SUSTAINABLE MANAGEMENT OF BROWN KIWI AND OTHER THREATENED BIRDS IN NORTHLAND

A document providing guidance to landowners, community groups and agencies for the protection and recovery of kiwi and their habitat

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1. INTRODUCTION

1.1 Background

Kiwi are flightless members of the ratite group of birds which includes emu, cassowary, ostriches, rhea, and tinamous. Kiwi are endemic to New Zealand and are the national emblem and taonga, reflecting their significance to New Zealanders. Northland is the stronghold for one of the six kiwi taxa, the brown kiwi or North Island kiwi (*Apteryx mantelli*). There are approximately 25 population clusters of kiwi remaining in the Northland region, all of which extend across public and private lands (Figure 1). Northland kiwi populations have declined greatly due mainly to predation pressure from dogs and mustelids, and increasing land development pressures throughout the region. The remaining population clusters can be saved from extinction only if there is improved community awareness and support, combined with the adoption of kiwi-friendly activities, improved statutory protection, and further integrated pest control.

Northlanders identify very strongly with kiwi and there is an increasing determination by landowners, landcare groups, iwi, land management agencies, communities, and private companies to work together to restore populations of kiwi and other threatened species. This determination has been galvanised over the last 10 -15 years for several reasons. Firstly, advocacy about the plight of kiwi was based on good local research that determined the causes of kiwi population decline and the types and levels of pest control or other management actions that are needed to reverse the declines. Secondly, technological advances in pest control have enabled more effective predator management to be implemented that can provide kiwi and other threatened species with safer environments. Thirdly, there has been improved availability of funding for biodiversity protection projects on private land that has led to greatly increased action on the ground.

1.2 Purpose of this document

This document provides a regional context for the application of two sets of national kiwi guidelines: the Kiwi Recovery Plan (Robertson 2003) and the Kiwi Best Practice Manual (Robertson and Colbourne 2003). (Both of these can be accessed from the Bank of New Zealand Kiwi Recovery Trust website.) The purpose is to provide guidance to all stakeholders and interested parties involved in kiwi protection and recovery in Northland. A primary goal is to assist with integration of efforts to protect kiwi (and other threatened species) being applied by the Department of Conservation (DOC), other statutory agencies, community groups, and individuals. Key aspects of this document are to:

- Identify current and potential kiwi management zones and potential corridors to connect them;

- Provide criteria for landowners and Landcare groups to determine whether kiwi recovery is an appropriate priority for particular biodiversity protection projects;

- Provide guidelines for district councils to ensure appropriate statutory provisions are in place to protect known kiwi habitat;
- Give an overview of current approaches to predator control (including dogs);
- Suggest approaches for land managers to concurrently restore other threatened species, and implement more integrated ecosystem management;
- Provide guidelines for raising public awareness and empowering stakeholders;
- Provide recommendations to managers to help avoid undesirable side-effects and ripple effects from their management;
- Provide standard approaches to monitoring kiwi population trends;
- Guide specialised kiwi activities, e.g. Bank of New Zealand Kiwi Recovery Trust Operation Nest Egg (ONE) and translocations;
- Provide guidelines for obtaining support and resourcing for kiwi management.

2. KIWI ECOLOGY

2.1 General

In Northland, female brown kiwi are considerably larger than males and weigh about 2.8 kg, compared with the males which weigh about 2.1 kg. Their long bills have nostrils located uniquely at the tip to help detect food, which includes a wide variety of invertebrates and vegetable matter such as fallen berries. Kiwi in Northland are strictly nocturnal, typically spending daylight hours in a burrow or under cover provided by dense vegetation, logs, fallen nikau fronds, or slash heaps.

Kiwi habitat in Northland is primarily indigenous forest and shrubland, but plantation forest, gorse-dominant shrubland, and rough farmland are also common habitats. Favoured sites are damp gullies in both indigenous and plantation forest and dense shrubland. In these habitats kiwi can reach densities of one bird per hectare, but very few sites in Northland have retained such high densities.

Breeding in Northland occurs throughout much of the year, subject to local rainfall. Egg-laying typically starts in late June and July, with hatching beginning in September-October (Robertson 2005a). A second clutch is usually laid in October-December, with a less well-defined pulse of chicks hatching in January-March. Nests are typically in burrows, including beneath logs and tree roots.

Two eggs are laid *c.*3 weeks apart and the first egg can be unattended for most of this period. Incubation is undertaken by the male for 75-85 days. Chicks stay in the nest for about a week (surviving by absorbing their yolk sac contents) before venturing out. They then return to the nest during the day for several weeks before becoming

independent. Most chicks remain close to (<1 km) their natal area for their first 6 months of life, but wider dispersal can occur when they become subadults, with individuals travelling up to 20 km from their natal site, during which time they can cross pasture and other developed land. Once kiwi have settled in an area, they remain there as long as suitable habitat remains. First breeding can occur at one year old, but most birds probably do not start breeding until they are 3-5 years old (Heather and Robertson 2000).

2.2 Threats

In the past, destruction of forest and shrubland has been a major factor in the decline of kiwi, and loss of shrubland is still an ongoing issue in parts of Northland. However, kiwi have continued to disappear from many large forest and shrubland habitats and are now rare in many others. The primary cause of the ongoing decline of all unmanaged kiwi populations in Northland is predation by introduced mammals, particularly stoats (*Mustela erminea*), ferrets or fitches (*M. furo*), dogs (*Canis familiaris*), and cats (*Felis catus*). Without management, the average annual decline of kiwi population studied in central Northland was 4% (Robertson 2005b), and some local populations have declined at much faster rates (Pierce 2004a).

Each predator species has negative impacts at particular life stages of kiwi, with dogs being able to kill kiwi in all life stages (Table 1). Stoats are able to kill kiwi up to *c.*1.0-1.2 kg in weight, which corresponds to chicks of about 6 months old. Ferrets are able to kill larger kiwi as well, e.g. large male ferrets can kill adult male kiwi, but there is no evidence to date of fully-grown female kiwi being killed by ferrets. Cats can kill kiwi juveniles and there is some evidence that they can also kill subadults up to about a year old

Table 1: Predators of different life stages of kiwi.

Life stage	Known predators (with main predators highlighted)
Adult/subadult	Dog, ferret, possum, cat, people, possibly pig
Eggs	Dog, possum, stoat, ferret, cat, pig
Chicks/juveniles	Stoat, cat, dog, ferret, pig, harrier (*Circus approximans*)

Of the four key predators, the overwhelming impacts on Northland kiwi are from dogs and stoats. Cats (feral and domestic) may be locally important, and there is evidence of frequent killing of kiwi by individual ferrets (H. Robertson, DOC, pers. obs.). Where ferrets are reasonably common, e.g. central Northland, their impacts on kiwi are likely to be severe. Key features of the main kiwi predators (stoats, dogs, ferrets, and cats) are described below:

Stoats

Stoats occur in all kiwi habitats in mainland Northland and they can swim up to 3 km to near-shore islands. Adult stoats occupy home ranges that are frequently linear in shape and average 50-100 ha for females and 100-200 ha for males (King *et al*. 2001, C. Gillies, DOC, pers. comm.). Productivity varies depending on food supply. Juvenile stoat dispersal occurs consistently during December-March in Northland,

although the relative importance of juvenile and adult stoats in contributing to kiwi chick deaths is unknown.

Dogs

Kiwi are particularly vulnerable to dogs because they lack a sternum and have under-developed wing and chest muscles, making them susceptible to crushing injuries caused by dog bites. Dogs of all sizes, breeds, and training are attracted to the smell of kiwi. They can kill many kiwi in a short space of time and bring about catastrophic declines in local numbers (Pierce and Sporle 1997, Taborsky 1988). Kiwi are particularly vulnerable near clusters of human settlement, including subdivisions if there are no dog restrictions, and in more isolated areas where pigs (*Sus scrofa*) are hunted and dogs are frequently lost. Dog-kills of kiwi can occur during the day as well as at night, the former mainly of birds sheltering beneath dense vegetation, e.g. along the edges of roads and tracks.

Ferrets

Ferrets are a relatively recent arrival in Northland (Miller and Pierce 1995), but they now occur throughout much of the region, particularly in drier areas and where there is pasture habitat and rabbits (*Oryctolagus cuniculus*) (a common prey for ferrets). Male ferrets are considerably larger than females and are capable of killing adult kiwi. Unlike stoats, they are strictly nocturnal and have home ranges in the order of 100-300 ha in New Zealand (Clapperton 2001).

Cats

Both feral cats and domestic cats kill kiwi chicks and subadults (Pierce and Sporle 1997). Feral cats occur throughout kiwi habitat in Northland, but appear to be most common in mosaic habitats of bush patches and wetlands set in farmland. Cat home ranges vary widely but average 120-300 ha at Trounson Kauri Park (Gillies 2001).

Possums

Brush-tailed possums (*Trichosurus vulpecula*) disturb nesting kiwi when they enter burrows, and occasionally eat kiwi eggs, and kiwi have been killed during battles over burrow occupancy (McLennan et al 1996, Pat Miller pers. comm.). Possum control using ground set traps poses a very high risk to kiwi, and many birds have been killed in this way (Pierce and Sporle 1997). All possum traps should be set 700 mm above ground level in areas with kiwi. Monofluoroacetate (1080) poison poses a very low risk to kiwi (Robertson et al. 1999a) but long-term possum control using bio-accumulating toxins such as brodifacoum may pose some risks to kiwi (Robertson et al 1999b).

