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Reconstructing avian biodiversity on Maungatautari

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Abstract The Maungatautari Ecological Island Trust (MEIT) was established in 2001. In 2006 the ~3,400 ha forested mountain of Maungatautari was protected by a ~47 km pest fence, and most introduced mammals within the fence have since been eradicated. Since then, 7 locally extinct indigenous bird species have been translocated to Maungatautari, one other has self-reintroduced, and many more avian translocations are planned. There are now 20 indigenous forest bird species present (from 12 at the project's commencement) and the total is expected to eventually exceed 30 species, many of which will be threatened species. Those avian species will be part of a functioning ecosystem that is likely to include at least 50 indigenous vertebrate species (birds, bats, lizards, tuatara, frogs and fish). The avian translocations and the restoration outcome monitoring programmes are described, and some characteristics and values of the project are discussed.

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INTRODUCTION

New Zealand's biota and ecosystems have been seriously impacted by human-mediated invasions of exotic species for ~800 years. This, together with human-induced habitat loss and direct predation by humans, has resulted in the extinction of almost half of the New Zealand avifauna (Holdaway 1989). Many remaining species only survive on offshore island refuges or protected mainland sites. The early impact of European contact on indigenous species was recorded on one of Cook's voyages, with the ship's naturalist noting the havoc caused by a cat among the local bird populations (Forster 1777, cited in Gillies & Fitzgerald 2005). Efforts to mitigate this impact occurred quite early with Richard Henry's translocations of many kiwi (*Apteryx* spp.) and kakapo (*Strigops habroptilus*) in the 1890s from the Fiordland mainland to Resolution I, which ultimately failed due to the invasion of the island by stoats (*Mustela erminea*) (Hill & Hill 1987). The New Zealand Wildlife Service (subsequently part of the Department of Conservation; DOC) adopted translocations for species management in the 1960s with an initial focus on marooning endangered species on pest-free islands. Improved pest-mammal management technologies enabled pest eradications to be achieved, first on offshore islands and more recently at mainland sites with subsequent increased opportunities for translocations (Parker 2013). A conservation ethic has become a significant part of the New Zealand culture, and this is reflected in the growth and participation of community-based conservation groups taking an active role in

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protecting and restoring New Zealand species and ecosystems (Parker 2008; Parker 2013).

Mainland ecological restoration provides a different set of challenges to those faced on offshore islands. For example, some translocated animals might more readily disperse from some mainland sites, and there might also be greater potential for reinvasion by some introduced predators at some mainland sites. To address the latter, relatively intensive pest monitoring can be especially important at mainland restoration sites (compared to offshore islands) and this greater effort can enable more rapid detection of and response to incursions than on most offshore islands. Greater accessibility can make this increased effort more achievable at mainland sites.

The initial focus for mainland restoration was intensive poisoning and/or trapping, to control particular introduced predators in particular areas (Saunders & Norton 2001). The establishment of the pest-fenced 225 ha Karori/Zealandia Sanctuary in 1995 (Empson & Fastier 2013) introduced a new technique for mainland ecological restoration. The logic behind pest-fenced mainland reserves has been questioned (Scofield *et al*. 2011) but the technique has been adopted at Maungatautari and a number of other sites around New Zealand (Burns *et al*. 2012; Day & MacGibbon 2007).

Here we describe ecological restoration at Maungatautari, avian translocations to Maungatautari from 2005 to 2012, future avian translocation candidates and the restoration outcome monitoring programme. Non-avian translocations (4 species so far) are not covered here. We also briefly discuss some of the challenges and successes associated with this comparatively large-scale community-based restoration project, and some current and future values.

THE RESTORATION PROJECT

Site description

Maungatautari is a forest-covered extinct volcano rising to 797 m ASL in the central Waikato (38°01′00″S 175°34′00″E). It is bound to the east and north by the Waikato River and Lake Karapiro (formed by a hydroelectric power dam on the river). The townships of Cambridge, Te Awamutu and Putaruru lie within 20 kms of Maungatautari – and Hamilton, Morrinsville, Matamata, Tokoroa and Otorohanga lie within 40 km. The mountain and its forested slopes are a dominant landform in the area.

The topography ranges from strongly rolling slopes at the base of the mountain to steep and very steep slopes near the peaks and in the gullies. Maungatautari soils (a mix of yellow-brown silt and clay loams and stony red-brown clay loams) are relatively unstable on steeper slopes or on disturbed land. Average rainfall is between 1,400 and 1,600 mm, compared to 1,100 to 1,200 mm on the surrounding flats. All of the streams arising on Maungatautari flow into the Waikato River system. The streams have high water quality where they leave the forest (MacGibbon 2001).

The total area of mature or regenerating native forest on Maungatautari is 3,363 ha (MacGibbon 2001) and ~75% of it has Scenic Reserve status, with control and management vested in the Waipa District Council which has a Memorandum of Understanding with the Maungatautari Ecological Island Trust (MEIT) for management functions. The remaining land is owned by adjoining farmers, iwi and Waipa District Council. In Dec 2012 a Deed of Settlement was signed between Ngati Koroki Kahukura and the Crown, which provides for the Maungatautari Mountain Scenic Reserve to be owned by *te hapori o Maungatautari* (the Maungatautari community). The transfer of ownership was to recognise the strong association that iwi (Maori) and others in the community have with Maungatautari. The Waipa District Council will continue to administer the Scenic Reserve under the Reserves Act 1977. The mountain is within the Maungatautari Ecological District, which is within the Waikato Ecological Region.

The forest

The forest remained relatively intact throughout the period of human occupation, and few plant species are thought to have become locally extinct following human colonisation. While most of the indigenous forest in the surrounding Waikato basin was cleared for agriculture, the upper portion of Maungatautari forest was left largely unscathed. Consequently, the canopy today is considered representative of its previous natural state. Timber, particularly rimu (*Dacrydium cupressinum*) and to a lesser extent tawa (*Beilschmiedia tawa*), has been extracted from parts of the lower slopes. Totara (*Podocarpus totara*) was also taken for farm fencing, and northern rata (*Metrosideros robusta*) and other species for firewood (T. Tauroa, *pers. comm.*).

The forest on Maungatautari comprises a typical Waikato altitudinal forest sequence from tawa forest at low altitude to tawari (*Ixerba brexioides*) at high altitude (Clarkson & Boase 1986). It is broadly classified as central North Island podocarp/broadleaf forest with several altitudinal zones of plant associations, including an uppermost zone with relatively low forest canopy and some exposed rock with only herbaceous vegetation in places. The higher parts have been termed ‘cloud forest’ with arboreal mosses and other plants requiring high humidity. The bush-line extends down to 300 m ASL around much of the mountain, but it is somewhat higher in places on some northern and eastern slopes where farmland has encroached

further up the mountain. Maungatautari is one of only 2 remaining extensive areas of indigenous forest in the central Waikato basin.

