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North Island kokako (*Callaeas wilsoni*) recovery update: 2000 to 2023

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Abstract: This paper describes North Island kokako (*Callaeas wilsoni*) recovery actions and outcomes since 2000 at 11 sites with relict populations, and at 12 other mainland and three offshore island sites to where they have been translocated. Populations are now secure on pest-free Te Hauturu-o-Toi / Little Barrier Island and Kapiti Island, and Tiritiri Matangi Island is a valuable advocacy site. Maungatautari is a large (3,300 ha) pest-fenced and pest-free site that has demonstrated rapid kōkako recovery. All other sites are unfenced and require ongoing control of key pests. The national total of kōkako pairs has increased from *c*. 458 in 2000 to *c*. 2,327 in 2023; however, latest counts indicate populations at seven sites have declined. Future kōkako recovery will be assisted most by improved, large-scale pest control tools for unfenced mainland sites, and by sustained effective pest control in large key relict populations (Pureora, Te Urewera, Rotoehu, Mapara, and Mokaihaha).

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INTRODUCTION

This paper documents the methods and outcomes of management undertaken to increase North Island kokako *Callaeas wilsoni* abundance and distribution in the 24 years after 2000, within the context of previous research and management. The programme is widely regarded as successful, but how was this achieved and what more is there to learn and improve?

North Island kokako (henceforth kōkako) were widespread throughout the North Island at the time of European settlement but declined rapidly thereafter, especially in the seven decades before 1950 (Salvador *et al.* 2019). This is consistent with the observation that in New Zealand 'deep endemic' bird species declined as human impacts increased (McDowall 1969). Formerly found "on all the ranges of the North Island forests" (Reischek 1886), kōkako were confined to scattered forests in the northern two-thirds of the North Island by 1970 (Lavers 1978). Hypotheses for their decline include forest clearance, predation, and food competition with introduced pest mammals (Williams 1976; Lavers 1978). Detailed studies from 1978 to 1984 of kōkako use of forest habitat at Pureora (Waikato) and Puketi (Northland), prompted by logging controversies in native forests, revealed key aspects of the species' biology, including year-round territoriality, diverse diet, and poor nesting success (Hay *et al.* 1985; Powlesland 1987; Best & Bellingham 1991). As a precaution, kōkako were translocated successfully to pest-free offshore islands, including Te Hauturu-o-Toi / Little Barrier Island (from 1981, henceforth Hauturu), Kapiti Island (from 1991), and Tiritiri Matangi Island (from 1997).

Research during 1989–1997 verified that mainland declines were primarily due to predation of eggs and chicks, and occasionally adults during nesting, by ship rats (*Rattus rattus*), brushtail possums (*Trichosurus vulpecula*), swamp harriers (*Circus approximans*), and, more rarely, stoats (*Mustela erminea*). Kōkako food supply was considered an important secondary factor (Innes *et al.* 1999).

Subsequent control of pest mammals sustained kōkako recovery in some relict populations, from which birds would later be harvested for reintroduction to parts of their former mainland range (Innes & Flux 1999; Innes *et al.* 2013). Such translocations sought to establish or sustain populations at Puketi Forest (Northland); Hunua and Waitākere Ranges / 'Ark in the Park' (Auckland); Maungatautari and Pirongia (Waikato); Otanewainuku, Manawahe, and Whirinaki (Bay of Plenty); Ngapukeariki (East Cape); Boundary Stream (Hawke's Bay); Parininihi, and Pouiatoa (Taranaki); and Pukaha / Mt Bruce (Wairarapa, Fig. 1). Of the 26 sites with current populations, Hauturu, Tiritiri Matangi, and Kapiti are pest-free offshore islands; Maungatautari is a large (3,300 ha) pest-fenced ecosanctuary, and all others are unfenced 'mainland islands' with constant mammal pest reinvasion from surrounding land (Innes *et al.* 2019).

During 2011–2014 translocations to new sites were suspended while the Kōkako Recovery Group (KRG) addressed genetic issues about whether populations should be mixed by translocation and how many genetic founders there should be in new populations. This work culminated in national prioritisation of kōkako populations, with the highest ranking going to relict (not translocated) populations that had never had fewer than 40 individuals (Te Urewera, Pureora, Mapara, Mokaihaha, and Rotoehu; Emily Weiser, unpubl. report, 2015). It also established guidelines for the minimum number of founder individuals from which new populations should be started, and the maximum number of individuals that could be harvested from source populations.

In this paper we expand this outline to describe key management actions that have been taken since 1999 to increase populations, and we document their outcomes, including changes in abundance and the distribution of kōkako and resultant conservation status changes for the taxon. While kōkako restoration is probably widely regarded as a conservation success story, there are no published accounts of how this was achieved and what could have been done better. We also collate recent new findings about kōkako biology and ecology, describe how the KRG interacts with iwi and community groups, and discuss current and future challenges for kōkako management. We hope the paper establishes an authoritative account of recent kōkako conservation that benefits biodiversity managers and administrators, and project participants.

PEST CONTROL AND ITS OUTCOMES

Intensive control of mammal pests is the primary management action currently undertaken to increase kōkako populations. Brushtail possums, ship rats, and stoats are key predators and disturbers of kōkako eggs, chicks, and adults; possums and ship rats also eat kōkako foods (Innes *et al.* 1999). Harriers are frequent predators at kōkako nests; however, they have only rarely been targeted for control in the past 20 years.

When acute toxins such as aerial 1080 are used, key pest control targets are to have residual (post-control) indices of 1% Residual Trap Catch (RTC; Bionet and National Pest Control Agencies 2020) for possums and 1% Residual Tracking Index (RTI; Gillies 2013) for ship rats at 1 November, which is about when nesting usually begins. When pest