Other factors

Locally, other factors can contribute to kiwi mortality, notably road-kills, entrapment in cattle-stops, and drowning in cattle troughs, ponds and swimming pools. Road strikes cause significant numbers of deaths in the Bay of Islands and some other

densely-populated areas. In the period 1991-2005, *c.*50 kiwi were killed on roads on the Kerikeri Peninsula (A. Walker, DOC, pers. comm.).

3. DISTRIBUTION AND POPULATION TRENDS

3.1 Former distribution and decline

Kiwi originally occurred throughout Northland, including the Aupouri Peninsula. In the 1970s, they were found throughout most forest and shrubland areas from the Brynderwyn Range to Awanui (Bull *et al.* 1985); however, by the early 1990s kiwi had all but disappeared from the Brynderwyn, Mareretu, and Tangihua Ranges and most other forest remnants south of a line between Whangarei and Dargaville (refer to Figure 1).

Some of these declines occurred relatively rapidly. For example, in the Paerata Government Purpose Wildlife Refuge near Tangiteroria, over 100 birds were present in the late 1980s (Potter 1990), but annual call-count monitoring indicated that, within 15 years, these birds had been virtually wiped out (Pierce 2004a). In the neighbouring southern parts of the Mangakahia Range in central Northland, Pat Miller recorded record counts of over 50 calls an hour in November 1992 (Miller and Pierce 1995), but 10 hours of listening in and adjacent to this area in April-June 2004 produced an average of one call per hour (Pierce 2004b). This pattern of decline was evident throughout much of Northland during the 1990s (refer to Section 3.2).

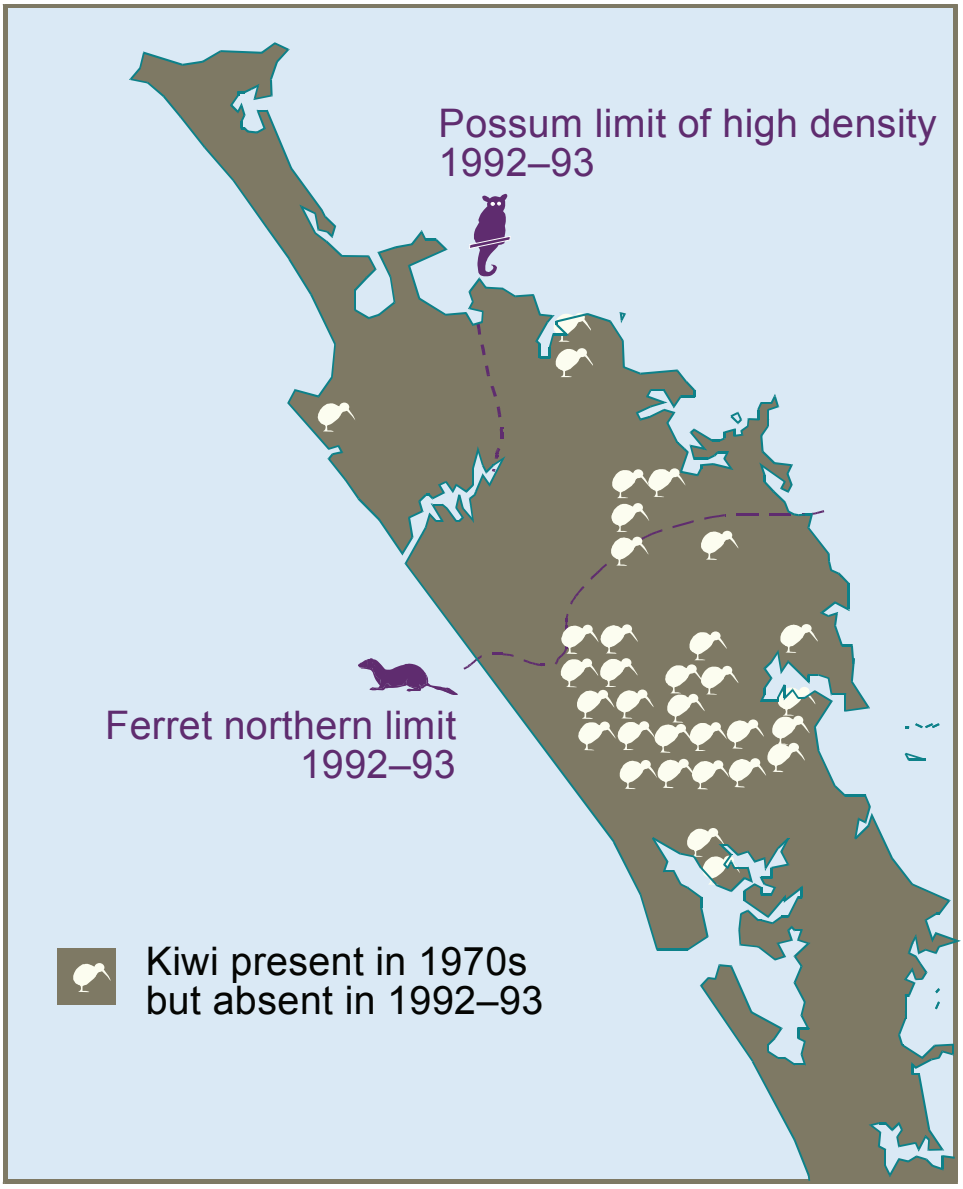


Figure 1: Map of Northland indicating kiwi populations lost between 1970s and 1992-93 (from Robertson 2005a).

3.2 Current distribution and population trends

Distribution

Currently, kiwi distribution and relative abundance is variable across Northland, with many artificial and natural barriers to dispersal. As a result, there are now about six main geographical groupings of kiwi in Northland, and within each there are several local concentrations or clusters (refer to Figure 2). The main geographical groupings are in the following areas:

- Eastern – clusters at Whangarei Heads, Ngunguru-Tutukaka, Mimiwhangata, Whangaruru Peninsula, and Russell Peninsula;

- South Central - clusters in the Purua-Marlow-Motatau and Pipiwai areas;

- Western/Kauri Coast – comprises a large kiwi zone which extends through the Opouteke, Tutamoe-Trounson-Waipoua area, possibly contiguous with the Waima cluster, and a South Hokianga cluster at Opara;

- Bay of Islands – this has many population clusters e.g. at Hupara, Waitangi, Waimate North, Kerikeri Peninsula, Purerua Peninsula, Mahinepua and Puketi;

- Kaitaia – clusters in the Whakaangi, East Kaitaia and Kaiaka areas and Maungataniwha, Herekino, and Warawara Ranges;

- Islands – North Island kiwi occur on islands within the Whangarei Harbour (Matakohe/Limestone), the Bay of Islands (Moturua, Motukiekie, Moturoa), and the Cavalli Islands (Motukawanui). Little-spotted kiwi (*Apteryx owenii*) are present on Taranga (Hen Island).

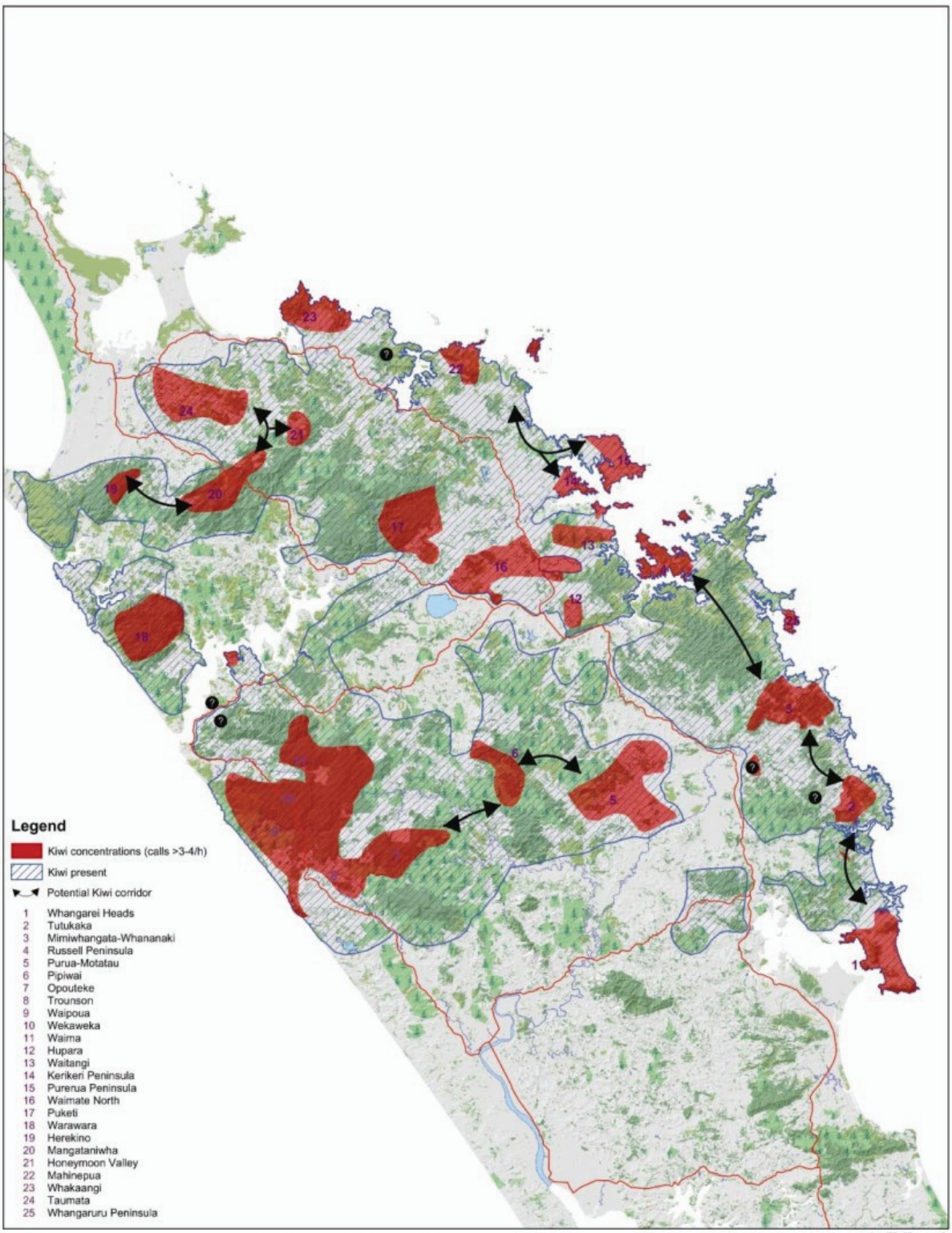


Figure 2. General distribution and relative abundance of kiwi in Northland based on data to 2005

The kiwi distribution depicted in Figure 2 must be regarded as general only as some areas are poorly surveyed or not surveyed at all for kiwi. In addition, kiwi can disperse 20 km or more from their natal area so it is possible for individuals to occur in any shrubland or forest area between Whangarei-Dargaville in the south and Awanui in the north. Many or all of the low density areas adjacent to population clusters would have had higher kiwi densities in the past, but numbers have been depleted through habitat loss, land development, and especially predation by dogs and other predators. These low density areas may have potential to provide corridors between the main clusters (refer to Section 4.4).