Indigenous forest birds present in 2000

By 2000 there were 12 remaining indigenous forest bird species known to be either breeding on the mountain or including it as a significant part of their home range, and 3 indigenous waterfowl species also bred in the forest edge (Appendix 1). North Island kaka (*Nestor meridionalis septentrionalis*), New Zealand falcon (*Falco novaeseelandiae*) and long-tailed cuckoo (*Eudynamys taitensis*) were occasionally recorded. Whitehead (*Mohua albicilla*) and North Island kokako (*Callaeas wilsoni*) were last recorded on Maungatautari in the 1980s (B. Seddon, P. Quin & B. Garland, *pers. comm*.). It is not known when other bird species became locally extinct.

Introduced mammals

Introduced mammalian pests generally arrived later on Maungatautari than in many other places, probably due to its relative isolation, *e.g.* the first known possum (*Trichosurus vulpecula*) record was in 1958 (MacGibbon 2001). The species known to be present in 2000 were red deer (*Cervus elaphus scoticus*), pigs (*Sus scrofa*), goats (*Capra hircus*), possums, cats (*Felis catus*), hedgehogs (*Erinaceus europaeus*), stoats, ship rats (*Rattus rattus*), house mice (*Mus musculus*), rabbits (*Oryctolagus cuniculus*) and hares (*Lepus europaeus*). Ferrets (*Mustela furo*), weasels (*Mustela nivalis*) and Norway rats (*R. norvegicus*) were also assumed to be present (Speedy *et al*. 2007). Farm stock were also present on some lower slopes and feral dogs (*Canis familiaris*) were probably present at times. Kiore (Polynesian rat; *R. exulans*) and possibly kuri (Polynesian dog) would have been present for several hundred years prior to European arrival. Aerial drops of 1080 poisoned baits for possum control were undertaken in 1997 and 2002 to control bovine tuberculosis, and ferret control has been undertaken for the same reason.

Ecological restoration

The current Maungatautari restoration project has been driven by members of the local community. There were good ecological reasons for restoring the site, including the diverse and relatively intact forest, the relatively large size and compact shape of the remnant, and the lack of adjoining forest habitat (which might enable some translocated species to disperse beyond the protected area), *i.e.,* Maungatautari is an island of native forest in a sea of exotic farmland. MEIT was formed in 2001, with the vision '*To remove forever, introduced mammalian pests and predators from Maungatautari, and restore to the forest a healthy diversity of indigenous plants and animals not seen in our lifetime*'. In 2011 a subsidiary vision '*To share the restored ecosystem on Maungatautari*' was adopted as part of a strategic planning exercise. Local iwi have supported the Maungatautari restoration project since its inception, and the project continues to run in partnership with the wider Maungatautari community and iwi.

In 2004 an Xcluder® pest fence was constructed around 2 separate blocks on the mountain totalling ~100 ha and all mammalian pests were eradicated from both of these sub-exclosures, primarily with aerial poisoning operations using brodifacoum in cereal baits. These sub-exclosures were intended to test fence effectiveness and pest-eradication techniques and to enable initial reintroductions of North Island brown kiwi (*Apteryx mantelli*) in 2005 and takahe (*Porphyrio hochstetteri*) in 2006. Both the fence and the eradication proved effective, and the 2 bird species were successfully translocated.

In 2006 the entire mountain was encircled with ~47 km of pest fence, to protect ~3,400 ha (including 2 additional small sub-exclosures totalling ~18 ha). All mammalian pests except mice, rabbits and hares were subsequently eradicated within the fence, using aerially-applied brodifacoum baits with follow-up ground hunting (Day & MacGibbon 2007; Speedy *et al.* 2007). The last individual rabbits and hares are currently being targeted and success is anticipated. Comprehensive monitoring, breach-response and incursion-response programmes have been established to maintain the pest status, and an electronic surveillance system enables immediate responses to fence damage (Day & MacGibbon 2007; Burns *et al.* 2912). Attempts to eradicate mice continued until 2011 by which time it was apparent that current techniques and/or resources were inadequate to achieve this goal on the main mountain block. Mouse control then ceased on the main mountain with the exception of the fenced perimeter, where control continued to reduce mouse burrowing pressure from the inside out (which might allow other pests to enter from outside) and to facilitate the management of invasion by other pests (by preventing mice from overwhelming control and monitoring devices inside the fenced boundary). MEIT termed this fenceline-only control the 'wall of death' control technique. Subsequent monitoring data suggested that those risks from high mouse density immediately inside the fence were less than expected, and the 'wall of death' technique has been discontinued for a trial period at least, during which time mice will be totally uncontrolled on the main mountain except for specific purposes (*e.g.,* protecting kakapo nest sites if necessary) and poison will only be deployed in response to known breaches or incursions by other pest species. Regular tracking-tunnel monitoring will continue, as will the permanent deployment of traps for mustelids.

Table 1. The 5 key questions that guide the Maungatautari Ecological Island Trust's initial assessment of a species potential for translocation to Maungatautari.

Question	Sources
1. Was this species likely to have been present on Maungatautari in the past?	Local knowledge, research outputs (including paleo-ecological), expert opinion and oral history (Maori and European).
2. Will this species compromise the successful establishment of future translocated species or might it have negative impacts on existing species?	Research outputs, expert opinion and evidence from other sites.
3. How vulnerable is the species to pest incursions or uncontrolled mice?	Research outputs, expert opinion and evidence from other sites.
4. Is the species vulnerable to current or future pest management techniques?	Research outputs, expert opinion and evidence from other sites.
5. Is the species endangered and requiring immediate conservation management regardless of former presence at Maungatautari?	Department of Conservation (DOC) threat classification, DOC recovery plan/group, research outputs and expert opinion.

Landcare Research has begun investigating some of the ecological impacts of uncontrolled mice at Maungatautari. MEIT still intends to eradicate mice on the main mountain when techniques and resources allow, and mice will be excluded from the 4 separately-fenced sub-exclosures (~100 ha). The pest management plan is reviewed annually.

Translocation planning and process

The pre-human fauna of Maungatautari forms the initial reference point for selecting suitable species for translocation, but there are many insurmountable constraints to replicating a previous ecological state. Maungatautari is now an isolated habitat remnant, whereas historically it would have been part of a much larger contiguous area, with a high degree of habitat connectivity to the surrounding landscape. Its current isolation together with the extinction of endemic keystone species including large avian herbivores and predators (Worthy & Holdaway 2002), as well as the continuing presence of some exotic species (of *e.g.* birds, invertebrates and fungi), will result in different population dynamics and interspecific interactions for many indigenous species; *i.e.* the ecosystem will be significantly different (MacArthur & Wilson 1967; Crooks & Soulé 1999; Lee *et al.* 2010). Therefore, the broad restoration goals are more pragmatic and directed towards what can be termed a novel ecosystem. This involves not only reintroductions, but the introduction of closely related species to replace some that are now extinct (*i.e.* 'analogue' species to fill vacant ecological niches). For example, takahe (*Porphyrio hochstetteri*) have been introduced to replace the extinct moho (*P. mantelli*), and the Chatham Island snipe (*Coenocorypha pusilla*) may be introduced to replace the extinct North Island snipe (*C. barrierensis*) (Worthy & Holdaway 2002; Tennyson & Martinson 2006). The translocation of takahe and snipe will also be important for their own intrinsic conservation needs. Some locally extinct species that are still available for translocation from elsewhere might be rejected because of their likely effects on other species, and little spotted kiwi (*Apteryx owenii*) (Kiwi Recovery Group advice to MEIT 2004) and North Island weka (*Gallirallus australis greyi*) (Miskelly & Beauchamp 2004) might be examples of this.