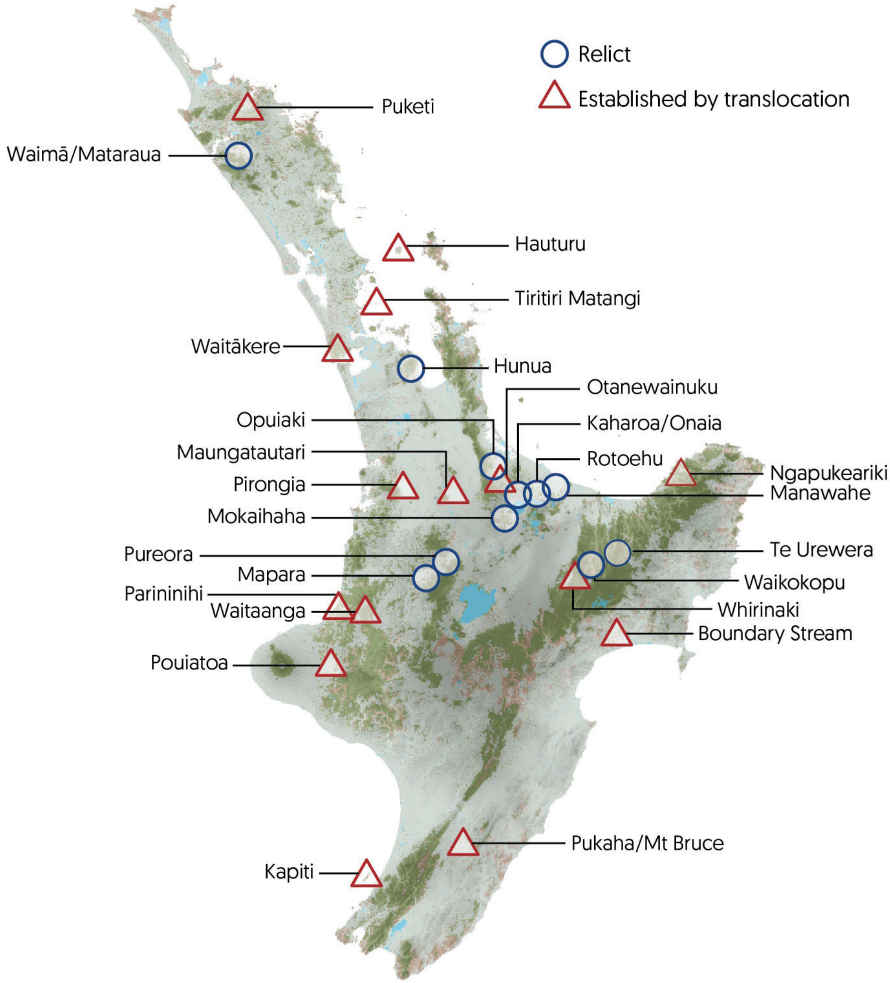

Figure 1. Current (2024) distribution of relict and translocated kōkako populations. The Hunua and Manawahe populations are shown as relict but were also boosted by translocated birds during 2006–2019 and 2019–2021, respectively. Pureora consists of four interbreeding subpopulations at Waipapa North and South, Okahukura, Tunawaea, and Mangatutu. The population at Waitaanga self-established after a translocation to Parininihi 30 km to the west.

control is ongoing, such as with bait stations, targets are to maintain possums below 5% RTC and ship rats below 5% RTI during the November–February breeding season. Other indexing tools such as chew cards or wax tags should not be used because no robust guidelines are available to calibrate their results against RTC and RTI. There are no formal, post-control targets for stoats because suitable methods have not been available.

We collated all available information about methods and outcomes of pest control targeting the key mammal pest species to protect kōkako populations at 25 unfenced mainland sites during the seven kōkako breeding seasons (October to February) of 2015–16 to 2021–22, inclusive. These sites are as shown in Fig. 1 but exclude Waitaanga, and for this analysis we separated the subpopulations (Mangatutu, Okahukura, Tunawaea, Waipapa north, and Waipapa south) of Pureora.

Possums

Across all sites, possum control was undertaken on average in 4.4 of the 7 years (n = 25). The most common method was using toxins in permanent or single-use bait stations attached to trees (45%, 51/112 site-years), followed by aerial 1080 and mixed trapping/ground poisoning (both 19%, 21/112 site-years) and trapping alone (17%, 19/112 site-years). Toxins used (in order of declining frequency) were potassium cyanide, aerial 1080, cholecalciferol, brodifacoum, 1080 in bait stations, and Double-Tap® (a mix of cholecalciferol and diphacinone).

A residual possum abundance of 5% trap-catch using the RTC method was measured and achieved around 1 November on average in 1.5 years of the 7, across all sites; that is, in 34% of years when possum control was attempted. It is likely that this abundance was achieved more often because residual abundance was not always monitored, especially after aerial 1080 operations, when >95% kills are now routine (Morgan *et al.* 2006) and some sites used bite mark indices not analysed here. In kōkako sites during 2015−16 to 2021−22, aerial 1080 achieved lower residual abundance (mean 0.9%, n = 8, *sd* = 1.31) than ground-based toxins (mean 1.9%, n = 31, *sd* = 2.0) or a mix of trapping and poisoning (mean 2.9%, n = 4, *sd* = 3.4), and much lower than trapping alone (mean 23.4%, n = 4, *sd* = 27.9).

Ship rats

Across all sites, ship rat control was undertaken on average in 5.6 of the 7 years (n = 25). This is more frequent than for possum control, because rat populations recover more quickly from low levels, including after aerial 1080 operations (e.g. Sweetapple & Nugent 2007). By far the commonest control method was toxins in permanent or single-use bait stations attached to trees (58%, 81/140 site-years), followed by aerial 1080 and mixed trapping/ground poisoning (each 15%, 21/140 site-years) and trapping alone (12%, 17/140 site-years). Toxins used (in order of declining frequency) were pindone, diphacinone, aerial 1080, brodifacoum, 1080 in bait stations, Double Tap®, and cholecalciferol.

A ship rat abundance of ≤5% RTI (Gillies 2013) was measured and achieved around 1 November on average in 2.7 years of the 7, across all sites; that is, in 48% of years when ship rat control was attempted. In kōkako sites during 2015−16 to 2021−22, aerial 1080 achieved lower residual abundance (mean 3.5% RTI, n = 13, *sd* = 7.5) than ground-based toxins (mean 8.9%, n = 72, *sd* = 15.3) or a mix of trapping and poisoning (mean 8.7%, n = 16, *sd* = 6.9), and much lower than trapping alone (mean 17%, n = 7, *sd* = 19.8).

Stoats

Currently the few available data suggest that stoats are rare predators at kōkako nests; however, they may be significant, albeit perhaps intermittent, predators of subadults and adults (Innes *et al.* 1999; Flux *et al.* 2006). Sign left at nests suggested that stoats caused failures of just 4% of 75 nesting attempts during years with pest control at Mapara (1995−1997); however, 12 of 31 banded females were lost in the 3 years after pest control ceased, and stoats preyed on all three nests at which the cause of female loss was known (Flux *et al.* 2006). They are capable of killing large chicks, subadults, and adults when nesting or roosting, and so are a management target at nearly all sites. Stoats are also targeted at many kōkako sites to protect other taxa, such as brown kiwi (*Apteryx mantelli*). Across all sites, stoat control was undertaken on average in 4.4 years of the 7 (n = 25). Methods included trapping with DOC200, Goodnature A24, DOC250 or (in earlier years) Fenn kill traps, as well as secondary poisoning via aerial 1080 or station-placed toxins. There are currently no robust tools to measure the residual (post-operation) abundance of stoats and so the effectiveness of stoat control for kōkako is difficult to assess; the most promising monitoring technique currently being developed is camera traps (Smith & Weston 2017; Craig Gillies, unpubl. report, 2023).

