Potential translocation sites for kokako in Taranaki

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ABSTRACT

During the twentieth century, the North Island kokako population in Taranaki, New Zealand, was reduced almost to extinction. Following initial habitat loss, predation by introduced brush-tailed possums and ship rats was identified as the main cause of decline. These predators can now be controlled to levels that will allow kokako populations to survive. This makes the translocation of kokako to Taranaki a possibility. This study examines the ecological requirements of kokako, predator control, translocation techniques, and evaluates the suitability of four Taranaki sites for translocations. The costs of predator control and benefits to other species are also considered. All four sites investigated proved ecologically suitable, but varied in terms of costs, practicality, and the benefits to other species. The two sites still holding remnant kokako—Waitaanga and Moki–Makino—are the most difficult sites to access and would be the most expensive to establish and operate. Whitecliffs would be the cheapest site in which to establish predator control. Egmont is the second cheapest option and there are synergies with blue duck and North Island brown kiwi programmes. Waitaanga, Moki–Makino and Egmont are all large forest blocks (>10 000 ha) and predator control would be carried out in core areas (c. 4000 ha) with the risk that birds might disperse through the remainder of the forest. Whitecliffs is a more discreet block, and predator control could be carried out across its entire area.

Keywords: North Island kokako, *Callaeas cinerea wilsoni,* species translocation, bird conservation, conservation areas, Taranaki, New Zealand

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1. Introduction

North Island kokako *Callaeas cinerea wilsoni* (hereafter termed kokako) were once widespread in the North Island of New Zealand. Over the last century, they have disappeared from many areas (Innes & Flux 1999). A survey of Taranaki forest between 1977 and 1981 found only localised populations (O'Donnell 1982). By the 1990s, kokako had declined almost to extinction in Taranaki. Four of the remaining birds were removed from the Waitaanga Conservation Area and Moki–Makino Conservation Area between 1993 and 1999 in the expectation that their offspring would be returned to Taranaki if and when causes for their initial decline could be overcome (Innes & Flux 1999). This expectation is shared by Taranaki iwi, particularly Ngati Tama from whose rohe the birds were removed.

Innes et al. (1999) analysed the response of kokako populations to different management regimes in two treatment and one non-treatment block. They were able to show conclusively that predation is the major cause of kokako decline in unmanaged forests and, more specifically, that introduced possums *Trichosurus vulpecula* and ship rats *Rattus rattus* are the key agents of decline. Eggs, nestlings, and nesting females are the most vulnerable, which suggests that the few remaining wild birds in Taranaki are likely to be old males. Stoats *Mustela erminea* are also predators of kokako, and the kokako in Te Urewera have been more successful in core areas where stoats are controlled (Jeff Hudson pers. comm.). However, it is now accepted that kokako populations are capable of increasing in the absence of stoat control, if possum and ship rat numbers are kept below certain limits (Flux & Innes 2001).

After several years of management at Mapara, near Te Kuiti, (Bradfield & Flux 1996), core areas of Te Urewera National Park (Hudson et al. 1995; Beaven et al. 1999, 2000; Burns et al. 2000) and other sites, possum and ship rat control techniques have been refined to the point where these predators can reliably be kept to the very low levels needed for kokako populations to recover. It is now theoretically possible to apply these techniques to sites in Taranaki in order to be able to reintroduce kokako.

One tool which has been used to manage kokako is translocation to sites in which predators are either controlled or non-existent (Innes & Flux 1999). Both hard (release direct into the wild) and soft releases (caging and/or supplementary food) have been, or are being employed. Hard releases have been used successfully, but releasing substantial numbers (20+) of birds at mainland sites is untested. A perceived drawback to releasing kokako into large areas of forest is that they could move out of a predator control area. To overcome this, a system is being trialled at Boundary Stream Scenic Reserve in which captured kokako are encouraged to breed in aviaries and their offspring released as juveniles. At the time of writing, no breeding has occurred in these aviaries so the system remains unproven.

This study investigates the possibility of restoring kokako to part of their former range in Taranaki. Factors involved in their demise are considered, and management options to reverse these conditions are discussed.

Recommendations are made on possible translocation sites, translocation methods and predator control options, with costs estimated for the most likely options.

1.1 POTENTIAL SITES IN TARANAKI

Four potential translocation sites in Taranaki have been considered suitable for kokako (Department of Conservation files, Wanganui), these are:

Whitecliffs Conservation Area This is an area of coastal and semi-coastal podocarp–broadleaved forest and scrub covering 1856 ha on the coast north of New Plymouth. The terrain consists of steep ridges prone to slipping to a papa base.

Waitaanga Conservation Area This is a tall, dense and varied forest covering 16 132 ha, dominated in places by podocarps, rata, and other broadleaved species, with stands of beech forest. The southern part is still virgin forest, while much of the forest in the north has been cut over. The terrain is a repeating series of steep ridges and valleys.