MacGibbon (2001) produced the first project plan for Maungatautari to guide restoration efforts. This provided a broad context for the large-scale ecological restoration of Maungatautari and recognised the need to initially construct the pest fence and then to eradicate the introduced mammals, to enable the successful translocation of endemic species that were vulnerable to such pests. MacGibbon (2001) recommended that a species reintroduction strategy be prepared. McQueen (2004) subsequently prepared this document and discussed potential species, timeframes and protocols for reintroductions. Five key questions were then developed by CSK, as an initial assessment for each individual species to guide MEIT in making a decision to proceed with a translocation proposal (Table 1). If approved by MEIT, a formal proposal is then prepared for DOC following their standard operating procedure for translocations. Expert advice is also sought as required.

Avian translocations to Maungatautari Jul 2005-Feb 2013

All birds translocated to Maungatautari are individually marked with numbered metal bands and with colour bands, or with passive injectable transponders ('PIT' tags). Seven species of birds have been translocated to Maungatautari between 2005 and 2012 (Table 2) and an eighth species, the New Zealand falcon, appears to have self-reintroduced as a breeding species. Falcon records

Table 2. Avian translocations to Maungatautari 2005-2012.

Year	Species	Status*	Source population	Number released	Current population	Notes	Reference
2005-2013	North Island brown kiwi (*Apteryx mantelli*), western taxon (WBK)	NV	Various wild & captive sites with WBK		25 unrelated founders at Feb 2013	Further translocations required to achieve reintroduction goals	
2006 2009 2013	Takahe (*Porphyrio hochstetteri*)	NC	Mana & Maud Is Kapiti I & Burwood Bush	2 2 3	7	One Maungatautari-bred chick translocated to Motutapu 2011, and 4 Maungatautari-bred birds to Burwood Bush in 2012; ongoing translocations required for management replacement for extinct moho (*Porphyrio mantelli*)	
2007-2010	North Island kaka (*Nestor meridionalis septentrionalis*)	NV	Auckland & Wellington Zoos	21	>26	Further translocations required for genetic management	
2009	Whitehead (*Mohua albicilla*)	NT	Little Barrier I	60	Unknown	Sightings of released and Maungatautari-bred birds in small flocks	J. Iles & K. Richardson *pers. comm.*;
2009 2009 2010 2011	Hihi (*Notiomystis cincta*)	NE	Little Barrier I Tiritiri Matangi I	20 59 37 39	70-80 at Oct 2012	Collaboration with Massey University and Zoological Society of London	Ewen *et al.* 2011; K. Richardson, *pers. comm.*
2010-2011	Yellow-crowned parakeet (*Cyanoramphus auriceps*)	NT	Captive-bred	12	Unknown	Long Island-sourced birds bred in private aviary; further translocations required for genetic management	
2011 2012	North Island robin (*Petroica longipes*)	NT	Pureora	40 40	Unknown	Sightings of released and Maungatautari-bred birds	

*Conservation status after Miskelly *et al.* (2008); NC *Nationally critical*; NE *Nationally endangered,* NV *Nationally vulnerable*; AR *At risk*; NT *Not threatened.*

have generally increased during the course of the project and in late 2011 a fledgling falcon (with down feathers visible) was seen fluttering near an epiphyte mass high in a rimu tree, with at least one adult bird in attendance (M. Lammas, MEIT, *pers. comm*.). By 2012 there was evidence of up to 4 territory-holding pairs on Maungatautari (K. Richardson, *pers. comm*.). In the 2012/13 season a pair of falcons nested on the edge of Cambridge township and (with human protection) successfully fledged 2 chicks (CSK *pers. obs*.). A general recovery of this species in the Waikato might perhaps be a collective outcome of several significant Waikato restoration projects including Maungatautari.

All 7 species translocated so far have achieved at least short term success, *i.e.* they have survived initial translocation and release. Six of them have subsequently bred at Maungatautari and the seventh, yellow-crowned parakeet (*Cyanoramphus auriceps*), may have bred but this has not yet been confirmed. Most species translocated to Maungatautari are expected to establish self-sustaining populations simply by the release of sufficient founders and the maintenance of an environment sufficiently free of introduced mammals. For example, translocations of whitehead and robin (*Petroica longipes*) have been successful at several other restoration sites (*e.g.* Tiritiri Matangi and Tawharanui; Parker 2013; KAP, Massey University, *unpubl. data*; see also Parlato & Armstrong 2012), and regular sightings (flocks and pairs) and breeding activity (sightings of unbanded birds) suggest that this will be repeated at Maungatautari. However, some species already at Maungatautari such as takahe and possible future introductions such as kakapo, will require on-going management as part of a larger managed meta-population. Indeed more species in the future are likely to need some regional or national meta-population genetic management, to avoid the effects of long-term fragmentation/isolation. Detailed species accounts follow.

Kiwi

By 2000 brown kiwi appeared to be at least functionally extinct in the Waikato. The genetic form that would once have been present is the 'western' brown kiwi (WBK), and following advice from the Kiwi Recovery Group, MEIT chose WBK

for reintroduction to Maungatautari. It has been estimated that *c.* 8,000 WBK still remain in the Tongariro/Whanganui/Taranaki area (Scrimgeour & Pickett 2011), and MEIT initially assumed that translocating sufficient birds to quickly establish a viable founder population would not be difficult. However, the special iconic status of kiwi has required MEIT to work through many cultural, community, bureaucratic and local political issues before kiwi translocations could take place. Progress with kiwi reintroduction has been much slower and more complex than originally expected.

Following advice received initially in 2004 (J. Mclennan, *pers. comm.*) and more recently from Otago University (Weiser *et al.* 2011) via DOC Tongariro/Whanganui/Taranaki Conservancy (J. Scrimgeour, DOC, *pers. comm.*), MEIT's 3 reintroduction goals for WBK have been to (1) initially release a group of at least 20 unrelated founders onto the main mountain (birds with unknown pedigree are assumed to be unrelated for this purpose); (2) add a further 20-25 unrelated founders within 5 years of the first goal being achieved; (3) add a further 15 unrelated founders within 100 years of the first goal being achieved. The Kiwi Recovery Group has recently advised MEIT (H. Robertson, DOC, *pers. comm.*) that a minimum of 30 unrelated founders will be sufficient if subsequent on-going 'trickle' genetic interchange with other sites is anticipated. MEIT's goals are therefore likely to be the above 3 if they can be achieved with available resources and support, but if that is not achievable a minimum of 30 unrelated founders will be translocated within 5 years as a minimum or 'fall-back' goal. In the latter case there will need to be follow-up translocations of the required additional founders within an acceptable timeframe (Jamieson & Allendorf 2012; Jamieson & Lacy 2012) and WBK stakeholders will need to provide an early commitment to ensuring that that will indeed happen.