Nest success outcomes

The success of nesting attempts has been measured with adequate samples for robust analysis at four sites. The mean percentage of monitored nests fledging at least one young in a season was 20% at Manawahe (2018−19 to 2023−24, n = 19), 30% at Parininihi (2017−18 to 2022−23, n = 87), 59% at Pirongia (2017−18 to 2023−24, n = 71), and 67% at Hunua (2013−14 to 2020−21, n = 67; DB, AR, unpubl. data). The low success rate at Manawahe was not primarily due to predation but to unusually high rates of egg unviability (70% of clutches during a 2014−15 to 2016−17 study). Hypotheses to explain this outcome in this small, isolated population include genetic effects (inbreeding depression) and increasing drying of the forest, leading to poor quantity and quality of key native fruits (Gaye Payze & Ian Flux, unpubl. report, 2017; Ian Flux, unpubl. report, 2021). Nest success at Parininihi was lower than at Pirongia and Hunua and is probably due to less successful pest control at this lower-altitude forest, which may have a higher year-round carrying capacity for ship rats. Mean annual ship rat RTIs were 24% at Parininihi during 2017−18 to 2021−22, cf. 5% at Pirongia and 2% at Hunua.

TRANSLOCATIONS AND POPULATION PRIORITISATION

Kōkako translocations are undertaken both to bolster the genetic diversity and demographic potential of existing relict populations or translocated populations that have few founder individuals, and to establish populations at high-quality new sites and thus help restore the species across its original range.

During 1981 to 2011, kōkako populations were reintroduced at seven sites (Boundary

Stream, Pukaha / Mt Bruce, Ngapukeariki, Puketi, Whirinaki, Waitakere, and Otanewainuku), and birds were added to an eighth site (Hunua) to reinforce numbers and genetic diversity of the relict population there. New sites included three offshore islands (Hauturu 1981, Kapiti 1991, and Tiritiri Matangi 1997). There were unsuccessful attempts to reintroduce the species at Trounson Kauri Park and to establish it on Lady Alice Island (north Auckland) and Secretary Island (Fiordland). Males alone were contentiously placed on Mokoia Island (Lake Rotorua) for tourism advocacy reasons in 2006, and three were still alive in July 2022 (Innes *et al.* 2013; Carmel Richardson and Graeme Young, unpubl. data). In total 286 birds were moved and released in 94 translocations to 16 sites during 1981−2011 (Innes *et al.* 2013).

During September 2012 to February 2024 a further 296 kōkako were translocated, reintroducing the species at five sites (Maungatautari, Parininihi, Pirongia, Pouiatoa, and Waitaanga) and reinforcing existing populations at six others (Puketi, Waitākere, Hunua, Otanewainuku, Manawahe, and Kapiti Island; Table 1, Fig. 1). Over the entire time in which there have been translocations (1981−2022), major sources of birds have been populations at Mangatutu and Waipapa (both Pureora, 91 birds each), Mapara (King Country) and Ōtamatuna (Te Urewera, 60 birds each), Tiritiri Matangi Island (Auckland, 56 birds), Kaharoa (Bay of Plenty, 53 birds), Mataraua (Northland, 31 birds), Hauturu (Hauraki Gulf, 27 birds), Rotoehu (Bay of Plenty, 25 birds), and Tunawaea (Pureora, 15 birds).

Kōkako translocation techniques and procedures

Current best practice techniques for kōkako translocation are collated in Collen *et al.* (2016). This document covers source and destination site selection; the number and composition of birds to transfer; techniques for capturing, processing, holding, transporting and releasing birds; plus recommended destination site pest control and post-release kōkako monitoring. *In situ* management

Table 1. Destination and source sites for all kōkako translocations undertaken from September 2012 to February 2024, in chronological order by the date of first translocation to each site. The table format repeats that of Appendix 1 in Innes *et al.* 2013, which shows all translocations undertaken before September 2012. In column three the total number of kōkako translocated and the number of females (determined by DNA or tarsus length) are given, respectively, in brackets. Mauimua is Lady Alice Island. The Waitākere project is Ark in the Park. Asterisks indicate destination sites that received kōkako to renew lost populations; releases at other sites were reinforcing an existing population. Note that at least 5 birds translocated to Parininihi dispersed *c*. 30 km east to settle at Waitaanga; as of 2024, no kōkako have been translocated directly to Waitaanga.

Destination site	Total kōkako translocated Sep. 2012− Feb. 2024	Source populations and dates
Puketi*	23	Mataraua (10,6), Sep−Oct 2012; Mauimua (1,0), Apr 2013; Hamilton Zoo (2,1), May 2013; Mataraua (3,2), Feb 2014; Mataraua (7,4), Aug−Oct 2014.
Waitākere	31	Mapara (3,1), Sep 2015; Mangatutu (8,3), Aug−Sep 2015; Mangatutu (10,4), May 2016; Mapara (10,4), May 2016.
Hunua	30	Mapara (6,3), Sep 2015; Mangatutu (6,3), Sep−Oct 2015; Mangatutu (7,3), Jun−Oct 2016; Waipapa (11,6), May−Jun 2019.
Maungatautari*	40	Mangatutu (18,11), Sep−Oct 2015; Mangatutu (22,8) Apr−Oct 2016;
Otanewainuku	21	Kaharoa (11,3), Aug 2016; Kaharoa (10,4), Aug 2018.
Parininihi*	45	Tiritiri Matangi Island (20,9), May−Jul 2017; Mangatutu (15,7), Apr−Jun 2018; Waipapa (10,4), Aug−Sep 2018.
Pirongia*	54	Waipapa (20,7), Jun−Aug 2017; Waipapa (10,5), Jun 2018; Tiritiri Matangi Island (14,8), Jul 2018; Waipapa (10,6), Jul 2022.
Pouiatoa*	20	Hauturu (20,5+), Jun−Jul 2018.
Manawahe	12	Kaharoa (6,3), Aug 2019; Rotoehu (6,3), Sep 2021.
Kapiti Island	20	Waipapa (9,4), Jul 2021; Tunawaea (Pureora, 4,2), Jul 2021; Mangatutu (7,4), Jul 2021.

Table 2. Priority rankings for all kōkako populations, as determined by the Kōkako Recovery Group, based on Emily Weiser, unpubl. report, 2015. Higher priority is given to populations that (a) are relict cf. translocated, (b) have >40 founders, and (c) have >2,000ha of potential habitat. Sites in column 3 are ordered based on the smallest known population size (number of individuals) or the number of kōkako that were translocated, which appears in parentheses after the site names.

Priority	Explanation	Sites
1	Relict mainland populations with a minimum bottleneck size of 40 kōkako	Pureora (138), Te Urewera (99), Rotoehu (50), Mapara (48), Mokaihaha (43)
2	Secure, pest-free, offshore and pest-fenced mainland populations	Kapiti Island (53 translocated 1991−2021), Maungatautari (40 translocated 2015−16), Hauturu (32 translocated 1981−1994)
3	Relict mainland populations with a minimum bottleneck size of <40 kōkako	Opuiaki (26), Waimā–Mataraua (25), Kaharoa (22), Manawahe (12, but 12 translocated 2019–2021), Hunua (3, but 63 translocated 2006–2019)
4	Sustained small bottleneck (Waikokopu) or translocated populations with >2,000 ha habitat	Waikokopu (16), Waitākere (53 translocated 2009−2019), Otanewainuku (40 translocated 2010−2018), Parininihi (45 translocated 2017/18), Pirongia (54 translocated 2018−2022), Puketi (29 translocated 2007−2014), Whirinaki (20 translocated 2009), Pouiatoa (20 translocated 2018), Ngapukeariki (19 translocated 2005), Waitaanga (self-established ca 2018)
5	Small, translocated populations with < 2,000 ha available habitat	Boundary Stream Mainland Island (20 translocated 2001−2007), Pukaha / Mt Bruce (16 translocated 2003−2010), Tiritiri Matangi Island (advocacy and harvest site)

of relict populations (Fig. 1) and completing genetic or demographic goals of reintroduction projects that are already underway have often been prioritised by the KRG over attempts to establish new populations at new sites. The KRG considers it vital that source populations are large and genetically diverse enough to sustain harvesting of birds, which primarily demands sustained and effective pest control before and after harvesting. There is also a necessary, parallel, human process to be undertaken with all translocations, to ensure that managers and iwi at both ends of the mooted translocation are supportive.