Moki Conservation Area and Makino Conservation Area (hereafter termed Moki–Makino) These adjoining areas cover 3517 ha and 7189 ha respectively. They contain a mix of forest types, from regenerating podocarp forest in the east, through broad-leaved forest with emergent podocarps and rata, to stands of beech on some ridges and some areas of scrub. The terrain is also a repeating series of steep ridges and valleys.

Egmont National Park This area, covering 33 784 ha, has an altitudinal sequence of vegetation from lowland, broadleaved forests with emergent rata through to subalpine scrub and alpine herbfields. It also contains areas of swamp vegetation. Forest in the north and west is considered suitable for kokako.

Egmont National Park, Waitaanga Conservation Area, and Moki–Makino Conservation Area are all administered by the Department of Conservation. Parts of the existing Whitecliffs Conservation Area and some other adjacent or nearby protected areas are included in a Deed of Settlement between the Crown and Ngati Tama. The Settlement has yet to be fully implemented. The parts of Whitecliffs Conservation Area and some other protected areas adjacent or nearby (i.e. Mount Messenger Scenic Reserve) will have their protected area status uplifted and will be transferred to Ngati Tama ownership. A conservation covenant will be established on the new title to these areas in order to ensure ongoing protection and reasonable public access. An Advisory Committee made up of Ngati Tama and Minister of Conservation nominees is proposed to be established for the newly covenanted areas and the adjoining conservation areas to provide advice to the Minister of Conservation and Ngati Tama on management and conservation issues with these lands. It is hoped that the Committee will ensure co-ordinated conservation management occurs for the benefit of everyone involved.

Before a translocation site can be chosen it is important to consider if it would provide for the ecological requirements of kokako, if predator control at that site is possible, which translocation method will be most suitable and what will the relative costs of each site be, as well as the potential benefits to other species. Addressing these issues is the purpose of this study, which is intended to guide future decisions about how and where to return kokako to Taranaki.

2. Objectives

The objectives of this study were to assess:

- The ecological requirements of kokako, and whether the proposed Taranaki sites provide for them
- Requirements for predator control at the proposed Taranaki sites
- Translocation techniques which could be used to restore kokako to Taranaki
- Potential benefits for other threatened species at the translocation site

3. Methods

Information needed to assess ecological and predator control requirements for kokako and translocation techniques is summarised in Flux & Innes (2001), Innes & Flux (1999) and Innes et al. (1999). These documents provided a foundation for the assessments made in thus study. However, there has been progress made in understanding of kokako management since they were published. Some of this information remains unpublished or in Department of Conservation files. A number of published and unpublished reports were studied to supplement this basic information.

Discussions were held with Jeff Hudson, then the kokako recovery group leader, and other Department of Conservation staff in Opotiki, Te Kuiti, New Plymouth, Stratford and Wanganui. As well as seeking to get updated information on kokako management and translocation techniques, information was sought on any predator control operations or monitoring which were not yet described in the literature, as well as any historical, social or practical information which could impact on the success of any planned kokako translocation.

Field trips were made to four locations in which kokako have been successfully managed. These were Otamatuna (Te Urewera National Park), Rotoehu, Ranginui (Waipapa Ecological Area) and Mapara. The aim of these field trips was to see at first hand habitat in which kokako flourish and further assess aspects such as vegetation, topography and predator control.

Finally, field trips were made to Taranaki sites previously considered as potentially suitable for reintroduction of kokako (Waitaanga, Moki–Makino, Whitecliffs and Egmont National Park). These trips were mainly to assess aspects such as vegetation and topography but practical aspects, such as access, were also considered. Common features of areas where kokako have been successfully managed were compared to those of the suggested Taranaki release locations.

There are many variables which may affect the suitability of one site versus another, these include: security, access, choice of translocation technique, labour costs, potential bebfits for other threatened species, and cultural considerations. Each site was considered in the light of these variables and recommendations made which allow for more than one possible scenario.

4. Results

4.1 ECOLOGICAL REQUIREMENTS

Kokako feed on a variety of food sources, including fruit, leaves, epiphytes, invertebrates, buds, flowers, and nectar (Powlesland 1987). They have simple requirements for location and construction of their nests. In the absence of introduced mammalian predators, they were widespread throughout the North Island, indicating that they are able to utilise a variety of forest types. There is little evidence that competition for food is a limiting factor (Innes et al. 1999). In light of this knowledge, it is reasonable to assume that forest which is similar in terms of climate, topography and vegetation to sites in which kokako currently thrive will potentially support a translocated population.