Most of the kiwi translocated to Maungatautari have been young chicks artificially hatched at Kiwi Encounter/Rainbow Springs in Rotorua, from wild-sourced eggs (Colbourne *et al*. 2005). The first 4 potential founders were young Tongariro Forest-sourced chicks released at Maungatautari in 2005. Further birds have been sourced from Tongariro, Taranaki, the King Country, Waimarino and captive-breeding programmes operated by the Otorohanga Zoological Society, Kiwi Encounter/Rainbow Springs, and Te Puhia. By Feb 2013 the known population of unrelated founder birds on Maungatautari was 25, thereby exceeding the Goal 1 target. More than that have been translocated; but birds with known close relatedness to others have been discounted as primary founders, 2 have proven to be non-viable breeders, 2 arrived with existing deformities or injuries which made them unsuitable as breeders, there have been a small number of deaths from misadventure and a few others have gone 'off the radar' because of radio transmitter failure (they are not counted unless their existence is known). MEIT's field kiwi technician uses a kiwi dog and AWOL kiwi are occasionally found and re-tagged.

From 2005 to 2011 kiwi were only released into the northern and southern sub-exclosures, which total ~100 ha. The initial reason for this was the main mountain block was unfenced and had mammalian predators until 2006. Releases of kiwi onto the main mountain following the complete fencing and the removal of pests were further delayed by the difficulties in sourcing sufficient unrelated founders. Therefore, kiwi releases were until recently restricted to the fenced sub-exclosures, where the necessary intensive management and monitoring could be more easily achieved. The first release of a new unrelated founder bird onto the main mountain was undertaken in Jul 2012, and 25 had been released there by Feb 2013. With recent sourcing of new birds from the Waimarino area via direct wild-to-wild translocations, it is possible that the 5-year goal of 40-45 unrelated founders might now be achieved on time. Goal 3 is likely to be achieved well within the timeframe (100 years) from the trickle of birds that are likely to be made available in future by other WBK projects and from relict birds rescued from unmanaged habitats where kiwi will progressively decline to local extinction (McLennan *et al.* 1996).

The first kiwi bred in the sub-exclosures at 2 years of age in 2007, 2 years after their initial release. Breeding success has been high in the 6 seasons up to and including part of the 2012/13 season (breeding was still underway at the time of writing in Feb 2013), with a total of 61 known chicks having been produced to date. Intensive management has been required to address the risks of overcrowding and inbreeding in the sub-exclosures. The pairing of some closely related founder birds has largely been avoided by the careful allocation of individuals to each sub-exclosure, and by stud-book management. This intensive management has required the radio-tagging of all adult birds including females, and of all chicks soon after hatching. The progeny of founders have been 'grown on' to >1.2 kg (when they can resist predation by stoats) and then translocated to other WBK conservation projects. This has (1) reduced the risk of close-relationship breeding in the second generation before the initial threshold of 20 unrelated founders was reached, (2) reduced overcrowding in the sub-exclosures, and (3) built credit with the recipient conservation entities, which might facilitate the procurement of new unrelated founders from their areas for Maungatautari in the future.

The first Maungatautari-bred birds were translocated to Tongariro Forest in 2010, and by Feb 2013 MEIT had translocated a total of 37 young

kiwi to Tongariro Forest, Taranaki and Waimarino. MEIT is continuing its intensive kiwi management programme into 2013, with most of the current progeny now being released onto the main mountain (rather than being exported), together with any new founders translocated from elsewhere, thereby achieving goal 1. Radio-tags are progressively being removed from most kiwi on Maungatautari (after some initial main-mountain post-release monitoring), as the 8-year intensive reintroduction programme is scaled down. It is anticipated that goals 2 and 3 will subsequently be met, and the achievement of those outcomes is likely to be facilitated by the formation of a WBK Management Group (following the publication of the WBK Taxon Management Plan; Scrimgeour & Pickett 2011).

A call-count monitoring programme will soon be initiated on the main mountain to measure the establishment of the kiwi population. Juvenile survival is likely to decline as the population density reaches saturation on Maungatautari, thus creating opportunities for translocations to other restoration sites. It is likely that ~100 birds per year will be available for such future translocations (J. McLennan, *pers. comm*.), and Maungatautari will then become a valuable 'Kohanga Kiwi' site for WBK recovery (McLennan 2006; Holzapfel *et al*. 2008; Scrimgeour & Pickett 2011) – and this will help to overcome the difficulty of sourcing founder birds for future WBK restoration projects. The populations in the 2 sub-exclosures are likely to be maintained and periodic genetic interchange with the main mountain will be part of low-level on-going management.

Takahe. Two pairs of takahe have been introduced into 2 sub-exclosures. One pair has successfully bred producing 6 young to date, the first 5 of which have been translocated to other managed sites. DOC undertakes the national meta-population management of takahe for genetic and other purposes, and Maungatautari is managed as part of the 'island' (*i.e.,* non-Fiordland) population within that programme. Takahe are provided with small amounts of supplementary food at Maungatautari, as this facilitates monitoring and management. Radio-tags are also used for monitoring. The first translocation of takahe to the main mountain occurred in Feb 2013, with the release of a pair from Kapiti I. Some areas of former farmland were included within the pest fence, and these primarily grassland areas are expected to provide core habitat sites for takahe.

North Island Kaka. Kaka can travel long distances, and some evidence suggested that captive-raised juveniles were less likely to disperse from the release site than wild-caught juveniles, but no evidence was available to suggest how wild-caught or captive-raised adults might respond to translocation (R. Empson, Zealandia Sanctuary, *pers. comm*.; Berry 1998). MEIT therefore followed the Karori/Zealandia and Pukaha/Mt. Bruce models and used captive-bred juveniles for translocations starting in 2007. Young captive-bred birds were left with their captive parents at source breeding establishments for 3-5 months to learn basic life skills. They were then translocated to Maungatautari and held in an on-site aviary for a further 3-5 months to reduce post-release dispersal. Following release, on-going supplementary food was provided to further anchor them at Maungatautari.