Population genetics and priorities for sustained management

The KRG accepts that maintaining genetic diversity will increase the likelihood of the long-term persistence of kōkako populations, and thus the taxon. However, demographic, financial, logistical, cultural, and other considerations are also important for population management decision-making. Preliminary modelling suggested that isolated kōkako populations of around 50 pairs will lose allelic diversity through genetic drift and require periodic replenishment with immigrants from other populations, and that populations smaller than 25 pairs should be avoided to minimise inbreeding depression (Ian Jamieson & Danilo Hegg, unpubl. report, 2011).

From 2012 the KRG worked with Dr Emily Weiser (then at Otago University) and the model, Allele Retain (Weiser *et al.* 2012, 2013), to estimate the retention of rare alleles in all populations with and without supplementation of new birds at different rates and times. The model estimated the number of kōkako that could be taken from each source population (without compromising its own viability) to supplement sites requiring further translocations, and the number of founder individuals required to establish new populations to ensure the retention of high proportions (80−90%) of rare alleles (Emily Weiser, unpubl. report 2015).

As a result, the KRG ranked all populations to reflect their relative importance for maximising the probability of long-term persistence of the taxon (Table 2). Higher rankings were given to populations that were relict (original), had a larger and short-duration minimum bottleneck population size (cf. small and long-lasting), and had a large available habitat area and thus a potentially large final population size with management. The modelling enabled the KRG to conclude as practicable guidelines that key factors to increase kōkako population growth rates are a minimum of 36 founders (unrelated kōkako that successfully produce progeny that survive to adulthood) and a maximised population growth rate to a large size (requiring few mammalian predators and abundant, high-quality kōkako food). Greater final population size is also assisted by choosing large release areas, increasing the scale of pest control and enhancing the connectivity of populations that are near each other but currently isolated.

A current requirement of the KRG for new sites is a minimum of 2,000 ha of available native forest habitat (assuming a potential final population of 250 pairs with an 8 ha territory per pair), which exceeds the area available at some past release sites (Table 3). Outcomes at sites <2,000 ha have been variable. Populations are struggling at Manawahe and Pukaha; Kaharoa had 57 pairs in 2022 and site managers are attempting to increase its effective habitat area by establishment of a corridor to Otanewainuku, while pest-free Tiritiri Matangi Island (220 ha) demands ongoing addition and removal of birds to avoid inbreeding. Kōkako are currently managed in only *c*. 12% of the area of contiguous forest available at mainland sites, due to the labour and expense of control of pests, especially ship rats (Table 3).

Table 3. Sizes of kōkako populations at October 2023, listed from north to south. Numbers are from standardised surveys of territorial adults described in unpublished reports to the Kōkako Recovery Group and exclude juveniles and subadults. Note that populations are only surveyed episodically. Hauturu was surveyed by subsampling, whereas all other sites were surveyed by counting territorial adults. 'Pureora' includes Waipapa north and south, Mangatutu, Tunawaea, and Okahukura subpopulations. Mataraua and Waimā are two disjunct sites separated by *c*. 5 km of contiguous native forest, and are treated here as one population but under two management regimes. 'Kōkako added / removed' shows numbers translocated in (+) or out (-) during 1981–2024. 'Managed area' is for ground-based ship rat control, and tends to be smaller than for possums and stoats. 'Total habitat area' is our estimate of podocarp-broadleaved forest area contiguous with the pest-managed site.

Site	No. pairs	No. singles	Total kōkako	Survey year	Kōkako added / removed	Managed area (ha)	Total habitat area (ha)
Puketi	2	5	9	2022	+29	650	15,000
Mataraua– Waimā	9	21	41	2022	-36	1,824	30,000
Hauturu	422	18	862	2013	+32, -27	2,930	2,930
Tiritiri Matangi	23	8	54	2023	+19*, -56	220	220
Waitākere	16	10	42	2021	+53	2,400	20,000
Hunua	229	9	467	2022	+63*	2,000	17,000
Opuiaki	23	8	54	2023	0	1,100	6,500
Otanewainuku	31	7	69	2020	+40	1,200	10,000
Pirongia	16	5	37	2022	+54	1,370	13,500
Manawahe	4	4	12	2023	+12	775	844
Maungatautari	47	7	101	2020	+40	3,300	3,300
Kaharoa	57	10	124	2022	-53	953	705
Rotoehu	231	7	469	2023	-25	1,367	2,000
Ngapukeariki	8	2	18	2023	+19	1,300	8,000
Mokaihaha	71	10	152	2022	0	2,136	2,136
Te Urewera	144	16	304	2015	-60	Unk.	50,000
Waikokopu	8	4	20	2015	0	Unk.	50,000
Pureora	672	21	1365	2020–23	-197	8,750	30,000
Mapara	145	11	301	2022	-60	1,400	1,400
Whirinaki	6	2	14	2021	+20	2,000	10,000
Waitaanga	3	0	6	2023	0	220	20,000
Parininihi	11	6	28	2022	+45	3,650	20,000
Boundary Stream	36	6	78	2021	+20	811	3,000
Pouiatoa	6	4	16	2022	+20	1,000	20,000
Pukaha / Mt Bruce)	15	8	38	2023	+16	942	942
Kapiti Island	91	2	184	2021	+53	2,000	2,000
TOTAL	2327	211	4865			44,298	381,477

*One of the kōkako translocated to Tiritiri Matangi Island and two translocated to Hunua arrived as eggs.

Habitat quality

Habitat quality at potential new sites is now assessed before the KRG will support translocation proposals. This is because abundant good-quality food year-round is a key factor determining how many nesting attempts kōkako make (Flux *et al.* 2006; Innes *et al.* 2010). In this assessment process, developed by IF, the abundance of 10 key food plants – pigeonwood (*Hedycarya arborea*), karamū (*Coprosma lucida*), kanono (*Coprosma autumnalis*), rewarewa (*Knightia excelsa*), māpou (*Myrsine australis*), toro (*Myrsine salicina*), bush lawyer (*Rubus cissoides*), wineberry (*Aristotelia serrata*), puka (*Meryta sinclairii*), and fuchsia (*Fuchsia excorticata*) – over 2 m tall is counted by a stationary observer through a 360°degree view at five points, 50 m apart, along 8–10 200 m transects with random start-points (Ian Flux, unpubl. report, 2014). Pigeonwood/porokaiwhiri is a particularly important food of nesting and nestling kōkako and grows throughout their historical range, and so its presence is given extra weighting in scoring and assessing sites.