Kokako are currently found at altitudes from less than 200 m a.s.l. at Kaharoa and Rotoehu to about 750 m a.s.l. in the Urewera and Waipapa. All the suggested Taranaki release sites fall entirely or mostly within this range. (Parts of Egmont National Park are considerably higher than this, but the proposed translocation site in the park is at about 500 m a.s.l.)

Though rainfall figures for specific kokako locations are hard to find, the annual rainfall figure for Pureora of 1800 mm (Powlesland et al. 1998) is probably a fair average for 'typical' kokako habitat. Locations with less than half this figure or more than double this figure may not be suitable. Rainfall for most of Taranaki is within this range (Bayfield et al. 1991; Department of Conservation 2002; Ravine 1996). Annual rainfall in western parts of Egmont National Park is about 1500 mm. This rises drastically up to 7500 mm at North Egmont which suggests that not all of Egmont National Park may be suitable for kokako.

Powlesland et al. (1998) quote a mean annual temperature at Pureora of 10.5ºC, which would be similar to much of Te Urewera and cooler than Rotoehu. Mean annual temperatures are not available from proposed release sites but in inland Taranaki they range from 12–13.5ºC (Ravine 1996). The northern Taranaki sites would be close to this, but Egmont would be cooler, especially at altitude. There is nothing to suggest that temperature would be a problem for a translocation.

Topography of sites where kokako are currently found varies considerably, from flat or undulating in parts of Rotoehu and Waipapa to steep ridges and valleys at Otamatuna and Waitaanga. It is unlikely that topography would be a limiting feature for kokako survival. At Waitaanga and Moki–Makino, the country is typical of North Taranaki with repeating series of steep ridges and valleys, not unlike Te Urewera. Whitecliffs is similar but in places slips have revealed underlying papa and the ridge slopes are even steeper. The terrain in Egmont National Park is varied, but in the proposed release site is considerably gentler than the other sites, with a gentle rise to the south being broken by several small streams and rivers. This is similar to Waipapa.

In the managed kokako sites visited during this study, the vegetation is varied. The canopy at **Mapara** is dominated by tawa *Beilschmiedia tawa*, with few emergent podocarps and occasional rewarewa *Knightia excelsa*, and hinau *Elaeocarpus dentatus*. The understorey, as is often the case in tawa dominated forest, is sparse through much of the forest. Near the edges or where there are light gaps, it comprises hangehange *Geniostoma rupestre*, kanono *Coprosma grandifolia*, mahoe *Melicytus ramiflorus*, karamu *Coprosma robusta*, shining karamu *Coprosma lucida,* and fuchsia *Fuchsia excorticata*, with pate *Schefflera digitata* common in wetter places. Goat-palatable species have increased considerably since goat control was initiated in 1979 (Bradfield & Flux 1996). **Rotoehu** is similar with more emergent podocarps. The part visited had fewer shrubs and more tree ferns in the understorey, with supplejack, *Ripogonum scandens,* also plentiful. **Otamatuna** is more diverse, with several broadleaf species in a more open canopy, including tawa, rewarewa, quintinia *Quintinia serrata*, hinau and kamahi *Weinmannia racemosa*, with emergent northern rata *Metrosideros robusta*, rimu *Dacrydium cupressinum*, occasional totara *Podocarpus totara*, and miro *Prumnopitys ferrugineus*. There are also small pockets of hard beech *Nothofagus truncata*. The understorey is both thicker and more diverse than Mapara or Rotoehu. The same common species are present, but there are many other species, such as marbleleaf *Carpodetus serratus*, small-leaved Coprosmas *Coprosma* spp., pepperwood *Pseudowintera colorata,* and other small trees and shrubs, interspersed with stands of ponga *Cyathea dealbata*.

Ranginui is very different to the other locations. It is dominated by tall podocarps, mainly rimu, kahikatea *Dacrycarpus dacrydioides,* and matai *Prumnopitys taxifolia*, with occasional smaller tawa. The same common shrub species are present in the understorey, but are more scattered, with ponga and other tree ferns being much more common. Supplejack is also widespread.

Kokako appear to successfully utilise a variety of forest types, however at some sites birds may be unevenly distributed within forest blocks. Within the managed area at Otamatuna, kokako remain largely confined to older forest on upper slopes and ridge tops and spend less time in secondary forest lower down (Jeff Hudson pers. comm.). A similar situation occurs at Mapara (Tertia Thurley pers. comm.). Kokako may have a preference for older, mature forests over younger regenerating forest, but this remains unclear. Potential reasons are unknown but could be related to the density and variety of epiphytic species, the presence of particular epiphytes (pers. obs.; Jeff Hudson pers. comm.) greater diversity of food types or social or song factors. All potential Taranaki translocation sites contain suitable mature forest, with dominant species similar to either Mapara or Ranginui, although there is some variation within and between these forests.