Population trends

Research at Purua (Robertson 2005a) indicates that sustainability of that population requires a minimum of 6.1% of eggs to successfully develop into adults. In the absence of predator control only 3% of eggs laid achieve this level of recruitment. In the same study, localised predator control (predator trapping and possum poisoning) resulted in recruitment rates of 10-20%.

Annual kiwi call-count monitoring has been carried out by volunteers and the DOC in four areas of Northland from 1995 to 2005. This monitoring indicates that trends in kiwi call rates (and presumably kiwi numbers) were generally downward in all areas in the 1990s, with catastrophic declines occurring in some places (Figure 3). The downward trends in the 1990s almost certainly resulted from predation by mammalian predators, with many documented cases of dogs killing adult and juvenile kiwi (Pierce and Sporle 1997), ferrets killing adults, and stoats killing juveniles (Robertson 2003). Call rates appear to have stabilised since 1999, reflecting increased management effort, with one of the four areas experiencing increased call rates (Figure 3). The current focus is to establish sufficient listening stations to monitor local populations in each management unit (refer to Section 5.11).

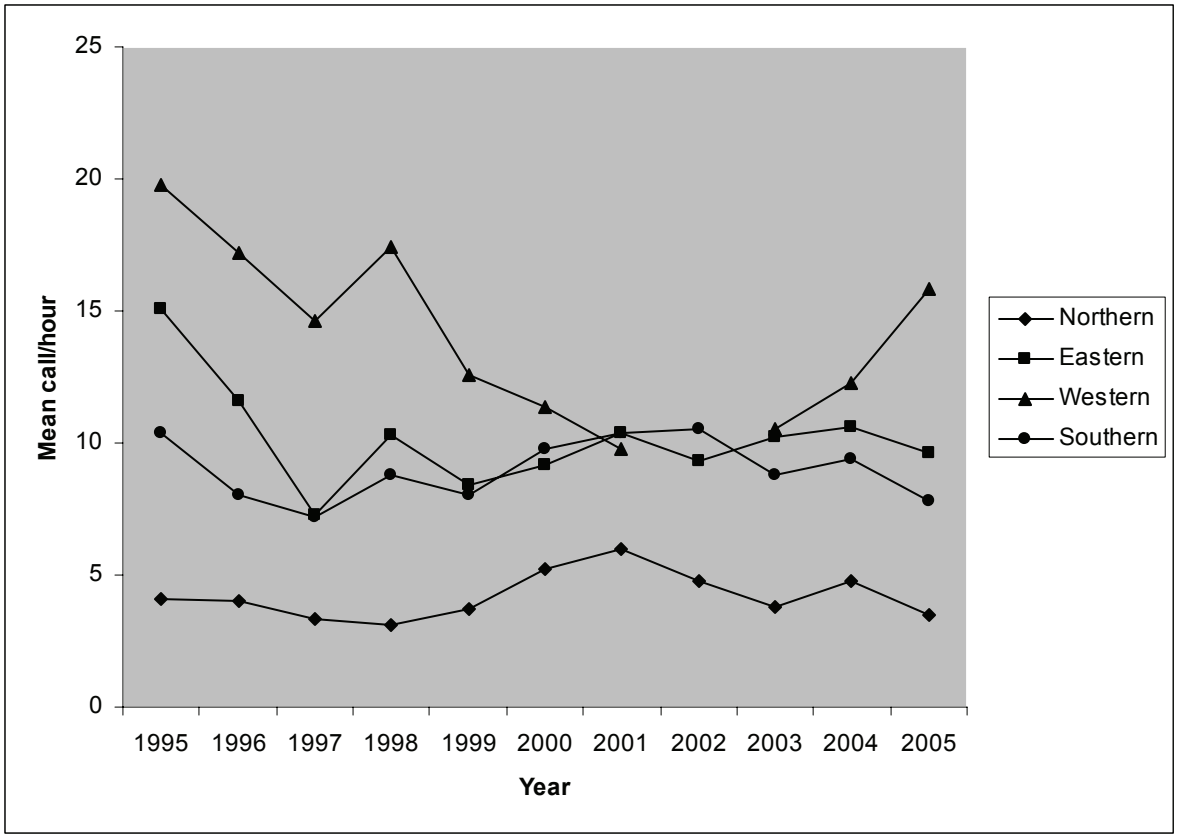


Figure 3: Mean annual hourly call rates per hour for kiwi at each of the four original monitoring areas in Northland, 1995-2005.

4. OPPORTUNITIES FOR KIWI POPULATION RECOVERY

4.1 Current kiwi initiatives

Kiwi populations are currently being actively managed or management is imminent at about 30 sites across Northland, including nearly all of the clusters shown in Figure 2. Table 2 provides details of these sites, including the parties involved, the year management started, size of the managed area, estimated number of kiwi pairs, and number of kiwi listening stations or other monitoring methods. Many management initiatives are collaborative approaches, with the following parties directly involved: DOC (nine clusters), Landcare groups or community (eight), other trusts/private groups (four), NZ Kiwi Foundation (nine), Carter Holt Harvey (two), and private landowners (at least four). Many other Landcare groups and private landowners are also contributing to kiwi population recovery as a result of their management activities.

Table 2: Summary of sites in Northland where kiwi management is underway or planning for implementation is well advanced as at mid 2005.

Population cluster	Parties involved	Start year	Area managed (ha) 2005	Kiwi pairs (2004 conservative estimate)	Listening stations 2005
Eastern					
Whangarei Heads	Whangarei Heads Landcare Forum, DOC	1999	6000	40+	15 *
Ngunguru, Tutukaka	Tutukaka Landcare Coalition, Kaiatea Landcare, DOC	2000	1000+	30+	6
Mimiwhangata	DOC	1990s	3000+	Unknown, high call counts	1
Whakapara	Ian Beattie	2005	A[1]	Unknown, moderate call count	Nil
Russell Peninsula	New Zealand Kiwi Foundation	2000	2000	100+	Up to 7
Taupiri & Elliots Bay	NZ Kiwi Foundation	2004	120	4+ but unconfirmed	1
South Central					
Purua-Motatau	DOC	1994	6000+	Unknown, high call counts	12 *
Pipiwai	Carter Holt Harvey	2005	1000	*c.*20	Surveyed
Kauri Coast					
Trounson-Waipoua	DOC, Waipoua Forest Trust	1995	1000+	Hundreds	6 *
Wekaweka	Wekaweka Landcare	2004	1000+	Unknown, moderate call counts	Surveyed
Opouteke	Carter Holt Harvey	2005	1000	40+	Surveyed
Waima	Te Mahurehure Roopu Whenua Taonga Trust & DOC	2005	A	Unknown, moderate call count	Surveyed
Bay of Islands					
Hupara	Hupara Landcare Group	2005	A	Unknown, high call count	0
Waitangi	DOC	2001	1000+	Unknown, high call counts	2 *
Waikino	Waikino Group	2005	800+	Unconfirmed	Surveyed
Kerikeri Peninsula	NZ Kiwi Foundation	1990	2500	80+	Up to 6
Wharau Rd (Sth side of KK Inlet)	NZ Kiwi Foundation	2002	500	10+	2
Purerua Peninsula	NZ Kiwi Foundation	20001	3000+	200+	Up to 5
Waimate North	Waimate North Landcare Group	2004	9000	Few hundred	8
Te Tii/ tapuaetahi	NZ Kiwi Foundation	2004	300	Low call count	
Kauri Cliffs	NZ Kiwi Foundation	2001	2500	10+ unconfirmed	2
Takou Bay	Takou Were to Mokai Trust/ NZ Kiwi Foundation	2004	2000	10+ unconfirmed	2
Puketi	Te Oho Mai Puketi	2004	A	Unknown, low call counts	Surveyed
Taupo Bay	Taupo Bay community group	2005	600	Unknown	0
Mahinepua	Mahinepua Radar Hills Landcare Group	2002	1400	*c.*20	8

Population cluster	Parties involved	Start year	Area managed (ha) 2005	Kiwi pairs (2004 conservative estimate)	Listening stations 2005
Kaitaia					
Whakaangi	Whakaangi Landcare Trust	2004	2900+	400	9
Wells Road	Higginson/Khaine	1990s	50	Low-moderate call count	1
Herekino	Renwick/Sporle	1990s	50+	Low-moderate call count	1
Honeymoon Valley	Private	2005	500	Unconfirmed	0
East Herekino	Managed by Kiwi Foundation	2005	2000+	Unconfirmed	0
Herekino West	Herekino Landcare Group	2004	1000	Low kiwi numbers, unconfirmed	0
Islands					
Matakohe	Friends of Matakohe/ Limestone Island, DOC	2001	27	ONE site	0 *
Motukawanui	DOC	1990s	380	Unknown	0

Notes: 1. A = area still to be decided.
2. * = also monitored by banding or telemetry

The New Zealand Kiwi Foundation is also facilitating management in blocks in Airfield Rd (Otangaroa), Paitu (Kaeo), Top Energy (Ngawha), Whanagape Track and Station and more than 20 other smaller blocks where kiwi are present in low to moderate numbers.