Potential new kōkako sites are regarded as having acceptable habitat when (with at least eight transects) the mean number of key food plants exceeds five per transect; the mean total food plants per transect less one standard deviation exceeds 50; and pigeonwood is seen in ≥30% of transects and has a mean score of >10 plants per transect. The procedure was first calibrated in the most productive relict kōkako habitats at Mapara, Te Urewera and Rotoehu in 2014. The baseline thus established was subsequently used to assess and compare the relative diversity of key kōkako food-plants within ten proposed kōkako sites. No subsequent site, yet assessed, has shown an equal or higher diversity score; however, several sites assessed as having diversity close to baseline scores now have increasing kōkako populations. Conversely, the two sites ranked lowest for diversity are both struggling to maintain kōkako.

SURVEYS AND POPULATION TOTALS

Kōkako populations are monitored to determine the number of translocated birds that form pairs in breeding seasons after release and so are likely to be genetic founders, and to estimate population growth rates. The KRG assumes that if 40 unrelated kōkako establish territories, then at least 36 of these will survive and may become genetic founders, based on adult annual survival being 90%, from previous studies on banded birds (Basse *et al.* 2003, Sinclair *et al.* 2006). Detailed monitoring to verify that birds breed and that their offspring also contribute genetic material to future generations is very expensive.

Currently the KRG recommends that there be annual kōkako censuses for each population until 25 territorial pairs have established, followed by a survey each 4 years until 50 pairs are confirmed. Survey and monitoring techniques and their possible pitfalls are described in detail by Flux *et al.* 2019. Experienced observers are required. Most censuses are counts of all territorial adults undertaken during April–October (outside the breeding season). Other kinds of surveys focus on juveniles when they are still with their parents after fledging, and include 'roll calls' in which a sample of territorial birds is rapidly mapped before and after aerial poisoning operations, to estimate their survival (Veltman & Westbrooke 2011).

A fourth survey type is the subsampling of very large populations. This method is a response to the prohibitive scale and expense of counting all territorial adults in very large (>100 pairs) populations (Ian Flux *et al.*, unpubl. report, 2013). The first trial survey used four observers to count kōkako within five 100 ha circular plots selected inside stratified vegetation maps on Hauturu (2,930 ha). On average, 38 person-hours were required for observers to satisfactorily resolve the number of territorial pairs present in each plot. Mean density was 14.4 (*sd* 3.13, *se* 1.56) pair territories per 100 ha, resulting in a population estimate of 422 +/- 115 pairs. The subsampling method was compared with a standard full census at Mapara. In the North Block the standard method took 10 person-days and yielded 22 pairs; the subsample method took 1.5 person-days and estimated 21 pairs. In the South Block, the standard method took 38 person-days and yielded 52 pairs; the subsample method took 11.5 person-days and estimated 77 pairs.

Most recent tallies of adult kōkako numbers at all current sites are shown in Table 3. The magnitudes of errors associated with the counts are unknown.

National population changes through time

It is difficult to determine annual growth rates accurately at most sites because censuses are undertaken only episodically and there are just three (of 26) sites where birds have not been either added or removed by translocation during 1981–2024 (Table 3). However, the national total of territorial pairs has increased steadily (mean rate of increase 7% p.a.), from 458 in 2000 to 2,316 in 2023 (Fig. 2).

The proportion of the national total number of kōkako that is in populations derived from translocations has increased from 24% (109/458) in 2000 to 33% (798/2384) in 2023. The annual contributions of Hauturu to this calculation are calculated on a single survey there in 2013. The total population in relict sites that have received no translocations has increased from 339 pairs in 2000 to 1,586 pairs in 2023, during which time 385 birds were removed from them for translocation. In this same period, the total number of populations

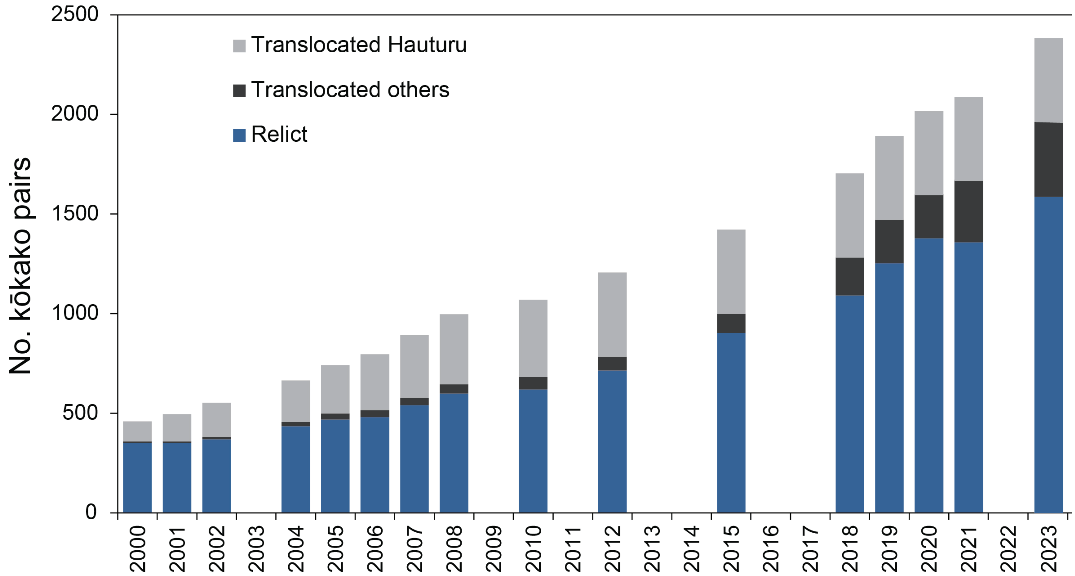

Figure 2. Total numbers of territorial kōkako pairs in translocated (Hauturu and others) and relict populations during 2000–2023. Note that the population on Hauturu has only been surveyed once (in 2013). Numbers at Hauturu are apportioned to previous years assuming a constant growth rate from founder birds and are kept at 422 pairs in years after 2013, on the assumption that the population is at carrying capacity. Populations at all other sites came from repeated field counts. Year gaps reflect episodic censuses of key populations.

increased from 15 to 26 and the number of sites with more than 25 pairs increased from 5 to 16 (regarding the four subpopulations at Pureora as separate, as they were in 2000).

Most sites founded with translocations of 16–54 kōkako each (Otanewainuku, Boundary Stream, Pukaha / Mt Bruce, and Kapiti Island) took 11–17 years to reach 20 territorial pairs, and Pukaha / Mt Bruce at last survey (2023) had declined to 15 pairs. Populations at four early release sites (Ngapukeariki from 2005, Puketi from 2007, and Waitākere and Whirinaki from 2009) and two more recent ones (Parininihi from 2017 and Pouiatoa from 2018) had not yet reached 20 pairs by 2023. The unfenced Pirongia population reached 20+ pairs in 7 years, and the pest-fenced, mammal-free (except for mice, *Mus musculus*) Maungatautari site achieved this milestone (in fact 47 pairs) in just 6 years, and so it has been the fastest growing of all known translocated populations.