Twenty one juvenile kaka (10 males and 11 females from 3 captive breeding pairs) were released from the on-site aviary at Maungatautari between 2007 and 2010. All 11 females were fitted with back-mounted radio transmitters which had an estimated battery life of 4-5 years. Within 6 months of the initial release of 7 birds (3 males and 4 females) in 2007, all 7 appeared to have left the mountain, despite a prolonged pre-release holding period in the on-site aviary, and the post-release provision of supplementary food. One female was subsequently found dead on farmland adjacent to the mountain (via its transmitter signalling mortality) and a female and a male from that cohort have since been recorded back on the mountain. The fate of the other four 2007-released birds remains unknown.

Following 2007's disappointing outcome, in 2008 a captive breeding pair from Auckland Zoo was held in one part of the Maungatautari aviary to serve as an extra 'anchor' to reduce the dispersal of subsequent young birds released. That pair produced 2 broods (a total of 7 chicks) during their 2 years in the Maungatautari aviary and those progeny were released when 4-6 months old. Another 7 juveniles from 1 other captive breeding pair (3 in 2008 and 4 in 2009 from Wellington Zoo) were held for several months before release, in a flight adjacent to the Auckland Zoo breeding pair in the on-site aviary. After the installation of the captive adult pair as a potential anchor the retention/survival of released birds increased from 29% in 2007 to 71% during 2008-2010, but post-release monitoring was only done at feeders (which some released birds might not visit) and the progressively-growing free-flying flock is likely to also have had an anchoring effect on later-released birds, additional to that of the borrowed captive pair. The adult pair was returned to Auckland Zoo after 2 breeding seasons. The first wild breeding of kaka on Maungatautari was recorded in the 2009/10 season.

In spring 2010, 12 of the 21 released birds were recorded as present and visiting feeders (Collins 2011; CSK, *unpubl. data*). In winter 2011 a maximum flock size of 26 birds was recorded at a feeder and the majority of those were unbanded birds (C. Laxon, MEIT, *pers. comm*.).

Of the 3 source captive pairs, 1 produced 6 of the founder birds that were recorded at feeders in 2010, 1 produced 5, and the other produced only 1 (a male, and it is not known if this bird has bred). Because of this small genetic base MEIT plans to release more unrelated founders. Wild kaka have historically been regular winter visitors to Maungatautari and this might provide additional genetic input if some of those visiting birds choose to stay in future. Most kaka now seen on the mountain are unbanded, and while most are assumed to be Maungatautari-bred young birds (several broods are known to have successfully fledged) it is possible that some might be wild recruits from elsewhere. The New Zealand captive kaka breeding coordinator is currently actively increasing the captive breeding population (A. Nelson, Auckland Zoo, *pers. comm*.) and MEIT expects to receive more unrelated captive-reared birds for release in the future.

Whitehead. Whitehead translocations to islands and relatively discrete mainland sites have been successful (KAP, *unpubl. data*) so a single translocation from a primary natural population was considered sufficient to establish a population at Maungatautari. Sixty birds were translocated from Little Barrier I in 2009 with the sex ratio assessed to be close to 50:50. While the genetic diversity of the population on Little Barrier I is unknown, it has been assumed to be sufficiently robust. No whitehead-specific monitoring or management has been undertaken post-release; but 5-minute bird counts undertaken by Landcare Research have detected whiteheads since 2011, small flocks are regularly observed, and breeding has been confirmed with unbanded birds now being sighted more frequently than banded birds (K. Richardson, *pers. comm*.).

Hihi. It was considered desirable to reintroduce hihi (stitchbird; *Notiomystis cincta*) early in the restoration programme, as resident populations of tui (*Prosthemadera n. novaeseelandiae*) and bellbirds (*Anthornis m. melanura*) were expected to increase following pest removal; and as dominant niche-competitors (Rasch & Craig 1988) their increased densities might reduce the chances of hihi re-establishing successfully. The first 59 hihi were translocated in 2009, 3 years after pest removal. Bird monitoring at Maungatautari indicated that tui had already increased by 2009 but bellbirds had not, although more recent monitoring suggests that bellbirds have subsequently increased (J. Innes & N. Fitzgerald, Landcare Research, *unpubl. data*). By 2011, 155 hihi had been translocated – 135 from Tiritiri Matangi I and 20 from Little Barrier I – and hihi are now successfully breeding on Maungatautari.

The Tiritiri Matangi population was itself established by translocations from Little Barrier I in 1995 and 1996, and it is therefore a subset of the genetic diversity present on Little Barrier (Brekke *et al.* 2011). Tiritiri Matangi was chosen as the prime source for Maungatautari due to the relatively easy availability of sufficient birds there, but 20 birds were additionally translocated directly from Little Barrier I to potentially include alleles not present in the Tiritiri Matangi-sourced birds and also to include birds which were not behaviourally reliant on intensive management (the Tiritiri Matangi population is supported by supplementary feeding and artificial nest boxes). Six sugar-water feeding stations were however established at the Maungatautari release site and these are still maintained.

At least 26 breeding pairs were identified on Maungatautari in the 2012/13 season as part of an on-going PhD research project (K. Richardson, *unpubl. data*). It is not yet known to what extent hihi might require on-going specific management on Maungatautari (*e.g.,* the continued provision of sugar-water feeders). There is considerable individual and seasonal variation in the degree to which hihi use the feeders, with 62% of translocated hihi and 45% of Maungatautari-bred hihi known to use them during the 2011/12 season (K. Richardson, *unpubl. data*). A current research project is assessing the effect feeder use has on reproductive success of adult female hihi at Maungatautari (L. Doerr, *pers. comm*.). Artificial nest boxes were not provided, as they were considered unnecessary given the large area of old-growth forest available. It is anticipated that the large size of Maungatautari with its diverse flora and old-growth forest, and its freedom from all mammalian pests except mice, will eventually support the largest reintroduced population of hihi.

Yellow-crowned parakeet. The yellow-crowned parakeet reintroduction programme is in its early stages at Maungatautari. Twelve captive-bred birds, comprising 9 males and 3 females, have been successfully released from the Maungatautari aviary during 2010 and 2011 and post-release supplementary food is provided for them. A more balanced sex ratio was unavailable from the sole captive-breeding source of pure yellow-crowned parakeet. While some birds have been regularly seen and heard, it is too early to determine success and additional translocations will be critical. The initial intention is to establish a small captive-sourced free-flying group which visits feeders, which might then reduce the risk of subsequent wild-sourced translocated birds being lost to dispersal beyond the mountain. Further translocations of small numbers of captive-reared birds are planned, followed by wild-to-wild translocations of larger numbers, to establish a population with long term viability.

North Island robin

Many North Island robin translocations to islands and discrete mainland sites have been successful

Table 3. Potential future avian translocations to Maungatautari.