South Waitaanga is the most intact of the Taranaki forests (North Waitaanga is largely secondary forest). The tawa- and kamahi-dominated canopy is overtopped by many, very large rata and rimu trees, with some large totara, kahikatea, and matai also emerging. Hinau and rewarewa are also common in the canopy. The understorey comprises ponga, mahoe, marbleleaf, karamu, hangehange and other shrubs, and tree ferns. The larger trees carry a substantial load of epiphytes. Parts of Waitaanga also have stands of hard beech or silver beech *Nothofagus menziesii*.

Moki–Makino is similar to Waitaanga, but there has been selective logging over much of the area. This has resulted in stands of younger podocarps (rimu, totara, and kahikatea) in the east and tawa-dominated forest with fewer podocarps and several emergent rata or stands of rewarewa elsewhere. Much of the tawa is old and supports epiphytes.

Whitecliffs is similar to Moki–Makino over about half its area, but it also contains stands of coastal forest, with species such as puriri *Vitex lucens* and nikau *Rhopalostylis sapida* and large areas of regenerating scrub or gorse *Ulex europeus*. The older forest is on ridge tops and gullies in inland parts of the area, and extends into gullies closer to the coast.

Egmont is the most varied of all these areas, ranging from semi-coastal forest in the Kaitaki area, through tawa or kamahi forest with many emergent rata and rimu, through to sub-alpine scrub and alpine herbfields. Two special features are the absence of beech and a large swamp maire *Syzigium maire* dominated forest (Clarkson 1986). Tawa and kamahi dominated forests with emergent rata cover several thousand hectares on lower, north-east slopes and would be the most suitable kokako release area. The canopy is a little more broken than other Taranaki sites, with windfalls being a feature. Epiphytes are abundant.

Concern has been raised that goats *Capra hircus* may have had such a negative effect on forest condition in some Taranaki sites as to make them unsuitable for kokako. This is unproven, though goats may remove food sources which could be important at certain times of the year. Mapara certainly had a goat problem during the 1970s (Bradfield & Flux 1996) and there was still fresh goat sign when the area was visited in April 2003. At Aotuhia, in inland Taranaki, goats have caused major damage (pers. obs. 1995–1999) yet at least one kokako still lived there in 1997. However, the long term future of the forest is likely to be compromised if goats are not controlled. Goats have all but been removed from Egmont, while at Whitecliffs, Waitaanga and Moki–Makino they have been controlled to low levels (Table 1). Goats were seen around Whitecliffs during this study, but little evidence of recent goat browse was observed.

TABLE 1. GOAT KILLS PER DAY HUNTED, FOR THE FOUR POTENTIAL TRANSLOCATION AREAS.

	KILLS (PER DAY HUNTED)			
	1996/97	1997/98	1998/99	1999/2000
Whitecliffs CA	3.9	1.6	5.2	3.5
Moki–Makino CA	9.4	14.3	7.9	6.2
Waitaanga CA	3.7	3.5	3.9	5.2
Egmont NP	1.4	1.6	1.2	0.9

Data from Stronge (2000) and Stronge & Dijkgraaf (2001).

4.2 PREDATOR CONTROL

4.2.1 Possums

Four basic techniques have been used in existing kokako management areas for possum control, these are: aerial application of poison baits, use of bait stations, laying of cyanide paste, and trapping. Specific techniques and their successes or otherwise have been described in a number of publications (Bradfield & Flux 1996; Beaven et al. 2000; Innes et al. 1999). The conclusion of Innes et al. (1999) was that managers should aim to control possums to a level where indices are less than 1 possum per 100 trap-nights (<1% RTC) at 1 November. RTC levels of greater than 5% at 1 November are likely to signal failure to control possums to levels where kokako are protected (J. Innes pers. comm.). However, RTC becomes less reliable below 5% and it may be difficult to distinguish statistically between 1% and 5% (Ian Westbrooke pers. comm.). At Te Urewera, the target for possums is 5% RTC (Beaven et al. 2000).

4.2.2 Aerial application

Studies have shown that possums cannot be maintained at the 1% RTC target using aerial bait application, although where this technique was trailed at Mapara over three years there was a slight recovery in the kokako population (Bradfield & Flux 1996). Aerial bait application can be very effective for an initial knockdown of the possum population prior to using a more intensive control techniques.

4.2.3 Bait stations

The use of Brodifacoum in bait stations has been the most successful way to control possums. At Paengaroa Scenic Reserve, near Taihape, this technique reduced possum trap catch rates to 0, 0, and 1 possum per 300 trap nights over three years (Department of Conservation files, Palmerston North). Similar low levels (0.5–1%) where attained at Mapara using this method (Bradfield & Flux 1996). Concern about Brodifacoum getting into the food chain means it is no longer considered suitable at most sites. However, it could be acceptable at Egmont, where there are no deer or pigs (Department of Conservation 2002).