Kōkako conservation status

At the beginning of the 1999–2009 Recovery Plan (Innes & Flux 1999) kōkako were classified 'endangered' (20% chance of extinction in 20 years; severe fragmentation; no population >250) on the IUCN Red List (Collar *et al.* 1994). In 2002 DOC classified them as Nationally Endangered, with qualifiers CD (conservation dependant), HI (human-induced loss of range), and RF (recruitment failure; Hitchmough 2002).

In July 2022 the species was reclassified as 'least concern' by the IUCN because, while the national population is small and still heavily dependent on conservation management, the population trend is steadily increasing (BirdLife International 2022). Current classification by DOC is 'Threatened – nationally increasing', the lowest rank of 'Threatened', with qualifiers CD, Inc (increasing) and PF (population fragmentation; Robertson *et al.* 2021).

Several very recent kōkako census results (at Mataraua, Waitākere, Pukaha, Kaharoa, Mangatutu, Tunawaea, and Mapara) have shown population declines, causes of which are not yet clearly understood.

KŌKAKO RESEARCH

Research before 2000

Pioneering research during 1978–1984 that studied kōkako demography, diet, and use of forest habitat at Pureora (central North Island podocarp forest; Rod Hay, unpubl. report, 1981; John Leathwick, unpubl. report, 1981) and Puketi (Northland kauri forest; Powlesland 1987; Best & Bellingham 1991) was prompted by controversy over the logging of indigenous forest (King *et al.* 2015). These studies (from the central North Island, summarised in

Hay *et al.* 1985) revealed poor nesting success and demonstrated diet overlap between kōkako and possums (Leathwick *et al.* 1983; Fitzgerald 1984). These findings significantly shaped subsequent research and remain highly relevant to current kōkako management.

Separate studies during 1986–2006 assessed kōkako survival through aerial 1080 operations aimed at managing bovine tuberculosis at Pureora, using both cereal and carrot baits. Following initial studies with non-toxic baits and surveys to locate suitable birds, the team followed selected territory-mapped kōkako before and after aerial operations to assess their survival. Numerous unpublished reports to the then Forest Research Institute (NZ Forest Service, Rotorua) and to DOC (Te Kuiti) reported that few if any kōkako died of poisoning.

Participants at the June 1988 national kōkako workshop at Rotorua concluded that priority research for kōkako was to "determine whether predator, and browsing mammal competitor, population control will increase kōkako populations" (Innes *et al.* 1988). This was duly explored during 1989–97 by a demonstration of positive kōkako responses to pest control turned on and off at Mapara, Kaharoa, and Rotoehu (Innes *et al.* 1999). The research derived target residual abundances for ship rats and possums that are implemented for kōkako recovery to the present day.

Research 2000–2023

Accounts of previously derived knowledge that were published from 2000 onwards cover population genetics (Double & Murphy 2000; Hudson *et al.* 2000), field sex determination (Flux & Innes 2001), breeding biology (Flux *et al.* 2006), general biology (Higgins *et al.* 2006), translocations (Innes *et al.* 2013), and integration of kōkako data into reviews of forest bird mortality during aerial 1080 operations (Veltman & Westbrooke 2011; Veltman *et al.* 2014). Three papers used data from the 1989–1997 research to make further advances, showing that at least 3 years of effective pest control in each 10 should be enough to maintain kōkako populations (Basse *et al.* 2003) and that simultaneous control of ship rats and possums is required to maximise pest control benefit (Ramsey & Veltman 2005; Sinclair *et al.* 2006).

Four studies of kōkako evolutionary history and phylogeography confirmed and explored the bird's ancient lineage. The ancestors of the Callaeidae probably arrived via transoceanic dispersal after New Zealand had split from Gondwana (Ewen *et al.* 2006; Murphy *et al.* 2006; Shepherd & Lambert 2007; Lubbe *et al.* 2022). A study of historical kōkako distribution showed that they were widespread until 1950, but records suggested "a meaningful gap in its distribution that includes the Ruahine Range" (Salvador *et al.* 2019).

The mixing of kōkako from different source sites to establish genetically diverse founder populations during translocations also mixes birds that have different song dialects. Research at five sites showed that while translocated kōkako initially preferentially selected mates from the same area of origin, both they and the next generation of birds learned new song syllables from neighbours, so that assortative mating based on dialect was not a long-term impediment to population mixing (Rowe 2001; Bradley *et al.* 2013; Valderrama *et al.* 2012, 2013). Trials at the Ngapukeariki and Whirinaki translocation sites to see if 'acoustic anchoring' (broadcasting kōkako song over several weeks at the release site) would stop birds moving away from the release and pest control area showed that released birds were attracted to the playback, but it did not unequivocally demonstrate anchoring (Molles *et al.* 2008; Bradley *et al.* 2012).

KŌKAKO RECOVERY GROUP AND IWI ROLES

The KRG comprises seven people who give expert advice to DOC, but it cannot make decisions for the Department. In practice the two rarely disagree. DOC's terms of reference for the KRG are that it will provide advice, prepare recovery strategies, engage with iwi, inform decision makers and "where necessary undertake technical reviews and quality assurance of population management prescriptions". In reality the KRG has inadequate funding to fulfil all these roles. A new (third) recovery plan was completed and submitted in 2017; however, DOC stopped publication because it was revising iwi consultation processes. Seven years later no new process has emerged, and so the KRG is largely using the submitted plan anyway, retitled 'Priorities for kōkako conservation'.

Under this plan (p. 17), current long-term recovery goals are to:

1. Improve [North Island kokako] status to 'Not threatened' under the New Zealand Threat Classification System by restoring the national population to 20,000 mature individuals by 2035, and

2. Restore the species as a naturally functioning component of forest ecosystems across at least 10% of North Island forest area containing kōkako habitat (cf. <1% in 2004), including at least three populations in each local government region, by 2035.

The KRG has held annual meetings attended by many stakeholders since about 1990 and considers that free and open exchanges between all participants have been key to the programme's success. Since 2016 each site has been asked to supply a standard annual report that describes objectives, kōkako survey and pest control data, and future plans. The KRG spends most time listening to project leaders about outcomes and giving diverse advice, and also advises community groups and DOC about the suitability of potential new sites to receive kōkako. This latter function includes assessing habitat quality and deciding the best source sites for birds to be harvested, should translocations be approved.

The KRG facilitated several key practical documents, especially manuals of 'Kōkako standard management techniques' (Flux *et al.* 2019), translocation techniques (Collen *et al.* 2016), and captive husbandry (Rosemary Vander Lee & Ian Fraser, unpubl. report, 2011), although the species is no longer held for captive breeding. Kay Milton, from Supporters of Tiritiri Matangi Inc., wrote an advocacy guide for the species (Kay Milton, unpubl. report, 2015) because pest-free Tiritiri Matangi Island has many visitors and fulfils an important advocacy role for the national recovery programme. Most of the significant mainland sites for kōkako still have no or very outdated advocacy signage.