Most of the *c.*30 existing initiatives are primarily focused on kiwi recovery, but many also include recovery objectives for other species that are susceptible to mustelid and dog impacts. Sites where this is happening include Whangarei Heads, Ngunguru-Tutukaka, Mimiwhangata-Whananaki, Russell Peninsula, Trounson-Waipoua, and Matakohe (Limestone Island). Most of these sites support other threatened species, e.g. the nationally endangered pateke (brown teal; *Anas aucklandica*) and other wetland and coastal fauna, and several sites are being visited increasingly by kaka (*Nestor meridionalis*), red-crowned kakariki (*Cyanoramphus novaezelandiae*) and other threatened fauna (refer to Section 6).

4.2 Strategic targets

The Kiwi Recovery Group (which is convened by the DOC) provides strategic guidance on the recovery of kiwi species throughout New Zealand. It also provides considerable technical support and has published standard operational procedures for managing kiwi (Robertson and Colbourne 2003) and on-going advice and training. The Recovery Group has identified a target of 500 pairs as the strategic goal for each regional kiwi population within the next ten years (Kiwi Recovery Group pers. comm.). Clearly, this goal has already been achieved for the Northland region; with the managed areas currently likely to be supporting a total of 1000+ pairs (refer to Table 2). Enhancing and sustaining these populations is the current challenge. The following strategic targets are also recommended for kiwi recovery in Northland:

- Aim for management units in which kiwi numbers can ultimately reach several hundred pairs;

- Maintain corridors to enable gene flow across large parts of the Northland population, e.g. much of eastern Northland and along the Trounson-Waipoua-Waima-Opouteke-Mangakahia-Motatau-Purua continuum (refer to Section 4.4);
- Aim for the wider protection of indigenous biodiversity at each site (refer to Section 6);

- When kiwi are secure in viable populations at several locations within their current range, reintroduce kiwi to former parts of their range. Potential reintroduction sites include the Brynderwyn-Mangawhai area, Tawharanui Peninsula (Warkworth), Waitakere Ranges (Auckland) and Te Paki (refer to Section 5.7).

Although carrying capacities for kiwi are poorly known (and could increase with improved multiple pest management), densities of one pair per 2-5 ha currently occur in well-managed Northland forests. In other words, a forested area of 1000-2500 ha could potentially accommodate 500 pairs if all components were well-managed. Most of the individual management sites documented in Table 1 could therefore support populations of 500+ pairs. However, there is a need to ensure that each of these management sites is adequately supported in terms of resourcing and technical input (refer to Section 7).

4.3 What makes a good kiwi management site?

In deciding whether to manage kiwi at particular sites, careful consideration needs to be given to the feasibility and sustainability of local population recovery. Features that improve the likelihood of successful kiwi recovery include the following:

- Continuous forest or mixed forest/scrub and farmland habitat, ideally larger than 1,000 ha, that can ultimately support several hundred pairs of kiwi;

- Local landowner and community support for kiwi recovery, including a willingness to control dogs and other predators;

- The presence of large numbers (e.g. 100+) of kiwi that, with protection from predators, can maintain high rates of survival and productivity. This would preclude the need for supplementary work via ONE or translocations;

- Availability of support from local council(s) and other agencies to establish kiwi-friendly environments, e.g. pet-free zones;

- Feral pig and related pig-dog problems, and other conflicting activities, are either absent or manageable;

- The presence of other threatened fauna species that are being managed and which would benefit from intensive predator control (refer to Section 6);

- Reasonable terrain and access for trapping and monitoring;

- Potential for the establishment of corridors between managed sites. An alternative to the availability of continuous habitat, as noted above, is the presence of a series of smaller sites that are interconnected with safe corridors;

- Some predator management work is already underway in or adjacent to the target area;

- In the case of exotic forests, a substantial part (e.g. 20-30% or more) of the total target area is indigenous forest or shrubland that can provide refugia for kiwi during harvesting operations.

Clearly, not all of these site characteristics will be achievable, but the more that can be attained the better a site is likely to be. Conversely, it is important to reconsider plans to manage kiwi in sites with key or multiple unfavourable features (e.g. few kiwi present, small area, high level of pig-hunting across much of the area, or an unsupportive community).

4.4 Kiwi dispersal corridors

Current research indicates that many juvenile kiwi are long distance dispersers, with some radio-tagged birds from Trounson Kauri Park travelling up to 15-20 km into Waipoua Forest and the Tutamoe Range. Birds are also leaving the managed area at Whangarei Heads, and one bird has travelled over 60 km from its natal area at Moehau, on the Coromandel Peninsula. Maintenance of this capacity for long distance dispersal is important because it enables recruitment to occur throughout the extent of a local population. Wide dispersal also promotes genetic mixing of a population. Conversely, dispersal can be a problem if juveniles and chicks travel into unsafe areas where predators are not managed. Ecological linkages and corridors are an important consideration at two levels; locally, and for long distance dispersal.

Local corridors

Local corridors are important within an area covered by a population cluster as interconnected forest remnants are needed to ensure that kiwi can find new mates as required. Examples of this scenario are present at Whangarei Heads, Purua-Motatau, Trounson-Waipoua, and Waimate North, each of which has numerous discrete forest remnants with varying levels of connectivity. From telemetry studies, significant dispersal of subadult kiwi is known to occur between remnants within three of these population clusters (Whangarei Heads, Purua area, Trounson-Waipoua) and it is likely that dispersal occurs in all similar situations in Northland.

Long distance dispersal

Long distance corridors are desirable between populations, to enable maintenance of gene flow across a region. Virtually all of the main kiwi population clusters in Northland have potential long distance dispersal corridors linked to other kiwi sites (refer to Figure 2). If these corridors were maintained as safe habitats for dispersing subadults (i.e. dog and ferret control) and there was adequate productivity in the population clusters (i.e. all predators being well-managed to ensure survival to

dispersal age), many of these corridors could become functional again. For example, potential corridors could reconnect eastern coastal sites between Whangarei Heads and Russell Peninsula via Pataua, Brynavon, Ngunguru-Tutukaka, Mimiwhangata, and Russell Forest. The many northern Bay of Islands clusters of Hupara, Waitangi, Kerikeri Peninsula, Purerua Peninsula, Waimate North, Puketi, and Mahinepua could also be linked, although potential corridors across terrain dangerous for kiwi may need to be discouraged if problems with predation cannot be resolved. There is also potential for a trans-Northland corridor linking Waipoua, Waima, Mataraua, Trounson, Tutamoe, Opouteke, Mangakahia (Pipiwai), and Purua-Motatau, and possibly as far as the east coast corridor via Russell Forest. Another possibility is to link the 'Western' birds of Warawara and Herekino to Raetea, Mangataniwha, Eastern Kaitaia, Wells Road, Mangonui, and Whakaangi.

Relative priorities

Strategically, both types of corridors are important, but in terms of relative priorities the former (local corridors) is the more urgent requirement because it is particularly important to ensure that locally viable populations of kiwi are retained in Northland and these require urgent work. This work will require focused effort (particularly predator and dog control) within population clusters and the provision of safe corridors between local metapopulations within which kiwi habitat is maintained, and dogs and ferrets are controlled.

Planning to implement safe long-distance corridors between populations is also important, to ensure that this capability is available in the future. Appropriate planning controls are required at a District Council level to ensure that conflicting land uses are not permitted in proposed corridors.

5. MANAGEMENT METHODS

5.1 Predator control

Mustelids

Trapping of mustelids is challenging and requires considerable patience, perseverance, and professionalism. Standard approaches in Northland use Fenn Mark 6 traps, and have benefited kiwi in all study areas. Alternative traps (DOC200 and 250) are becoming increasingly available. Standard approaches currently involve:

- Year-round trapping (because ferrets occur throughout Northland and kiwi are therefore vulnerable at any time, c.f. potential for seasonal trapping where stoats but not ferrets occur);
- Select likely mustelid hunting areas (NBEG 2004);
- Double set Mark 6 Fenns in wooden or plastic tunnels, preferably with a floor to prevent traps being exposed if pigs upturn tunnels;

- Spacings of one trap per *c.*10-25 ha (more intense at smaller sites);

- Rabbit bait (salted rabbit is significantly better than eggs or pilchard; Pierce *et al*. 2005), switching to other bait types twice a year;

- Traps are checked and rebaited fortnightly in October-March and monthly April-September;

- If trap-shy mustelids are detected, use other lures, e.g. fresh rabbit replaced twice weekly, eggs, duck meat, possum. If problems persist, consider specialist advice regarding the use of certified predator dogs or trap site selection.

- Control of mustelids through trapping can lead to a build-up of rodent populations, and so pulsed management of rodents (see below) is warranted to ensure that they do not adversely affect other biota that is sensitive to rodent predation.