Other poisons which have been used in bait stations include Pindone, Feracol, Feratox, compound 1080, warfarin, racumin, and bromadiolone. Feracol has been shown to be relatively ineffective for possums (Department of Conservation files, Palmerston North). Compound 1080 was used at Mapara in 1995/1996 after three years of using Brodifacoum (Bradfield & Flux 1996), which resulted in only a slight increase in possum RTC. Pindone has been used at Otamatuna (Beaven et al. 2000) but, because it was used in conjunction with Feratox, it is not possible to say how effective it has been. Pindone, warfarin, bromadiolone, and racumin have all been used at Mapara since 1996 (Ian Flux pers. comm.) with varying results. Racumin was successful in 2002. Feratox is increasingly being used for possum control and has proven to be effective in lowering possum RTC below 5%, but not below 1% (Beaven et al. 2000).

4.2.4 Trapping

Trapping has been used at Te Urewera to control possums, but only in conjunction with cyanide paste. This resulted in possum RTCs of between 1% and 4.5%. Again, this is higher than the figure of 1% suggested by Innes et al. (1999), but below a suggested threshold of 5% for kokako protection. Presumably, increased effort using this technique would lower the possum population still further because these areas were only trapped to a target of 3% or 5%.

4.2.5 Existing possum control at the four Taranaki sites

All the proposed Taranaki translocation sites have had possum control (Harty 2002; Department of Conservation files at New Plymouth, Stratford, Wanganui) as outlined below.

Whitecliffs Two aerial 1080 operations, the most recent in May 1998 which covered 1750 ha. Since then 1200 bait stations, as well as bait bag lines, have been established around the periphery and on some internal ridges. These are run annually using Feratox, with some Feracol and cyanide paste. Traps are run for 1000 trap-nights in the Ahititi water catchment area. Trap catch rate dropped from 20.23% in 1997 to 4.04% following the last 1080 drop, and rose again to 12.3% by 2001.

Moki–Makino Two aerial 1080 operations, the most recent in October 2000 which covered 12 000 ha. Since then, 3500 bait stations, as well as bait bag lines, have been established around the periphery and along some ridges. These are run annually, using mainly Feratox with some Feracol and cyanide paste. Trap-catch rate dropped from 26.83% in 2000 to 4.33% in 2001, rising only to 5.23% by 2002.

Waitaanga Numerous 1080 operations have been carried out over parts of this area. The most recent by the Department of Conservation was 1995 and covered 17 000 ha, but about 75% of the area has been treated more recently by Horizons m.w. and Environment Waikato (Bryan Williams and Paul Prip pers. comm.). A total of 10 000 bait stations, as well as bait bag lines, have been established in the western parts of Waitaanga. Trap-catch rates have fluctuated from 3.13% to 14.69% between 1996 and 2002.

Egmont Broad scale possum control has taken place since 1993, the most recent an aerial 1080 operation between August and October 2002. Bait stations have been in place around the perimeter of the park for most of this time, using Brodifacoum, Feratox and 1080. An extensive monitoring operation following the recent 1080 drop showed possum trap-catch rates of 0.84% and 1.17% within the park and 6.21% around the perimeter.

4.2.6 Ship rats

Bradfield & Flux (1996) suggest ship rats need to be controlled to an index of less than 1% tracking, also on the 1st of November, again with a maximum threshold of 5% for successful kokako management (J. Innes pers. comm.). Results over several years from Te Urewera (Beaven et al. 2000) show that kokako populations can increase with higher ship rat indices, but the population increase is much more rapid if ship rat indices are kept at less than 5%.

Though ship rat populations are known to be reduced following aerial application of 1080 baits (Fanning 1994), numbers rapidly build up again (Powlesland et al. 1998). Maximum benefit is achieved with 1080 drops in October since they reduce the possum and ship rat populations for the entire kokako breeding season (J. Innes pers. comm.). An aerial drop of Pindone was undertaken in 1991/92 in Kaharoa which proved successful (Innes et al. 1999). Otherwise, ship rats have been controlled in kokako management areas using bait stations or by trapping.

Innes et al. (1999) reviewed the success of various poison operations, as measured by tracking tunnels, in Mapara, Rotoehu, and Kaharoa. They found that all operations reduced ship rat tracking rates and in 10 of 14 instances this was reduced to less than 4%. The less successful operations involved aerial drops of 1080 or using Brodifacoum in bait stations at 200 metre spacings. However, in every operation, ship rat numbers recovered quickly, usually in 3–5 months. Compound 1080, Brodifacoum (Bradfield & Flux 1996) and racumin (Ian Flux pers. comm.) in bait stations on a 100 m grid have all been effective at Mapara.