Iwi now have active roles in most kōkako conservation sites. Three sites (Ngapukeariki, Te Urewera, and Parininihi) are iwi-led, and iwi consultation and permissions are required at both ends of any planned translocation. Ngāti Rereahu and Tūhoe have been especially generous in allowing many kōkako to leave Pureora and Te Urewera respectively for translocation elsewhere. Management of the Te Urewera population was fully returned to Ngāi Tūhoe post-Treaty settlement entities in 2016; however, the KRG has not been provided with information about pest control methods or kōkako outcomes in this key relict population since. The important field base hut at Ōtamatuna burnt down in 2022, which will make it more difficult to undertake ground-based conservation management. Kōkako abundance has not been surveyed there since 2015 (Table 3).

DISCUSSION

Populations

Research and management arrived just in time to save kōkako as a moderately widespread species in North Island mainland forest ecosystems. These birds were, and remain, not as vulnerable to predators as the smaller, hole-nesting North Island saddleback (*Philesturnus rufusater*) and hihi (*Notiomystis cincta*), which both disappeared from the North Island in the late 1800s.

However, the last surviving individuals of numerous relict kōkako populations (e.g. Coromandel, Great Barrier Island [Aotea Island], Pirongia and vicinity, Maungatautari, Karakariki, Tihoi, and Wanganui) disappeared entirely during 1970−1995 before factors causing their decline were understood. During 2000−2023 further relict populations have been lost at Puketi (Northland), at Otanewainuku (Bay of Plenty), and at Moki, Makino, and probably Waitaanga (Taranaki). All current populations (although unknown for Te Urewera) are now pest-managed, and the long-term survival of the taxon requires effective, ongoing pest management. Since 2000, eleven populations have been re-established by translocation (at, in chronological order, Boundary Stream, Pukaha / Mt Bruce, Ngapukeariki, Puketi, Whirinaki, Waitākere, Otanewainuku, Maungatautari, Parininihi, Pirongia, and Pouiatoa); a twelfth population self-established when birds translocated to Parininihi dispersed 30 km east to Waitaanga. New populations were typically established using founders taken from the relict populations at a select few source sites, principally Mangatutu and Waipapa (Pureora), Mapara (King Country), and Ōtamatuna (Te Urewera).

The national population has grown steadily since 2000; however, at half the rate (7% p.a.) estimated from data collected on the Mapara population during 1992−2000 (14.9%; Basse *et al.* 2003; Sinclair *et al.* 2006). The reason for this slower rate is unknown and requires research. Some populations (e.g. Puketi, Waimā, Mataraua, Manawahe, Kaharoa, and Pukaha / Mt Bruce) have declined in some years, and others (e.g. Waitākere, Ngapukeariki, Whirinaki) have been slow to grow. However, initial slow growth of translocated populations has been typical, except at pest-free Maungatautari. Inadequate pest control and other habitat variation probably explains slow population growth at most sites. The impacts of stoats and harriers as predators are less well understood than the impacts of ship rats and possums.

Kōkako are abundant on both Hauturu (estimated 422 pairs in 2013) and Kapiti (91 pairs) Islands, and so these two sites have now fulfilled the goal of pest-free safe sites for the taxon. Growth rates at pest-fenced Maungatautari are high, and it is unfortunate that no other large (2,000+ ha) mainland sites are currently destined for fence construction, although a possible Wainuiomata site has been proposed (Jim Lynch, unpubl. report, 2021). The population on Hauturu is probably at carrying capacity. During the survey there in 2013 observers noted that the smallest territory size was 5.8 ha (mean 6.6 ha) and that few juveniles or subadults were sighted; perhaps this reflects a demographic response to the high density. Better understanding and recognition of where and when density-dependent negative feedback produces a declining rate of increase in mainland populations is required (Sinclair *et al.* 2006).

Tiritiri Matangi Island is a valuable and productive kōkako site despite its low prioritisation

(Table 2) and limited habitat. It was used during 1997–2017 to accumulate genes of captured Taranaki kōkako until birds with these genes could be returned by translocation to a pest-managed site (Parininihi). The constant risk of inbreeding at such a small (220 ha) site demands steady removal and replacement of birds. Sites receiving birds from Tiritiri Matangi have been Mokoia Island, Hunua, Waitākere, Parininihi, and Pirongia. Tiritiri Matangi receives 20,000 visitors annually; this, and the generally low vegetation and high density of kōkako, means that it is an important advocacy site for the species, including its status at other sites.

Reintroducing populations at new sites by translocation spreads the load of pest management to more people, and in a small way helps restore ecological integrity (Lee *et al.* 2005) and some original ecological processes to the native forests concerned. However, national population persistence, including retention of rare alleles, is best assisted by maintaining rapid growth and attaining large population sizes in a few key relict populations, especially Pureora, Te Urewera, Rotoehu, Mapara, and Mokaihaha (Table 2). For diverse reasons, management at these prioritised populations can always falter; pests were controlled at DOC-managed Mapara in only half of the last 20 years, and kōkako numbers and the animal pest management pest control in Te Urewera have not been reported since 2015. Translocated populations can contain only a part of the genetic diversity of the relict populations that they were harvested from. Population stages after release are establishment, growth, regulation and persistence (Seddon 1999). The single most important management action required to protect kōkako in the future is effective pest control to maximise population growth at all sites until carrying capacity is reached, but especially in key relict populations such as Pureora, Hunua, and Rotoehu, which have already attained high numbers (>200 pairs each).

New surveys of the large Hauturu and Te Urewera populations are also now urgently needed to maintain an accurate assessment of the size and conservation status of the national kōkako population.

Pest control

Mainland kōkako populations at unfenced sites are limited by the area over which there is pest control rather than the area of available forest (Table 3). Sustaining low numbers of ship rats, possums, and stoats for the November-to-February breeding period year after year is technically and physically hard work, especially for community groups and iwi that have to apply for funding for materials for their work, then supply labour unpaid and in their own time. There are diverse and sometimes conflicting sources of advice about the best control methods, and currently there is little accessible, objective evaluation and collation of new control methods by any agency, which is what community groups need. Resources of the National Pest Control Agencies (Bionet.NZ) cover many pests, but not ship rats; some guidelines are available from DOC and the Predator Free NZ Trust; however, pest control is complex and sites vary. The DOC database 'Pestlink', which previously collated results from many DOC operations, is currently not maintained apart from in relation to aerial 1080 operations.

Of the three main target taxa, possums are easiest to control and slowest to reinvade, while both ship rats and stoats are hard to control, for different reasons. Ship rats are very abundant year-round in 'warm' North Island forests in which kōkako prefer to live (Walker *et al.* 2019) and reinvade rapidly during and after control operations, including by aerial 1080 (Griffiths & Barron 2016; Carpenter *et al.* 2023). Their dense populations demand that control devices be placed quite close together, preferably 75x75 m or 50x100 m, which in turn demands large track networks, often in steep terrain, that must be maintained.