Cats

Although cats can be shot or captured in many types of traps, the most efficient control methods are kill-trapping with modified Timms traps and modified SA cat traps Standard approaches involve:

- One trap per *c.*20-50 ha, at carefully selected sites;

- SA Cat traps on wooden ramps at least 700 mm off the ground;

- Either SA Cat traps baited with minced rabbit (unsalted) or cat biscuits mixed with peanut butter, or Timms traps baited with fish or rabbit meat.

The NZ Landcare Trust organises regular trappers' workshops to provide opportunities for information updates, skill-sharing, and training.

5.2 Minimise predation by domestic dogs and cats

Large numbers of kiwi are killed by uncontrolled domestic dogs and cats. Of 194 kiwi deaths documented in Northland during the 1990s, more than 75% were caused by a range of dog breeds (e.g. German shepherd, poodle, and many fox terriers), and various dog activities, including pets being taken for a walk, wandering dogs, duck hunters' dogs, pig dogs, farm dogs, and semi-feral dogs (Pierce and Sporle 1997).

Effective management of domestic dogs and cats is important for the long-term survival of local kiwi populations. Most opportunities to overcome this problem have an advocacy component to minimise uncontrolled dog use and to raise public awareness (refer to Section 5.5). Trapping can also be carried out to control dogs and cats.

Where dogs cannot be excluded from an area (e.g. farmland), good dog control is the best defence against kiwi deaths by dog predation. This includes:

- not taking your dog into areas where kiwi live
- tying your dog up at night
- keep your dog under control at all times
- never dump unwanted dogs – deliver them to the SPCA

New Zealand dog control legislation now covers the need for people to control their dogs so they don't attack or harm threatened wildlife.

Increasingly, pet-free restrictions or covenants to protect kiwi are being sought for subdivisions in areas of known kiwi populations.

Poisons for cats and dogs are currently being developed and registration is being planned for these. These may be useful for feral animals, but would require particularly careful consideration before use in areas that might affect domestic cats or dogs.

Kiwi aversion training for dogs

The Northland Conservancy of the Department of Conservation, along with Tongariro/Taupo, East Coast, Great Barrier, Taranaki and the Coromandel are currently using a method of kiwi aversion training for hunters' dogs. This is primarily intended for hunters who seek permits to hunt pigs in DOC-managed blocks and some Carter Holt Harvey forests that contain kiwi. The method involves giving the dog a negative experience (an electric shock via an electric collar) when they show interest in kiwi stimuli (dead kiwi and fresh kiwi faeces). Dogs are re-tested at least once a year (preferably every 6 months) to keep their aversion certificate valid. The aversion training days are also a good time to reinforce good dog handling practices with owners, build relationships with hunters and also pass on general kiwi information such as identifying kiwi sign and distribution.

It is essential that dog owners are aware that aversion training does not work on all dogs and it does not guarantee that a dog is 'kiwi safe'. New methods of training and testing kiwi aversion for dogs are currently being worked on to increase the reliability of aversion training.

Kiwi aversion training should not be relied on for protection of kiwi from pet or farm dogs, and should not be the preferred option for kiwi protection in areas of further subdivision (see above).

5.3 Control of other pests

Where integrated pest control is undertaken for the recovery of other species or to provide wider ecosystem benefits (refer to Section 6), consideration needs to be given to the types of management methods, and the levels and duration of control. Suggested approaches are summarised below for possums, rodents, and other threats:

Possums

- Possums can be controlled effectively using encapsulated cyanide, both for initial control of high density populations and maintenance at low densities (NBEG 2004).

- Generally avoid anticoagulants such as brodifacoum because of the high levels of toxin required to kill possums, potential for resistance to develop following prolonged use, and the cumulative and residual effects of second generation anticoagulants on non-target species including kiwi.

- Timms traps, and especially Conibear or S A Cat traps, can be effective on a local basis.

Rodents

- Rats and mice (*Mus musculus*) (locally) can be trapped using various approaches (NBEG 2004).

- First generation anticoagulants (e.g. diphacinone) can be effective for reducing and maintaining low rat numbers and are preferable to using brodifacoum, especially for on-going rat control.

- Use of brodifacoum has provided some significant benefits for kiwi, partly through a significant increase in egg hatching rates due to possum removal, but mainly through greatly increased chick survival following secondary kills of predators and/or reduction of their prey availability (Robertson 2005a,b). **However, it should be used with caution** because of its capacity for bioaccumulation and transfer through food webs, and there are effective alternatives to its use. There are many papers on this topic and the DOC has developed criteria for the evaluation of potential use of brodifacoum. The long-term maintenance of sustained control using brodifacoum has not been proven beyond 7 years (Robertson et al. 1999b), c.f. predator trapping (refer to Section 5.1).

- If vulnerable invertebrates are present (e.g. snails, tusked weta), indexes of rat and mouse relative abundance should be obtained (NBEG 2004).

5.4 Minimise other threats to kiwi

Collisions with vehicles, drowning in steep-sided ponds, and getting caught beneath cattle-stops account for many kiwi deaths (Pierce and Sporle 1987). Approaches to minimise accidental kiwi deaths include:

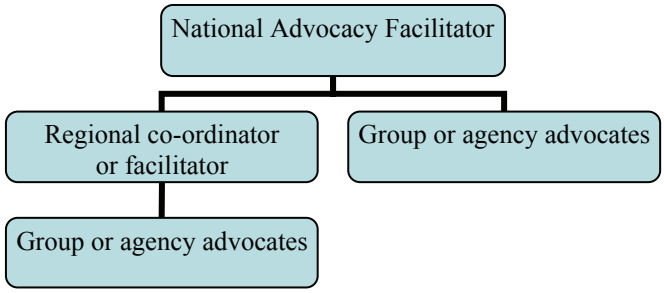
- Promote driver awareness (e.g. using signage) and speed restrictions at key sites, e.g. Kerikeri Peninsula;
- Consider funnelling birds towards underpasses (bridges) on busy roads by fencing road edges with netting, buried at the base;

- Provide gently-sloping banks on farm and forestry ponds, to enable birds that fall in to find a way out;
- Provide escape routes from all cattle-stops and cattle troughs (e.g. small ramps) in kiwi population clusters and corridors.

5.5 Advocacy, public awareness, and empowerment

Advocacy has become an important component of kiwi habitat protection and kiwi protection projects throughout Northland. On-going advocacy is important to ensure broad public acceptance and buy-in as well as active support and resourcing. Advocacy does more than just raise public awareness, it can also help to initiate and facilitate kiwi protection activities. This is very important, regardless of whether a project is implemented by the DOC or by private groups or individuals.

It is beneficial to have a formal structure and process for advocacy; to ensure good communication flows between kiwi practitioners at all levels, as set out below:



Key topics for advocacy

A list of key topics for kiwi advocacy is provided below:

- Kiwi biology
- Habitat protection
- Kiwi monitoring methods
- Predator control methods
- Dog control (and other domestic animals)
- Development of community groups
- Effective and practical Kiwi Protection Plans
- Where support and help can be obtained, including technical advice and funding sources
- That we can make a difference!

Potential audiences for advocacy are listed below, in no particular order:

- Landowners with kiwi
- Landowner/community groups
- Forest industry
- Crown agencies, including DOC

- Hunters & trappers
- Skill-based training programmes
- Information centre displays
- Schools
- Local and regional authorities - planners, councillors, dog rangers, pest control
- Iwi
- Tourists and visitors
- Potential sponsors, including corporates
- Service groups
- Consultants
- Real estate industry
- Science community
- Conservation groups
- Private individuals
- Captive institutions, kiwi houses.

Advocacy key tasks

These include:

- Raise awareness by providing information.
- Get people to identify with the issues and develop solution-based approaches.
- Motivate people to want to actively protect kiwi by providing opportunities for learning and active involvement.
- Provide information on protection options and implementation of these options.
- Teach skills and provide opportunities to support positive action (e.g. workshops for practitioners).
- Marketing of the project to gain support and resources.

Ways of making contact with relevant parties and involving them in projects
These include:

- Advocacy programmes
- Kiwi call-count monitoring and survey programmes
- Pest control
- Donations
- Threat monitoring
- Bank of New Zealand Operation Nest Egg visits [to where?]
- Visits to kiwi houses
- Field trips to showcase sites, where active management is protecting kiwi
- Workshops and presentations
- Shows and displays
- Display local kiwi zone signs.

Opportunities for improved communication, networking, and partnerships
These include:

- National kiwi practitioners hui
- Kiwi practitioners database
- Local and regional Authorities
- DOC
- Iwi, runanga, and hapu groups
- Bank of New Zealand Kiwi Recovery Trust and Recovery Group
- New Zealand Landcare Trust
- Other groups and agencies working nationally and locally.

Other information sources

- Websites; e.g. DOC (www.**doc**.govt.**nz**) ; Bank of New Zealand Kiwi Recovery Website (www.kiwirecovery.org.nz)- contains detailed information on kiwi and related activities for adults and children; various other kiwi protection initiatives.

- Kiwi Forever - a Bank of New Zealand Kiwi Recovery kiwi education resource which is linked into the New Zealand secondary school curriculum.

5.6 Injured and dead kiwi and eggs

Injured birds

Take any injured birds to a veterinary clinic as soon as possible. Transport in a darkened well-ventilated box or carton with the floor covered with newspaper. Keep in vehicle in a secure cool place (but not the boot) and avoid excessive noise. Provide details of circumstances of injury (refer Appendix) and report incident to nearest DOC office.

Dead birds

For freshly dead birds, if possible take a photograph of the bird *in situ* and examine scene for clues of cause of death. Carefully place in bag and keep chilled in fridge (if disease is suspected), keep fresh or frozen if toxin poisoning is suspected, or frozen (if other cause of death is evident) and contact DOC to determine future use of bird, e.g. cultural and scientific uses.