Species	Status	Potential source sites	Notes	References
North Island kokako (*Callaeas wilsoni*)	NV	Waikato/King Country sites, & Little Barrier I	Research-based translocation desirable	L. Molles, J. Waas, O. Overdyck & P. Jansen, *pers. comm.*
Kakapo (*Strigops habroptilus*)	NC	Codfish I, Anchor I, Pearl I, Chalky I & Little Barrier I	Initial trial translocation desirable to assess Maungatautari as breeding site, using males surplus to breeding programme; barrier required to prevent birds climbing over fence; prototype already designed and tested by MEIT	D. Vercoe Scott, *pers. comm.*
North Island saddleback (*Philesturnus rufusater*)	AR	Multi-source	Multi-source translocation desirable to maximise genetic and behavioural diversity of founders	T. Lovegrove 1996; KAP, *unpubl. data.*
North Island rifleman (*Acanthisitta chloris granti*)	AR	Pureora	Translocation protocols established; impact of mice unknown	T. Ward-Smith. *pers. comm.*
Cook's petrel (*Pterodroma cookii*)	AR	Little Barrier I	Long-term translocation programme required; translocation protocols established; impact of mice unknown	G. Taylor & M. Imber, K-J. Wilson, M. Rayner, R. Holdaway, E. Bell, M. Bell & H. Gummer, *pers. comm.*
Black petrel (*Procellaria parkinsoni*)	NV	Great Barrier I	Long-term translocation programme required; translocation protocols being developed/refined; impact of mice unknown	
Red-crowned parakeet (*Cyanoramphus n. novaezelandiae*)	AR	Wild and/or captive stock	Preferably translocate before yellow-crowned parakeets reach high density, to reduce risk of hybridisation	T. Greene. *pers. comm.*
Orange-fronted parakeet (*C. malherbi*)	NC	Unknown	To be investigated	
Chatham Islands snipe (*Coenocorypha pusilla*)	NV	Chatham Is	Analogue species to replace extinct North Island snipe (*C. barrierensis*); impact of mice unknown	Atkinson 1988; Roberts & Miskelly 2003
Blue duck (*Hymenolaimus malacorhynchos*)	NV	Wild and/or captive birds	Unlikely at present time due to paucity of 'classic' habitat; any translocation should assess habitat plasticity of the species	M. Williams, *pers. comm.*
Brown teal (*Anas chlorotis*)	AR	Captive birds	As for blue duck, but a few small ponds are included within the pest fence	BT Recovery Group, *pers. comm.*
Rock wren (*Xenicus gilviventris*)	NV	South I	As for blue duck; known from Holocene fossils from North I, but may be misidentified; potential analogue species to replace extinct North Island bush wren; impact of mice unknown	Worthy & Holdaway 2002. M. Willans & P. Gaze, *pers. comm.*
Little spotted kiwi (*Apteryx owenii*)	AR	Kapiti I	Potential conflict with brown kiwi	Kiwi Recovery Group, *pers. comm.*
North Island weka (*Gallirallus australis greyi*)	NV		Probable conflict with other species; any translocation should assess impact on other species	Miskelly & Beauchamp 2004
Long-tailed cuckoo (*Eudynamys taitensis*)	AR		Possible self-reintroduction, but translocation might be required – protocols to be developed	
North Island fernbird (*Bowdleria punctata vealeae*)	AR		Possible self-reintroduction, but translocation protocols exist	KAP, *unpubl. data*
Banded rail (*Rallus philippensis assimilis*)	AR		Possible self-reintroduction, but translocation protocols exist	
Spotless crake (*Porzana t. tabuensis*)	AR		Possible self-reintroduction	

*Conservation status after Miskelly *et al.* (2008); NC *Nationally critical*; NE *Nationally endangered*, NV *Nationally vulnerable*; AR *At risk*; NT *Not threatened.*

(Parlato & Armstrong 2012). Therefore, as with whiteheads, a relatively simple translocation from a primary source was considered sufficient to establish a population at Maungatautari. Forty robins were translocated in May 2011 and another 40 in Apr 2012, both from Pureora Forest. The sex ratios were assessed as close to 50:50. Some limited robin-specific monitoring was undertaken post-release, and 5-minute bird counts undertaken by Landcare Research have detected robins since 2011. Twenty two of the original 40 birds released were re-sighted during winter 2011. Territorial birds are regularly

observed and breeding has been confirmed by the presence of unbanded birds.

Future avian translocations To Maungatautari

Twelve indigenous forest bird species were surviving on Maungatautari when the restoration project started (Appendix 1). Another 8 have been added since then (Table 2) and at least another dozen species are likely to be considered for future translocations (Table 3). All translocations are subject to considerable scrutiny and consultation before being formally proposed. Some species might self-introduce (*e.g.,* long-tailed cuckoo, banded rail (*Rallus philippensis*), spotless crake (*Porzana tabuensis*) or North Island fernbird (*Bowdleria punctata*); and the indigenous forest avifauna at Maungatautari is likely to eventually exceed 30 species, making it one of the most avian-diverse mainland forest habitat blocks in New Zealand. Due to its size, habitat quality and pest status, Maungatautari is also likely to eventually support relatively large populations (compared to most other sites) of a number of threatened species, perhaps helping to reduce their threat ranking.

The continuing presence of mice on the main mountain might require some extra management for some translocated wildlife species, for example at kakapo nest sites, but that is yet to be determined. A translocation of saddleback/tieke (*Philesturnus rufusater*) is currently planned for May 2013, and funds are currently being raised for a kokako translocation in the near future. An add-on barrier to the inside of the pest fence will be required to prevent kakapo from climbing out from the inside, while still providing pests such as cats, stoats and ship rats with the opportunity to climb out if they do gain entry (a precautionary measure) – and funds are currently being raised for the installation of such a barrier, as a prelude to a kakapo translocation in the near future.

Monitoring for restoration outcomes

Bird monitoring is undertaken every 3 years using modified 5-minute bird counts on permanent transects (Fitzgerald *et al*. 2009). Non-treatment control sites elsewhere in the Waikato Ecological Region are included in the monitoring programme. The technique has been potentially strengthened by the addition of a distance sampling component; and also by 'maximum flock size' counts for kereru (New Zealand pigeon; *Hemiphaga novaeseelandiae*), and kaka are likely to be added to that in the future. Counts have been undertaken in the early summers of 2002, 2005, 2008 and 2011. Of the translocated species, kaka first began to appear in the counts in 2008. Four more species began to appear in 2011; whitehead, hihi, robin and falcon. Yellow-crowned parakeets have been heard between count stations, but have not yet been recorded at a station. From unpublished data (J. Innes & N. Fitzgerald, Landcare Research), and using the criterion of both the 2008 and the 2011 counts being greater than both the 2002 and the 2005 counts, 3 species have shown increases; shining cuckoo (*Chrysococcyx lucidus lucidus*), North Island tomtit (*Petroica macrocephala toitoi*) and tui. Using the reverse of the same criterion (decreases rather than increases), 3 species have shown decreases; blackbird (*Turdus merula*), North Island fantail (*Rhipidura fuliginosa placabilis*) and silvereye (*Zosterops lateralis*). Kereru and bellbird did not fit either criterion, but they both achieved their highest count in 2011.