At Otamatuna, Talon (Brodifacoum), Talon and Pest-off (also Brodifacoum-based), and Pindone were used over three successive years (Beaven et al. 2000). Ship-rat tracking rates over the kokako breeding season averaged 0%, 6.8%, and 15.5% respectively for each treatment (although Pindone was used in the year, ship rat tracking rates were very high non- treatment areas). In each operation, bait stations were refilled more than once in response to increasing ship rat numbers. Kokako numbers increased in every season.

Trials have been undertaken at Te Urewera using different layouts of traps or bait stations, including confining them to ridges, using a grid, or using a system called 'A-lines' (Beaven et al. 2000). The A-line system consists of a line along a ridge crest and two other lines running parallel to this, but 150 m below. These lines either have bait stations at 50 m intervals or rodent traps at 25 m intervals (Burns et al. 2000). This system has proved to be effective at reducing ship rat numbers and has reduced costs at Te Urewera (Burns et al. 2000). The ridge-line-only system reduced ship rat numbers, but only marginally. It is unclear at present if the A-line system will work equally well at other localities.

No specific ship rat control has been undertaken at any of the Taranaki sites. However all have had aerial 1080 applications, and the Egmont site is being trapped for stoats, which has resulted in a by-catch of rats (Department of Conservation files, Stratford). Of the sites considered for translocation, tracking tunnel data is only available for the Moki Conservation Area. These show low stoat tracking rates and variable, but generally high ship rat tracking rates (28%–60%). A study at Aotuhia in central Taranaki showed consistently low ship rat tracking rates (5–14%) over three years (1996–1998, D. Ravine unpub. data) in the absence of control.

4.3 TRANSLOCATION TECHNIQUES

Historically, a hard-release method of translocation has been used for kokako, generally on islands, with good success. Thirty kokako released this way were all re-sighted after at least a month, indicating that current methods are reliable and safe, although this remains largely untested in extensive mainland forest blocks (Flux & Innes 2001; J. Innes pers. comm.).

A soft-release method is currently being trailed at Boundary Stream. This involves construction of aviaries on site, breeding from adult birds in these aviaries, and releasing the juveniles produced. The perceived advantage of this method is that it should reduce any tendency for released birds to move out of predator control areas in extensive forest blocks.

Kokako at Boundary Stream failed to reproduce in the first year of this trial. This is not unexpected as it took three years for successful production of juveniles in captivity at Mount Bruce (Jeff Hudson pers. comm.). Consequently, it is currently not possible to say if this technique would be successful at Taranaki sites. It is also likely to be expensive and will potentially involve fewer birds than a hard release.

Other issues associated with the aviary system were raised during discussions with Department of Conservation staff during this study. Aviaries need to be attended regularly, which would involve setting up an infrastructure to ensure this happens. Security would be a major issue, particularly at remote sites. Finally, aviaries would have to be located in areas of suitable forest, in the middle (ideally) of predator control areas, which could cause access difficulties.

Part of the brief for this study was to consider whether a translocation should involve existing wild Taranaki birds. Hudson (1999) found there was no barrier, on genetic grounds, to translocations of kokako between populations. As existing wild Taranaki birds are likely to all be old males, it is unknown if they are still capable of successfully reproducing. Four birds caught between 1993 and 1999 have produced one offspring (Innes & Flux 1999; J. Innes pers. comm.). Observations at Te Urewera indicate that kokako dialects are very local (Jeff Hudson pers. comm.) and this may be a barrier to reproduction. It may, therefore, not be essential and may not even be possible to involve existing Taranaki birds. However, the possibility remains of taking the remaining wild Taranaki birds (currently known to be 2) into captivity or transferring them to an island, such as Tiritiri Matangi, in an attempt to maintain Taranaki genes (J. Innes pers. comm.). Another possibility would be to try and pair introduced females with existing wild males but they may not pair up or even stay at the sites where wild males remain.

Utilising Taranaki-sourced birds or their offspring in a translocation programme would contribute towards fulfilling the expectations of iwi and the public that kokako would be returned to Taranaki following the removal of birds in the 1990s.

4.4 POTENTIAL BENEFITS FOR OTHER SPECIES

One of the themes of the kokako recovery plan (Innes & Flux 1999) is that intensive predator control needed to ensure kokako recovery could also benefit most other components of their forest ecosystems. Forest passerines, mistletoes (*Peraxilla* spp.), rata, and kamahi are just some examples of this. Possum control is already undertaken in each of the Taranaki release sites for this very reason. In the proposed Egmont release site, stoat control is being undertaken for blue duck *Hymenolaimus malacorynchos* and North Island brown kiwi *Apteryx mantelli* and is likely to benefit kokako.