Dead eggs

Abandoned eggs are occasionally found outside burrows and these should be labelled with pencil (on shell) and kept chilled (but not frozen) en route to a DOC office – they will arrange transport to Massey University (refer to Kiwi Best Practice manual, module 10, Robertson *et al.* 2003). An experienced egg Candler must ensure that the egg is infertile or dead before chilling. Complete a kiwi death certificate (refer to Appendix). **Do not remove eggs from burrows, including single unattended eggs.** The first egg may be unattended for a day or two at a time until the second egg is laid.

However, if two eggs are present and they feel cold, then treat the nest as abandoned.

5.7 Bank of New Zealand Kiwi Recovery Trust Operation Nest Egg and translocations

Most population clusters have moderate to high numbers of kiwi and if they are given protection from predators, rates of survival and productivity will be sufficient to enable a population increase. There are, however, some situations where Northland populations merit being supplemented with translocated birds - firstly, when injured birds are ready for rehabilitation, and secondly, to augment small existing populations or establish new populations. Both instances require a permit and close liaison with DOC and the Kiwi Best Practice Manual (Robertson *et al.* 2003) should be followed. Any handling of kiwi or their eggs requires a permit from the DOC. These matters are discussed further below.

Rehabilitation of injured birds

Rehabilitated birds should be returned to their original site unless that site is under threat (e.g. significant risk of predation by dogs) and persistence of kiwi in the area is unlikely. Potential releases should be discussed with the DOC, to determine an appropriate managed area for each bird to be released as near as possible to the source area. Released birds should be radio-tagged and their progress monitored (refer to Kiwi Best Practice Manual, module 10, Robertson *et al.* 2003).

Translocations to supplement or establish new populations

ONE rearing and release or juvenile translocations may be warranted where managed populations are small or if there are concerns with infertility or lack of genetic diversity. ONE is the fastest way of recovering a kiwi population (Robertson 2005a, b); however, protection of adults from ferrets and dogs is also needed on a year-round basis. ONE is also complex and potentially expensive and requires a sample of source birds to be radio-tagged in order to find their nests and chicks, a captive hatching facility, a safe crèche site (preferably an island, e.g. Matakohe/Limestone Island), and ongoing telemetry at the release destination to determine success (refer to Kiwi Best Practice manual). Ideally, source birds should be from a well-managed site(s) outside the target area, because birds within the target area will be protected from predators and should be breeding productively.

There are potential variations to the above approach. Firstly, bypassing a captive facility by allowing chicks to hatch in the wild, subsequently radio-tagging chicks at the nest, and once they have reached the age at which they can become independent in the wild (i.e. 10-20 days old) then shift them to a crèche. This has been carried out successfully in Northland and is a cost-effective alternative to standard ONE procedure. Secondly, direct translocations of juveniles and adult kiwi from a vulnerable site to a managed site; although this technique has been attempted on few occasions, so outcomes are inadequately known.

5.8 Habitat enhancement and legal protection

Some key actions to benefit kiwi and their habitat include:

- Improved control of browsing animals (especially possums) and rats (major consumers of seeds and invertebrates), thereby providing more food for kiwi (refer to Section 5.3).

- Exclusion or control of grazing animals (domestic livestock, feral goats (*Capra hircus*), to provide more cover and reduce the risk of trampling of kiwi.

- Restoration of indigenous forest and shrubland habitats particularly buffers to existing habitat and corridors between habitats. Corridors need not be continuous as kiwi will cross open pasture for at least 400 m (Potter 1990) and potentially several kilometres in rough country with isolated forest or shrubland remnants. In many cases a laissez-faire approach of allowing shrubland (exotic and indigenous) to regenerate is adequate, although active seed collection and planting may be needed if seed sources are limited (c.f. NBEG 2004).

- The lack of burrows in some shrubland habitats forces kiwi to shelter above the ground which makes them more vulnerable to dogs. An option is to provide artificial burrows constructed of wood and pinned to the ground to prevent rolling by dogs or pigs.

- Formal protection of indigenous forest and shrubland habitat to ensure it is not cut down in the future e.g. QEII Trust, conservation covenants, District Council covenants (NBEG 2004).

5.9 Plantation forest management

Kiwi can be managed in plantation forests particularly if there are large enclaves of indigenous forest to provide the nucleus of a protected area. Requirements for pest management are identical to indigenous habitats (refer to Sections 5.1-5.4).

Kiwi also occur in exotic plantation stands and forest management practices can be implemented to reduce risks to kiwi:

- Maintain indigenous enclaves and corridors;

- Enhance revegetation to provide cover and maintain soil moisture levels;

- Plan harvesting implementation that allows escape routes to refugia and avoids the creation of "isolated" stands;

- Avoid burning as it can incinerate kiwi hiding in slash piles as well as drying out the substrate;

- Rescue injured kiwi and eggs from abandoned nests (refer to Section 5.6);

- Implement dog and pig control (refer to Section 5.2);

- Ensure that pest control operations do not impact on kiwi, e.g. elevate traps 700 mm above the ground and avoid bio-accumulative herbicides or pesticides;

- Ensure that staff, contractors, and visitors are aware of the presence of kiwi and related protective measures, e.g. dog exclusion, interpretation panels;

- Need to check resource consent requirements (with NRC);

- When planning for clearance of scrub (including gorse), consider whether kiwi may be present (refer 5.11 Monitoring) and implement appropriate precautions, e.g. provide escape routes, undertake translocations if there are no escape corridors, or there is no suitable alternative habitat nearby.

5.10 Fences

Fences may become effective tools for managing kiwi populations in the following ways:

- Predator exclusion fences, as proposed for Bream Head, may provide opportunities for the reintroduction of little spotted kiwi; as well as maintaining a protective environment for the present population of brown kiwi;

- Kiwi fences made from netting designed to prevent kiwi dispersal into dangerous sites (e.g. subdivisions with dogs), and to channel movement towards safe road crossings (e.g. bridges);

- Netting fences that direct predators towards intensive trap sites.

5.11 Monitoring

Monitoring can be undertaken by call-counts, a combination of call-counts and territory mapping, the use of kiwi dogs, assessments of footprint size, and intensive telemetry (refer to Robertson and Colbourne 2003). The first four of these methods are discussed further below.

Call-count monitoring

Most Northland monitoring is based on call-count monitoring. This was initiated in the mid-1990s and it was refined in the early 2000s as new management areas were established. The following guidelines should be applied for call-count monitoring in a typical kiwi population cluster:

- Select six or more stations that provide good listening coverage of (potentially) high numbers of kiwi. Where possible, allocate the same listener to each station for consistency between years and use exactly the same listening position;

- At each of the stations, listen during the first two hours after dark on four calm nights (these need not be consecutive) during the dark phase of the moon in late

May-June. Two hours are essential (not one hour) as there is high intra-night variation in calling rates between the first and second hours (but less inter-night variation for two hours);

- Complete the standard kiwi listening forms or, preferably, an electronic template derived from the standard forms. If using standard forms, record each hourly period on a separate sheet, to obtain a total of eight one-hour counts for each station. Send completed forms to local kiwi listening coordinator (details provided annually).

Call-count monitoring is a useful method to determine whether pairs of kiwi are present year to year and is sensitive enough to detect declines in kiwi populations. It is less useful for the detection of increases in numbers because of a 2-3 year lag in sub-adult calling rates (refer to section on Age structure below).

Territory mapping

In addition to collecting call-count records, it may be useful to map the locations of birds calling on each of the four nights, which will help to determine the number of pairs in each listening area. It may be assumed that each male will call at least once during the four nights and that each male will have a mate.

Age structure

It is worth determining the age structure of kiwi populations in areas where there is uncertainty about the effectiveness of trapping. This can be achieved using a certified kiwi dog and handler to find and age a sample of 20-30 kiwi. This will help to determine the survival of kiwi chicks and juveniles and could be repeated at 3-5 year intervals. It is best carried out in areas which have moderate to high kiwi numbers, so that a statistically robust number of detections are made.

Footprint size

An alternative to the age structure method (above) is to measure the length of all kiwi footprints seen during the winter months (however be aware that their footprints are similar to turkey prints). Footprint lengths of *c.*50-80 mm represent young kiwi that have survived (or hatched after) the summer period of greatest stoat abundance. Footprints over 90 mm in length are likely to be adults. This approach will provide an indication as to whether some young birds are being recruited into a population.

6. MANAGEMENT FOR WIDER SPECIES AND ECOSYSTEM BENEFITS

Management requirements to protect and enhance kiwi populations are relatively simple – eradicate or control mustelids, dogs, and cats to low levels, and minimise deaths and injuries involving road vehicles, artificial ponds, cattle-stops, and other threats. This management regime also produces benefits for many other fauna species, particularly the following:

- Pateke are vulnerable to the same suite of mammalian predators as kiwi and are also vulnerable to collisions with road vehicles. An extensive part of the east coast of Northland (Teal Bay, Mimiwhangata, Whananaki) is being managed for pateke recovery by the DOC and many pateke occur in, or have recently returned to, other "kiwi management areas" (Russell Peninsula, Purerua, Tutukaka). This trend could well continue throughout managed sites on the east coast and at sites in the northern Bay of Islands. Management prescriptions for this species are being developed by the Pateke Recovery Group.

- Other wetland birds, e.g. matuku (Australasian bittern; *Botaurus poiciloptilus*) and banded rail (*Rallus phillipensis*). These species also suffer from predation and vehicle collisions. They are uncommon in most kiwi management zones, but where they do occur they are likely to benefit from standard "kiwi management".