The Maungatautari pest monitoring programme involves regular examinations of large numbers of pest tracking cards, which have also recorded lizard tracks. This might be further developed to add lizard relative-density and species composition to the outcome monitoring programme. Weta (Anostostomatidae and Rhapidophoridae) track-ing has already been used for this purpose (Watts *et al.* 2011). Similarly, bird tracks have also been observed on cards, and several silvereyes, a few blackbirds and 2 hihi have been caught in rodent traps under covers on the ground (P. Quinn, MEIT, *pers. comm*.). In future tracking cards might usefully contribute to the monitoring of small ground-frequenting cryptic bird species such as snipe, small rails and fernbird.

Landcare Research in Hamilton currently manages and undertakes these monitoring programmes. The EcoQuest Education Foundation (in partnership with the University of New Hampshire) runs undergraduate student field programmes on Maungatautari, which include some long-term monitoring (Sinclair & Brejaart 2011).

An annual (or biannual) distance monitoring survey of the mountain was initiated in 2012 by MEIT and the Hihi Recovery Group in conjunction with research institutions, targeting hihi but with the intention of incorporating other key reintroduced forest birds (*e.g.,* kokako and tieke/saddleback) in subsequent years. Pest monitoring lines (no more than 200m apart across the mountain) are regularly walked by staff and volunteers, and encouraging awareness, providing training and incorporating these personnel into species work continues to enhance MEIT's ability to monitor reintroduced species beyond the smaller exclosures.

Specific post-release monitoring of translocated species is undertaken to obtain data to guide future management. Some monitoring programmes are intensive (*e.g.,* kiwi and hihi), and some are simply opportunistic observations (*e.g.,* whitehead). DNA samples have also been retained from some translocations and they are kept in permanent storage as a resource for future potential research.

An avian disease survey was conducted during the period Jun 2006-May 2007 (M. Goold, *pers. comm*.). Baseline health screening samples

were collected from 80 birds of 12 species, on or immediately adjacent to Maungatautari. Thirty-two silvereyes, 3 grey warblers (*Gerygone igata*), 7 fantails, 2 pukeko (*Porphyrio melanotus*), 1 kereru, 1 kingfisher (*Todiramphus sanctus*), 2 tomtits, 4 eastern rosellas (*Platycercus eximius*), 2 greenfinches (*Carduelis chloris*), 13 magpies (*Gymnorhina tibicens*), 6 feral turkeys (*Meleagris gallopavo*) and 7 blackbirds (*Turdus merula*) were captured using mist nets, traps and hand captures. *Chlamydia elisa* tests on 77 birds were negative. Direct microscopic examination of faecal smears from 37 birds revealed *Coccidia* in silverye, fantail, blackbird and greenfinch. No other endoparasites were observed. Microbiological cultures on cloacal swabs from 78 birds were negative for *Salmonella* and *Yersinia*, but *Campylobacter jejuni* was found in silvereyes, pukeko and turkeys, and unidentifed *Campylobacter* spp. (not *C. jejuni*) were found in magpies. PCR screening for avian malaria from 63 birds produced positive results in fantails, silvereyes, blackbirds and magpies, but blood smears from 66 birds were negative when screened for haemoparasites. Estimated white blood cell counts on these slides produced expected values except for 5 blackbirds, 3 turkeys, 2 silvereyes and 1 greenfinch, which had slightly elevated counts. One eastern rosella was positive for *Circovirus* on PCR screening. Crop washes taken from 16 birds of 4 species were negative for motile organisms (*e.g.,* protozoa). No special techniques were used to recover external parasites, but none were seen during handling. Twenty nine individual birds were weighed at capture. All appeared healthy except 1 blackbird which had bilateral eyelid lesions histologically suggestive of, but not pathognomic for, pox virus.

DISCUSSION

There are inherent differences between an agency or institution-driven ecological restoration project and a community-driven project. A government agency charged with conservation responsibilities can be expected to have a business-like and professional approach to the work. A research institution can be expected to involve more experimental design and rigorous data collection. A community project however is likely to be more ideology-driven, with the involvement of people being one of its primary aims – and some are also personality-driven – and these drivers have helped to initiate and develop the Maungatautari community project. But MEIT is also addressing the need for good business management, clear strategic planning and professional ecological management. MEIT is actively forming partnerships with (for example) universities and crown research institutes, to maximise learning opportunities and improve ecological management. The necessary involvement of many people and groups can bring its own management difficulties, but a community having 'ownership' of a project can also bring many advantages (Parker 2008). Maungatautari currently has more than 350 volunteers whose active and enthusiastic participation is essential for the success of the project. The volunteer contribution has recently been estimated to be equivalent to 37 full-time positions (M. Anderson, MEIT, *pers. comm*.).

To many involved in the Maungatautari project, the failure to eradicate mice at this early stage has been a disappointment. Maungatautari, like the rest of mainland New Zealand, has experienced 7 centuries of dramatic ecosystem changes, primarily caused by at least 17 species of introduced mammals (including humans, kiore and dogs/kuri). But Maungatautari has never before experienced the effect of uncontrolled mice alone. While mice will have been present on the mountain for over 150 years (Ruscoe & Murphy 2005), they are likely to have been suppressed to low densities by other mammals, and any ecological effects attributable to them alone have probably been minimal. MEIT's new pest management plan will change that. There will be no significant population control for mice over most of the mountain, apart from food availability and climate/weather. The specific ecological effects of mice cannot be foreseen, but it is possible that a high-density mouse population will have some profound effects. Little is known about the effects of mice on indigenous species and ecosystems on mainland New Zealand, but they have caused significant effects in other ecosystems such as on Gough I and Mana I (Cuthbert & Hilton 2004; Newman 1994). Maungatautari's new pest management plan will provide a valuable opportunity to learn much about the impacts of mice on the mountain, and the outcomes of the research will have value beyond Maungatautari. The ~100 ha of mouse-free habitat in the 4 sub-exclosures will provide a safe home for some indigenous species that might be vulnerable to uncontrolled mice.

There are many other invasive exotic species that are uncontrolled and common over much or all of the mountain, including eastern rosellas and other birds, several species of introduced predatory wasps (especially the common wasp *Vespula vulgaris*), European honeybees (*Apis mellifera*), the orange pore fungus (*Favolaschia calocera*) and many invertebrate species. The impacts of most of these species can only be guessed at, but research has shown that introduced European wasps for instance can have significant impacts on forest ecosystems in the Waikato (Harris & Oliver 1993). But the impacts of exotic species including mice are not expected to greatly reduce the list of bird species that can potentially be translocated to Maungatautari. A visitor to Maungatautari's southern sub-exclosure (the prime visitor area) will see an ecosystem that is largely dominated by indigenous species. Even

on the main mountain, a casual visitor is unlikely to see any obvious effects of mice and the general forest birdlife there is likely to be very similar to that in the mouse-free sub-exclosures.