All sites already have possum control, but not at the required intensity, and none have ship rat control. Powlesland et al. (1998) demonstrated rapid recovery of North Island robins following temporary reductions in ship rat numbers. North Island robins, *Petroica australis longipes,* are present at Whitecliffs, Waitaanga and Moki–Makino (pers. obs.) but have not been reported from Egmont since 1905 (Cotton & Molloy 1986). Other bird species present at the Taranaki sites which could benefit from ship rat control include threatened species such as kereru *Hemiphaga novaezelandiae* (all sites) and yellow-crowned kakariki *Cyanoramphus auriceps* (Waitaanga and Moki–Makino), fernbird *Bowdleria punctata* (Egmont) as well as more common forest passerines including North Island tomtit *Petroica macrocephala toitoi*, riflemen *Acanthisitta chloris-granti* and whitehead *Mohoua albicilla*. Prey switching by stoats, from rats to birds, was noted by Bradfield & Flux (1996) so not all the theoretical benefits may actually happen.

Other threatened taxa which might benefit from ship rat control include short-tailed bat *Mystacina tuberculata tuberculata*, long-tailed bat *Chalinolobus tuberculatus* (Moki–Makino and Waitaanga), striped skink *Oligosoma striatum*, 'Apion weevils' (Waitaanga), *Powelliphanta* 'Egmont' (Egmont) and *Dactylanthus taylori* (Egmont and Waitaanga). Mouse populations are known to increase with removal of ship rats (e.g. at the Rotoiti Nature Recovery Project, Dave Butler pers. comm.). The effects of this have not yet been studied, with the implications for lizard and invertebrate faunas of particular concern.

4.5 COSTS

The costs presented here are guidelines to provide basic comparisons between sites. Sites selected for translocation will require a more detailed cost analysis. Predator control work is expected to be the major cost in re-establishing kokako to Taranaki. There would be an annual cost until the kokako population is considered secure, after which pulsed management could reduce predator control to as little as three years in every ten (Basse et al. 2003). Monitoring of kokako and predators would also be a annual requirement until such time as the new population was considered secure. It is envisaged that most kokako for translocation would come from Tiritiri Matangi Island (Innes & Flux 1999) so there will be costs involved with capture and transport. If the aviary-release method is used, this will also be very costly.

4.5.1 Establishment costs

All sites would need some track establishment work to set out bait station or trap lines. All sites have a track system in place, but in no case is this extensive enough for a kokako predator control operation. Recent track cutting in Egmont National Park for stoat control has been budgeted at $250–$500 per kilometre, depending on terrain—a value of $350 per kilometre is used in the estimates in Table 2. Costs in Table 2 are based on trap and bait station spacing of 100 m on lines, and 150 m between lines. Bait stations will be used for possum and ship rat control with supplementary trapping of ship rats. It is estimated that at this spacing it would cost $154 per kilometre to purchase bait-stations and rat traps, plus the cost of leg hold traps over and above those that the Conservancy already has. For further details refer to Appendix 1.

TABLE 2. ESTIMATED COSTS OF ESTABLISHING PREDATOR CONTROL FOR KOKAKO PROTECTION AT FOUR SITES IN TARANAKI.

SITE (AREA PROTECTED)	REQUIRED LINE LENGTH (km)	LINE STILL TO CUT	COST OF CUTTING LINE*	COST OF TRAPS AND BAIT STATIONS†	**TOTAL SET-UP COST**	ANNUAL SERVICING COST ($30/ha)
Whitecliffs (1856 ha)	100–120	70–90	24,500–31,500	23,900–26,980	**48,400–58,480**	55,680
Moki–Makino (4000 ha)	200–240	160–200	56,000–70,000	47,800–53,960	**103,800–123,960**	120,000
Waitaanga (4000 ha)	200–240	200–240	70,000–84,000	47,800–53,960	**117,800–137,960**	120,000
Egmont (4,000ha)	200–240	120–160	42,000–56,000	47,800–53,960	**89,800–109,960**	120,000

* Based on $350 per kilometre.

† $154 per kilometre, plus cost of leg-hold traps.

Only Whitecliffs is small enough (1856 ha) to realistically consider predator control over the whole area. Approximately 30 km of lines already exist, mainly protecting the edges of the block. Egmont, Moki–Makino, and Waitaanga costs are all estimated on a treatment area of 4000 ha, as used in the Te Urewera model. Existing stoat control lines in Egmont cover 80 km across about 4500 ha. This may lead to a reduction in servicing costs, since kokako protection can use the same lines as used for part of the ship rat and possum control work. At both Moki–Makino and Waitaanga there are some lines around the edges, but the majority of the lines required would need to be established.