- Coastal birds, such as karora (little blue penguin; *Eudyptula minor*), oi (grey-faced petrel; *Pterodroma macroptera*), and reef heron (*Egretta sacra*) are vulnerable to predators and currently breed only sparingly along the Northland coast and islands, but could potentially breed in all coastal sites currently being managed for kiwi.

- Kaka, weka (*Gallirallus australis*), and kukupa (NZ pigeon; *Hemiphaga novaeseelandiae*) are affected by various combinations of dogs, mustelids, possums, and cats, and benefit when these predators are controlled to low levels.

- Shorebirds, such as northern New Zealand dotterels (*Charadrius obscurus*) and variable oystercatchers (*Haematopus unicolor*), are susceptible to a wide range of mammalian pests, and also benefit from pest control.

One of the challenges for the kiwi programme is to provide more integrated management for other fauna species and forest ecosystems generally. For example, by controlling possums to low levels, forest health and ecological processes (flowering, fruiting, seed dispersal) will improve, along with numbers of many forest birds, including kukupa. By targeting rats in addition to possums and other herbivores (e.g. goats and pigs), germination and growth rates will increase. Many bird species, e.g. red-crowned kakariki, North Island kaka, bellbird (*Anthornis melanura*), and kukupa, have recently increased where more integrated management is being implemented in areas such as Bream Head, Whangarei Heads, Tutukaka and Purua.

Although most bird species require rat control only during the breeding season, year-round control of rats, mice, and hedgehogs would provide benefits for many terrestrial species, e.g. lizards, weta, kauri snails, and other invertebrates. Kiwi and other insectivorous and omnivorous species may also benefit physiologically from sustained rodent control if it improves the abundance and variety of invertebrates and fruit on the forest floor. There may be further benefits of rodent control, resulting from fewer mustelids and cats being attracted to an area, but this has not been studied. A key consideration to be aware of is that targeted control of higher predators (mustelids and cats) may result in increased rodent densities, and hence lead to harmful effects to those species most vulnerable to rats and/or mice.

Appendix 1 lists some key biota of indigenous forest and wetland habitats in Northland and the pest animal and plant species that need to be targeted in order to achieve recovery of indigenous species in these habitats.

Simple monitoring is encouraged in order to measure responses of other key biota to particular pest regimes. This can range from simply recording sightings of species such as matuku, pateke, kaka, kakariki, and penguins; more prescriptive monitoring of kukupa; measuring numbers of pairs and annual productivity of shorebirds; or vegetation monitoring and invertebrate transects (refer to Handford 2000 and NBEG 2004). Refined templates for monitoring are also available from the New Zealand Landcare Trust

7. RESOURCING AND SUPPORT

7.1 Funding sources and applications

The level(s) of predator control required to implement a kiwi recovery project often requires input from expert trappers and relatively expensive equipment, and also has considerable requirements for advocacy. There are a range of options for securing financial support for groups and individuals seeking to implement a kiwi recovery project.

It is strongly recommended that applications for funding are submitted with a management plan that has clear objectives linked to a task-based implementation programme, to show evidence of good planning, detailed knowledge of local biota and threats, and an appreciation of what will be involved in carrying out the plan. Planning templates are being developed by the New Zealand Landcare Trust. The key to successful applications is often the ability to tailor a project to meet the stated criteria of a particular fund. Factoring in an 'in-kind' contribution is important – including all the time, resources, and financial support that the applicants themselves will put in. Indications of support from other agencies or projects are also very useful. Many funding organisations also prefer to fund group-based projects rather than individuals – see Section 7.4 below. Some require that groups be legal entities (such as a charitable trust or incorporated society), most have specific application forms and many are only open for applications at specific times.

The following are some key potential sources of funding for kiwi recovery projects in Northland:

The **Bank of New Zealand Kiwi Recovery Trust** welcomes funding applications from kiwi conservation organisations seeking to enhance kiwi populations. The Trust's funds are allocated through a yearly funding cycle on a contestable basis. Applications generally close in May, for funding for the following July to June.

The **WWF Habitat Protection Fund** has also provided significant assistance for predator control for kiwi recovery projects in Northland. Their funds are allocated three times a year, with applications closing on 1 February, 1 June, and 1 October.

Central government's **Biodiversity Condition Fund** is jointly administered by the DOC and the Ministry for the Environment and aims to improve and then maintain the condition of indigenous vegetation, species, and habitats. A number of kiwi recovery projects in Northland have benefited significantly from Condition Fund support. Technical advice and planning input can be obtained via the **Biodiversity Advice Fund**. Both of these funds are only available for private or Māori land.

Other sources of funding include the **Transpower Landcare Trust Grant** programme (which have provided seed funding for a number of Landcare group projects), **Northland Regional Council's Environment Fund, Gaming organisations, the ASB Trust, and Nga Whenua Rahui**.

New Zealand Landcare Trust coordinators have a good understanding of the various funding sources and are able to help groups with their funding proposals. Further details occur in Restoring the Balance (2004) – copies are available from Northland Regional Council. Securing funding for long term kiwi recovery projects remains a potentially significant challenge for the sustainable management of kiwi populations in Northland.

7.2 Collaborative management

Stoats can have a home range of more than 200 ha, and Northland kiwi have been monitored dispersing up to 15-20 km from their natal burrows. The scale of kiwi projects means that collaborative approaches with other landowners and managers are usually essential to protect sufficient areas of habitat.

In many of these cases where people work collaboratively with their neighbours, either formally or informally, to protect kiwi habitat, they are taking a 'landcare approach'. There are now over 20 community groups addressing kiwi issues in Northland. The New Zealand Landcare Trust is available to help such collaborative projects get started, find funds, and provide access to practical advice.

It is not only adjoining landowners that are the key to a successful collaborative management approach. Involvement and engagement with a wide range of community 'stakeholders' and government agencies (DOC, District and Regional Councils), will enhance the success of a project. As discussed in Section 7.3 below, the DOC has a wide range of technical expertise in kiwi management that can assist to increase the success of kiwi recovery projects.

In Northland, the NZ Kiwi Foundation is taking another approach to collaborative management. The Foundation currently manages more than 15,000 ha of private land for kiwi protection and enhancement – much of it with funding support from the landowners involved.

Northland Kiwi Landcare Forum

Under the auspices of Northland Kiwi Landcare Forum, the New Zealand Landcare Trust provides coordination, assistance, and networking opportunities for community groups carrying out kiwi protection focused projects. The forum provides an umbrella to facilitate close liaison between these groups and supporters. Representatives of the Bank of New Zealand Kiwi Recovery Trust, NZ Kiwi Foundation, NZ Landcare Trust, landcare groups and DOC are all striving to avoid duplication of effort and ensure that the needs of kiwi in Northland are met. It also seeks to support and maintain the motivation and enthusiasm of those involved in protection of kiwi habitat. A loss of focus and 'burnout' of individuals is a very real risk to maintaining the effort required to sustain kiwi populations on private land. The efforts of the many individual landowners who are not part of group projects are also recognised.

7.3 Technical support and training

Kiwi recovery projects require application of specialist technical knowledge and training. This has been mainly in the areas of operational planning, kiwi monitoring, and hands-on predator control techniques.

Northland is singularly fortunate to have a number of highly skilled and experienced practitioners in the region, most of whom are also excellent communicators, providing an extremely valuable resource for the many kiwi recovery projects underway in the region.

Department of Conservation

The Northland Conservancy of the DOC has a number of staff with considerable experience in kiwi population recovery, with knowledge and skills developed during projects such as management of Trounson Kauri Park, the Whangarei Kiwi Sanctuary, and Waitangi Forest. Their skills include predator control, Operation Nest Egg initiatives, and intensive monitoring, including the use of kiwi dogs. Their willingness to share this expertise with other kiwi recovery projects is increasingly resulting in upskilling of community-driven projects. The success of community initiatives for kiwi recovery in Northland relies on this level of technical support being maintained and extended. A key area for future DOC effort is trialling alternative means of predator control to identify the most cost-effective techniques.

Bank of New Zealand Kiwi Recovery Trust Advocate (in association with the NZ Landcare Trust)

This position contributes a wealth of kiwi management experience in to the Northland region, providing expertise to many projects, particularly those on private land.

New Zealand Landcare Trust – Trapper Training, Operational Planning

Predator trapping is generally accepted as requiring specialist knowledge and input, although the 'science' of predator control is still evolving. One component of ensuring that community-driven predator control projects achieve maximum potential is to

ensure that the trappers involved share information with other trappers and practitioners, and have easy access to experience and new methods and products developed elsewhere in the country.

Training opportunities for trappers are currently facilitated by the New Zealand Landcare Trust, with expert input from a range of others, including DOC trappers, and Bank of New Zealand Kiwi Recovery Trust advocates.

Many projects struggle with the development of credible, practicable and effective operational plans for their projects. The New Zealand Landcare Trust has a current project to develop templates and resources to assist with this issue. Independent experts, e.g. Dr Ray Pierce, have been contracted by the Trust and DOC to assist in the areas of project development, review, and on-going technical advice. Other specialists include veterinarian, recovery centre and Auckland zoo personnel.

8. OVERVIEW OF FUTURE MANAGEMENT

Kiwi have been declining in Northland at the rate of about 4% per annum and are now confined to about 25 population clusters. About 20 of these clusters are currently actively managed by DOC, Landcare groups, NZ Kiwi Foundation, Carter Holt Harvey, and others. Recovery and sustainability of these populations in Northland will require ongoing collaborative effort between landowners, communities, agencies, and other parties. Key recommendations to achieve protection, recovery, and sustainable integrated management of kiwi and other threatened species in Northland are set out below:

- Establish management units that can accommodate several hundred pairs of kiwi, i.e. sites of 1,000+ ha containing large patches of forest or shrubland (refer to Figure 2 and Section 4.2).