The cost-effectiveness of pest-fenced projects has been recently discussed (*e.g.* Scofield *et al*. 2011; Innes *et al*. 2012; Scofield & Cullen 2012) in comparison to non-fenced projects where pests are continually controlled to low levels rather than eradicated. The relative values of such different pest management regimes will become clearer with time – but it is already clear that highly vulnerable species such as tieke/saddleback and kakapo can only be returned to mainland sites which have sufficient freedom from the relevant pests, a status that seems unlikely to be achieved without a pest fence. Maungatautari is currently the only such mainland site of sufficient size for kakapo (D. Vercoe Scott, DOC, *pers. comm*.), and it also has key food-plant species which in other sites are known to trigger and sustain kakapo breeding (Wilson *et al.* 2006; Elliot *et al.* 2006) but the extent to which that will happen on Maungatautari is yet to be discovered.

The current annual operating cost for the Maungatautari project is in the order of $1.8 million. For comparison, Little Barrier I and Raoul I are DOC-administered offshore/outlying island reserves with some similarities to Maungatautari in terms of ecological value, but public access to them is by permit only and subject to fees and significant transport costs (whereas access to Maungatautari is currently unrestricted and free). The current direct annual operating costs for each of those real islands is $0.45 million for Little Barrier and $0.65 million for Raoul (R. Renwick, DOC, *pers. comm*.), but that does not include the costs of the significant mainland infrastructure and servicing that is required to support them. Occasional capital costs can be significant for both scenarios, *e.g*., for a pest fence (with an expected 40-year life) for a mainland site, or for a solar power generation system (with an expected 10-year life) for a remote staffed island reserve. The real costs and conservation outcomes for both alternative scenarios, and also for mainland non-fenced pest-managed sites, are yet to be adequately evaluated for comparative purposes.

MEIT's intention is to maintain the 'wilderness' character of the main mountain, but the 2 main sub-exclosures (the north and the south) will be more visitor-focussed, with some artificial enhancements. The overall intention is to enable most translocated species to form self-sustaining wild populations – but for a few species a supplementary feeding programme has been initiated, for 6 reasons:

1. To provide opportunities for post-release monitoring.
2. To provide immediate support for birds that need to learn how to find and use wild foods (*e.g.*, captive-raised kaka and kakariki/parakeets).
3. To enable the relatively easy capture of birds at feeders for on-going management or research purposes.
4. To provide on-going support for species where previous research or management has demonstrated supplementary food may enhance the probability of a population establishing and persisting (*e.g.*, hihi; Chauvenet *et al*. 2012; Low *et al*. 2012).
5. To potentially reduce the risk of newly-released birds dispersing beyond the mountain.
6. To provide viewing opportunities for visitors.

Maungatautari has already been a primary study site for a variety of student research projects, with both its accessibility and the scale and degree of the restoration being attractive features. Crown Research Institutes have also initiated research projects on the mountain. It is expected that such interest will increase further. MEIT employs an educator on staff and this position caters for school visits during term time, and for other groups. Several local schools have relationships with MEIT which involve their students in (for instance) planting and monitoring programmes. Volunteer and paid guides host many groups and individuals visiting the project. A staffed Visitor Centre has been established at the entrance to the southern exclosure.

There is good evidence for significant increases in tui and bellbird numbers in Maungatautari satellite towns such as Cambridge (12 km away) since the restoration programme began, and tui have recently been recorded breeding in Cambridge (CSK, *unpubl. data*). Data from residents living around Maungatautari show that maximum winter tui numbers doubled within 10 km of the fence between 2006 and 2010 (N. Fitzgerald & J. Innes, *unpubl. data*).

Maungatautari-bred kiwi and takahe have already been translocated to other restoration projects to help them to achieve their goals, and to assist with the species recovery programmes. It is expected that more species will be translocated to other sites as the project develops. Maungatautari is well suited to this purpose by being easily accessible and having relevant infrastructure in place.

Introduction programmes for 7 bird species have commenced since the project began, and an eighth species (falcon) is showing initial signs of self-reintroduction. Takahe, hihi, whitehead and robin are all showing initial signs of population establishment. Kiwi and kaka have both required adaptive management to achieve initial reintroduction success and they are breeding well. The yellow-crowned

parakeet reintroduction programme is still in its initial phase and breeding has not yet been confirmed. By 2012 the number of indigenous forest bird species on Maungatautari was already 67% greater than when the project started, and when the avian translocation programme has been completed it is anticipated that Maungatautari will have the most biodiverse assemblage of indigenous forest bird species on mainland New Zealand, and they will be part of a functioning ecosystem this is likely to include at least 50 indigenous vertebrate species (including birds, bats, lizards, tuatara, frogs and fish).

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Maungatautari has been possible because of more than half a century of inspired, visionary, innovative and dedicated hard work by many people in New Zealand, and indeed Richard Henry's pioneering work on Resolution I more than a century ago was an early precursor to the more recent work. Some of those people were among the first to recognise that introduced mammals, in particular rats, were indeed a primary threat to NZ's endemic wildlife. Their work involved the development of the rationale and the techniques for pest mammal eradications on an industrial scale, techniques for translocating forest birds, the management of pest mammals on large mainland blocks and the development of pest fencing. Eleven New Zealanders in particular have pioneered the way to Maungatautari; beginning with the Godfather of threatened species conservation Richard Henry, then Brian Bell, Don Merton, Ian Atkinson, Dick Veitch, Rowley Taylor, Bruce Thomas, Alan Saunders, Ian McFadden, Jim Lynch, and finally David Wallace who initiated the Maungatautari project. We apologise to the many others who have also made huge contributions in this field, for not having the space to include them here. Comments from John Innes, Hugh Robertson and Kate Richardson improved the manuscript, and we thank Ralph Powlesland for his editorial role for this special issue of Notornis.

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APPENDIX 1. Indigenous bird species present within the Maungatautari forest in 2000 (CSK *unpubl. data*).

Paradise shelduck (*Tadorna variegata*); nests in forest edge.
Grey duck (*Anas superciliosa*); nests in forest edge.
Grey teal (*Anas gracilis*); nests in forest edge.
Swamp harrier (*Circus approximans*); hunts within forest, breeding unknown.
Kereru (*Hemiphaga novaeseelandiae*); breeding confirmed.
Shining cuckoo (*Chrysococcyx lucidus*); breeding assumed.
Morepork (*Ninox novaeseelandiae*); breeding confirmed.
New Zealand kingfisher (*Todiramphus sanctus*); breeding confirmed.
Welcome swallow (*Hirundo neoxena*); feeds within forest, recently nested in large culverts inside fence.
Grey warbler (*Gerygone igata*); breeding assumed.
North Island fantail (*Rhipidura fuliginosa*); breeding confirmed.
North Island tomtit (*Petroica macrocephala*); breeding confirmed.
Silvereye (*Zosterops lateralis*); breeding assumed.
Bellbird (*Anthornis melanura*); breeding confirmed.
Tui (*Prosthemadera novaeseelandiae*); breeding confirmed.