The absence of effective tools to monitor stoat populations has meant that the effectiveness of stoat control could not be cost-effectively examined; hopefully camera traps will improve this. Stoats have large home ranges (40–65 ha in North Island podocarp forests; King & Veale 2021), and so traps can be widely spaced; however, many stoats are known to avoid traps when alternative food is abundant, and some are so innately cautious as to be effectively untrappable (Johnstone *et al*. 2024). Stoats may also reinvade from well outside a kōkako management block or spend little time inside the block. Little wonder that aerial 1080 is preferred by many community groups as a 'year off' from intensive ground-based pest control, because it typically controls all three target mammals to near-zero abundance (Byrom *et al.* 2016; Robertson *et al.* 2019). However, all three target species reinvade rapidly and aerial 1080 is too expensive to apply annually everywhere.

Surprisingly, the launch of Predator Free New Zealand as a conservation vision in 2016 and the concomitant establishment of ca 20 landscape-scale projects (mean area *c.* 43,000 ha; Predator Free 2050 2021) has not so far made managing kōkako blocks (with mean area of ship rat control *c.* 1,846 ha) any easier. This is partly because the only large-scale ship rat control tool being trialled is aerial 1080 (O'Malley *et al*. 2022), which is already a known tool for kōkako managers.

Our results suggest that aerial 1080 achieves lower residual abundances of ship rats and possums than bait stations or trapping, and it also kills stoats (Murphy *et al.* 1999), all on large scales and at *c.* 20% of the per-hectare cost of ground operations (Parliamentary Commissioner for the Environment 2011). However, ship rats recover rapidly and frequently become temporarily more abundant 1–3 years after a 1080 operation (Sweetapple & Nugent 2007). Aerial 1080 applications have been implemented in eleven kōkako sites: Mapara, Mokaihaha, Ngapukeariki, Parininihi, Pouiatoa, Pukaha / Mt Bruce, Pureora, Rotoehu, Mataraua, Waitaanga and Whirinaki. Ongoing use of aerial 1080 over large areas is required to maximise the cost-effectiveness of kōkako recovery.

Need for research

DOC recovery groups have no ready access to research funding and the KRG has not facilitated any substantial field research for 20 years. Universities and museum staff obtained funds to study song and phylogeny, respectively, but no substantial ecological research about limiting factors (especially predation and food supply) has been undertaken since initial kōkako research ended in 1997. The detailed 1978–1984 studies on habitat use (Leathwick *et al.* 1983; Hay *et al.* 1985; Best & Bellingham 1991) are again relevant to current kōkako management because of the declining control of browsing ungulates in recent years (Leathwick & Byrom 2023). Numbers of ungulates and other browsers such as wallabies are therefore increasing at many kōkako sites, with little-understood repercussions for the diverse leaves and fruits that are probably responsible for the episodic big breeding years that periodically boost kōkako numbers (Flux *et al.* 2006). The impacts of stoats on kōkako populations remain little understood. Finally, further study of Hauturu and some dense mainland populations would be valuable to learn more about kōkako demography at sites at carrying capacity.

The future

Kōkako management is characterised by diverse collaborations between community groups, iwi, and agencies, including regional councils, and Ngā Whenua Rāhui and operations staff of DOC. Relationships between community groups and DOC vary from site to site. Previously available community-allocated funding ceased in 2017, coinciding with new major national programmes such as Jobs for Nature and Predator Free 2050 Ltd which prioritised employment and predator control, respectively, rather than biodiversity improvement. Some community groups complain that DOC has lost many employees with substantial experience, knowledge, and skills relating to pest control. DOC has stopped deriving 'best practice' pest control methods from its Pestlink database. One view given is that 'DOC is reliant on communities to do their work and then make[s] it very hard to do it' (G. Young, Kaharoa Kōkako Trust, pers. comm.).

However, DOC now undertakes much more aerial 1080 pest control via the National Predator Control Programme than 15 years ago, partly because OSPRI (formerly the Animal Health Board) has eradicated bovine tuberculosis from many areas and so does fewer aerial 1080 operations than it used to. Also, the Department has *c.* 4,000 threatened species requiring management and a limited budget, and DOC staff themselves have more paperwork associated with projects than 15 years ago, due, for example, to the Health and Safety at Work Act 2015.

Research into kōkako ecology, pest control methods and outcomes is needed, but funds are inevitably scarce for this when DOC is obliged to manage many species that are more threatened and require more urgent management. Kōkako recovery has not had an updated formal recovery plan for 7 years, and pest management at some key relict sites (e.g. Opuiaki, Mapara, and Waipapa) has been haphazard. The loss of the support hut at the former Ōtamatuna mainland island (Te Urewera) and extensive treefall along pest control lines at Waipapa after Cyclone Gabrielle in 2023 are reminders that in remote areas where ground-based work is required, under-investment in infrastructure (e.g. huts, tracks, bait lines, bait stations, traps) increases the risk that conservation targets won't be achieved.

Increased iwi involvement is a significant and welcome recent trend in kōkako conservation; however, this demands substantial reciprocal learning and exchange between iwi and kōkako managers. With such open collaboration, we believe that further iwi engagement in kōkako restoration offers huge mutual benefit, but it will clearly take time to become effective at all sites.

New, cost-effective, large-scale pest (predator and browser) control tools are needed to take the strain off community groups. Rapid kōkako population growth at Maungatautari has shown what is possible at sites free of all pests, including deer, pigs, and goats. The Predator Free 2050 initiative (Department of Conservation 2021) may yield this in time; however, no significant new tools have been developed so far.

Vegetated corridors that dispersing kōkako will use are being implemented to connect some currently isolated populations (especially Kaharoa–Otanewainuku) and are possible at others (Mapara–Pureora and Rotoehu–Manawahe). This should increase the effective population size at these sites.

The kōkako programme is widely viewed as successful (King 2023); however, we should not be complacent. Climate change may reduce the future availability and quality of forest tree fruit, a key kōkako food (Yukich Clendon *et al.* 2023), increase baseline pest densities, and increase the likelihood of novel pathogens establishing in kōkako habitats.

The Waimā–Mataraua (Northland) kōkako population declined from 68 pairs in 2018 to 10 pairs in 2023, despite ship rat and possum control targets being met, and stoats being trapped; we do not understand why. Declines were also revealed in the latest surveys at Waitākere, Kaharoa, Mapara, and Pukaha / Mt Bruce, and in very recent (2024) surveys at Pureora (DB, AR, unpubl. data), while the nationally significant populations in Te Urewera and on Hauturu have not been surveyed for a decade.

A current short-term recovery goal of 3,000 pairs by 2025 is certainly unachievable, and in fact a national population decline at next collation now seems possible.

The quality and quantity of pest management need to be improved and community groups need more institutional support. Twenty years after timely research that successfully paved this taxon's path towards recovery, more research is now badly needed if long-term recovery goals are to be achieved.

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