- Aim to protect a diverse suite of indigenous biodiversity at kiwi management sites, e.g. work towards integrated management that addresses the effects of other pest animals and pest plants, and other threats (refer to Sections 4.2 and 6).

- Select management sites that optimise the likelihood of kiwi recovery and, ultimately, support initiatives to return kiwi to their former range after securing viable populations within their current range, e.g. lower Northland and on the Aupouri Peninsula (refer to Section 4.2).

- Establish and maintain habitat corridors within and between kiwi population clusters, unless the level of risk (to kiwi) within the corridors is too high (refer to Section 4.4).

- Maintain year-round predator control at managed sites, recognising not only seasonal vulnerability to stoats, but also year-round vulnerability to ferrets (refer to Section 5.1).

- An urgent key need is to focus on minimising dog impacts, which requires collaborative work between communities; hunting clubs, DOC, and Councils, to

ensure that important kiwi habitats and corridors are recognised and managed accordingly (refer to Figures 2 and 3, and Section 5.2).

- Other causes of death, e.g. road-kills and drowning, need to be addressed at an individual and community level and also via statutory planning processes (refer to Section 5.4).

- Maintain annual call-count monitoring at all kiwi management sites and, if necessary, implement more intensive monitoring (refer to Section 5.11).

- All sites that are being managed for kiwi (and other vulnerable biota) should have a management plan in order to provide a clear management direction and to assist with obtaining ongoing support and resourcing (refer to Section 7.1).

- Maintain and, if possible, expand the currently high level of technical support provided by the DOC to community initiatives and increase the levels of support from Councils (refer to Sections 7.2, 7.3).

- Ensure that the current level of technical input facilitated and provided by the New Zealand Landcare Trust to support community initiatives is maintained via workshops, field support, information sharing, reviews, and other opportunities as they arise (refer to Section 7.3).

- Ongoing funding is required at levels adequate to maintain a professional approach to the sustained implementation of predator trapping.

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REFERENCES

Butler D., McLennan J. 1991: Kiwi Recovery Plan. *Threatened Species Recovery Plan Series No. 2*. DOC, Wellington.

Clapperton K., Advances in New Zealand mammalogy 1990-2000: Feral ferret. *Journal of the Royal Society of New Zealand 31*: 185-203pp.

Colbourne R. 1999: Kiwi in exotic forests. In: Notes from a workshop on kiwi in exotic forests, Whangarei, May 1999. Unpublished report, DOC, Whangarei.

Colbourne R. and Kleinpaste R. 1983: A banding study of North Island brown kiwis in an exotic forest. *Notornis 30*: 109-24.

Gillies G. 2001: Advances in New Zealand mammalogy 1990-2000: House cat. *Journal of the Royal Society of New Zealand 31:* 205-218.

Handford 2000: Native forest monitoring: a guide for forest owners and managers.

Heather and Robertson 2000: The field guide to the birds of New Zealand. Viking, Auckland.

Herbert T. 2000: Kiwi monitoring. in Trounson Kauri Park Mainland Island annual report for 1999-2000. *Unpublished report*. DOC, Waipoua.

King C.M., Griffiths K., Murphy E.C. 2000: Advances in New Zealand mammalogy 1990-2000: Stoat and weasel. *Journal of the Royal Society of New Zealand 31:* 165-183.

Marchant S. and Higgins P.J. (eds) 1990: Handbook of Australian, New Zealand and Antarctic Birds, Vol. 1. OUP, Melbourne.

McLennan J.A. 1992: Nationwide monitoring of kiwi populations *DSIR Land Resources Contract Report No. 92/91*. Prepared for Science and Research Division, DOC, Wellington.

McLennan J.A., Potter M.A., Robertson H.A., Wake G.C., Colbourne R., Dew L., Joyce L., McCann A.J., Miles J., Miller P.J. and Reid J. 1996: Role of predation in the decline of kiwi, *Apteryx* spp. *New Zealand Journal of Ecology 20*: 27-35.

Miller P.J. and Pierce R.J. 1995: Distribution and decline of the North Island brown kiwi (*Apteryx australis mantelli*) in Northland. *Notornis 42*: 203-11.

NBEG 2004: Restoring the Balance: Biodiversity self help toolkit. Northland Biodiversity Enhancement Group.

Pierce R.J. 2003: Kiwi Management Plan for Carter Holt Harvey Forests. *Wildland Consultants Ltd Contract Report No. 547*. Prepared for Carter Holt Harvey, Tokoroa.

Pierce R.J. 2004a: Call-count monitoring results for North Island brown kiwi in Northland 2002. *Wildland Consultants Ltd Contract Report No. 946*. Prepared for DOC and New Zealand Landcare Trust, Whangarei.

Pierce R.J. 2004b: Surveys of kiwi in Carter Holt Harvey Forests in Northland, April-June 2004. *Wildland Consultants Ltd Contract Report No. 895*. Prepared for Carter Holt Harvey, Tokoroa.

Pierce R. and Sporle W. 1997: Causes of kiwi mortality in Northland. *Conservation Advisory Science Notes No 169.* DOC, Wellington.

Pierce R.J., Westbrooke I.M. 2003: Call count responses of North Island brown kiwi to different levels of predator control in Northland, New Zealand. *Biological Conservation 109:* 175-180.

Pierce R.J., Miller N.M., Neill E., Gardiner C., Kimberley M. 2005: Field trials of fresh and long-life bait trials for stoats in Northland. *Wildland Consultants Ltd Contract Report No. 1113*. Prepared for DOC, Whangarei.

Potter M. 1990: Movement of North Island Brown Kiwi (*Apteryx australis mantelli*) between forest remnants. *New Zealand Journal of Ecology 14*: 17-24.

Robertson H.A. 2003: Kiwi Recovery Plan 1996-2006. DOC, Wellington.

Robertson H. 2005a: Are Northland Kiwi Doomed? *Unpublished Powerpoint presentation*. Science and Research Unit, DOC, Wellington.

Robertson, H. 2005b: Are Kiwi Doomed? *Unpublished plenary lecture*. 3rd Biennial Australasian Ornithological Congress. Blenheim.

Robertson H.A., Colbourne R. 2003: Kiwi (*Apteryx* spp.) Best Practice Manual. DOC, Wellington.

Robertson H.A., Colbourne R., Graham P., Miller P.J. and Pierce R.J. 1999a: Survival of brown kiwi exposed to 1080 poison used for control of brush-tail possums in Northland, New Zealand. *Wildlife Research 26:* 209-14.

Robertson H.A., Colbourne R., Graham P., Miller P.J., and Pierce R.J. 1999b: Survival of brown kiwi (*Apteryx mantelli*) exposed to brodifacoum poison in Northland, New Zealand. *New Zealand Journal of Ecology 23*: 225-231.

Sporle W. 2004: Whakaangi Kiwi Survey 2004 (draft). *Unpublished report*. Prepared for Whakaangi Landcare Group.

Taborsky M. 1988: Kiwis and dog predation: Observations in Waitangi State Forest. *Notornis 35*: 197-202.

APPENDIX 1

LIKELY EFFECTS OF KEY PEST MAMMALS ON SOME INDIGENOUS NORTHLAND BIOTA

	Possum	Mustelid	Cat	Dog	Rat*	H'hog	Pig
Kiwi	✓	✓✓	✓✓	✓✓			✓
Pateke	?	✓✓	✓✓	✓✓	✓✓		✓
Bittern	✓	✓✓	✓/✓✓	✓✓			✓
Blue penguin	✓/✓✓	✓✓	✓✓	✓✓	?		✓
Kukupa	✓✓	✓✓	✓/✓✓		✓✓		
Kokako	✓✓	✓✓	✓/✓✓		✓✓		
Kaka	✓✓	✓✓	✓✓	✓	✓/✓✓		
Kakariki		✓✓	✓		✓✓		
Robin/tit	✓	✓/✓✓	✓		✓✓		
Lizards		✓/✓✓	✓/✓✓		✓✓	?	
Shorebirds	✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓
Kauri snail, other invertebrates	✓✓	✓	✓		✓✓ + mice	✓/✓✓	✓✓
Fernbird		✓			✓✓		
Crakes/rails		✓			✓		
Bats	?	?			?		
Forest understorey	✓✓				✓✓		Browser/ grazer, weeds
Flowering/fruiting	✓✓				✓		
Threatened plants	✓/✓✓				?		Browser/ grazer, weeds

Key: ✓✓ = High impact; ✓ = Possibly low/lesser impact

* Primarily ship rats, but Norway rats also have negative impacts on shorebirds, kaka, lizards, snails, and other invertebrates.

Note: Other pests, e.g. mice, wasps, Argentine ants and weeds, can also have direct and indirect negative effects on indigenous fauna.

APPENDIX 2

DATA SHEET FOR SICK OR INJURED KIWI

Species:	Date:	Locality and Grid:
Observer and Address:		
Bill length (mm):		Weight (g) and date:
Diagnosis/ Cause of injury: (attach veterinary/autopsy report, photographs)		
Details: (e.g. band no., sex, age, description of rehabilitation)		
Fate of bird: (attach copy of the veterinary health clearance given before release)		

APPENDIX 3

DATA SHEET FOR DEAD KIWI OR KIWI EGGS

Species:	Date:	Locality and Grid:
Observer and Address:		
Bill length (mm): or Egg measurements:		Weight (g):
Cause of death: (attach autopsy report, photograph, etc)		
Details: (e.g. band no., sex, nest identification)		
Fate of specimen:		

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