1947; Watters 1953). This small island is only 200 m offshore and is connected to Stewart I. by a sandbar at very low tide. Southern tokoeka have also been recorded on privately owned Owen I. (47°07'S, 168°12'E), which has an area of 33 ha and lies to the east of Lords River (A. Roberts, DOC, pers. comm. 2002) It is possible that birds could have swum to the island, but it is more likely that they were deliberately released, as it is probably too small to sustain a natural population.

3.2 IDENTIFYING ISLAND SITES FOR POTENTIAL TRANSLOCATION OF KIWI

The information gathered during this study is summarised in Table 1, which provides a list of islands suggested by DOC conservancies (or by the author) as sites for possible kiwi transfers. Note that some are within stoat swimming distance but their use may be contemplated in the future if advances in stoat control occur that make mustelid management feasible. Mana I. currently has one kiwi but it could be removed if there were higher priorities for the island (in terms of translocation or holding of other rare taxa of kiwi).

Wellington Conservancy did not wish the Chatham Is to be considered because they are outside the natural range of kiwi. Southern Conservancy did not include the subantarctic islands, nor Solander I. (100 ha) because they felt that kiwi would compromise other ecological values at these sites (A. Roberts, pers. comm. 2002).

4. Discussion

Kiwi are already present on 28 islands around the mainland or within lakes in New Zealand. These include the largest islands, such as Little Barrier, Kawau, Kapiti, Secretary and Resolution. The number of islands now available to kiwi is limited, particularly those where viable populations could exist without active management.

There is increasing pressure to use those islands remaining for nearby kiwi populations. However, it is clear that there are not enough islands left for all taxa. Decisions will have to be made about which taxa should go where, and whether this decision should be based on the status of all mainland populations (i.e. a national overview) or on local needs. It is hoped that this document will provide the necessary background information to make these decisions.

5. Acknowledgements

I would like to thank the following DOC staff for assembling lists of potential islands in each of their conservancies: John Adams, Andy Grant, Peter Gaze, Richard Griffiths, John Lyall, Colin Miskelly, Keith Owen, Andy Roberts and Jason Roxburgh.

Lynn Adams, Shaughan Anderson, Paul Asquith, Karen Baird, Brent Beavan, Bill Cash, Isobel Castro, Charles Daugherty, Hannah Edmonds, Raewyn Empson, Bridget Evans, Ian Flux, John Gardiner, Richard Hall, Jane Maxwell, John McLennan, Steve McManus, Don Merton, Jonathan Miles, Kim Morrison, Ray Pierce, Detta Russell, Rod Warne and Murray Willians kindly provided me with records or reports of kiwi on islands.

I also thank Chris Edkins who drafted the map and Hugh Robertson for editing the manuscript.

DOC provided the funding for this investigation (Science investigation no. 1219).

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