If the aviary-release method being trialled at Boundary Stream is adopted, considerable additional costs will be involved. Cost of aviary construction is entirely dependent on the design chosen, which can only be finalised after the Boundary Stream trial is analysed. However, a figure in the region of $25 000–$50 000 would be realistic. In addition, there would be the costs incurred for bird feeding, aviary cleaning, and a water supply, as a bare minimum. At Boundary Stream, the aviaries are close to a permanently staffed field base. None of the proposed Taranaki release sites have this, although the proposed Egmont release site is less than 10 km from North Egmont visitor centre. Caged kokako would need attention daily. For security, aviaries would need to be quickly accessible and in a secure location. Only the Egmont site could readily provide this, though there would still be considerable costs involved. Such a location could be provided at Whitecliffs, in co-operation with local residents.

Were this system to be used at Waitaanga or Moki–Makino, an additional full-time staff position would probably be required, at a cost of about $35 000 per annum. This position could be tied in with pest control or other species work. Even at Whitecliffs or Egmont, at least half a man-year should be budgeted, at a cost of $17 500 per annum. When other costs of maintaining an aviary are considered, annual costs could be in the region of $25,000–$50,000.

Compared to all the costs detailed above, the actual translocation costs would be small—approximately ten days staff time ($1500), two hours helicopter time ($3000), plus vehicle running and freight costs ($2000).

4.5.2 Maintenance costs

Maintenance costs at Te Urewera ranged from $21 to $67 per hectare (Beaven et al. 2000) A variety of control methods were used resulting in a possum RTC of 2.4% and ship rat tracking rates of 14% in December and 5% by mid January for the cheaper per hectare cost and possum RTC of 1% for the higher expenditure (rats were not monitored). For additional details refer to Appendix 1. Maintenance costs are estimated at $30 per hectare for the Taranaki sites in Table 2.

5. Discussion

5.1 ECOLOGICAL REQUIREMENTS

The ecological requirements of kokako are well enough known to have confidence in identifying suitable habitat. Kokako were widespread through much of the North Island, including Taranaki (O'Donnell 1982), suggesting that they are able to utilise a variety of forest types. Indigenous forest with a varied food source of fruiting shrubs and trees appears to be the main consideration, in the absence of introduced mammalian predators. If a conservative approach to assessing habitat requirements is taken, then kokako should be released in older forest with a broad range of plant species and good populations of epiphytes. This is based on personal observation of sites visited which hold kokako, rather than published scientific evidence. Fortunately, this type of forest is found in, but not throughout, all the proposed release sites, with the best habitat being in much of Waitaanga and parts of Moki–Makino.

It is considered sensible to restrict release of kokako to sites which are close to or within the altitude, rainfall, and temperature range of sites with existing kokako populations. Again, all proposed release sites partly or fully meet this requirement. Only the Egmont release site is close to these limits, with very high rainfall towards the western side.

Topography does not appear to put any restraints on kokako viability so is not considered important, other than how it affects management. Soil types may have an impact, but vegetation type would reflect soil characteristics so soils were not directly considered in this study.

In terms of ecological requirements all sites appear to be suitable for kokako reintroduction. Waitaanga probably has the highest quality habitat closely followed by Moki–Makino. Both these areas still have wild kokako, with minimal predator control programmes in place. Whitecliffs and Egmont would also be suitable, though the better habitat is more patchy. Kokako were last seen in Egmont National Park in 1938 (Cotton & Molloy 1986), at which time they were still common in other Taranaki locations (Department of Conservation 1989). However, the birds early disappearance from Egmont is likely to reflect differing predator and habitat alteration impacts across Taranaki rather than habitat quality.

5.2 PREDATOR CONTROL

Possums and ship rats have been identified as the major predators of kokako. It is a requirement that both species are reduced to low, prescribed levels before kokako can be introduced to an area (Flux & Innes 2001). Though there is some evidence that stoat control improves kokako breeding success (Jeff Hudson pers. comm.) stoat control is not a requirement. Nevertheless, the current stoat control programme in Egmont National Park could benefit kokako.

All four Taranaki sites have received recent possum control, but possum indices are only low enough (at the time of writing) in Egmont National Park. No matter which site is chosen, a regular, intense possum ground-control operation will need to be established and maintained. There is no evidence that possum densities can be kept low enough using aerial poison drops alone, given the current interval between treatments (c. 7 years). The cost of a ground-based control programme would be lower at Whitecliffs and considerably higher at Moki–Makino and Waitaanga. Egmont costs would be intermediate between the two extremes. Possum monitoring is already carried out at all sites and would not incur any additional expense.

No specific ship-rat control has ever been undertaken at any of the proposed Taranaki translocation sites, and rat indexing only in the Moki Conservation Area. It is highly unlikely that ship rats occur at low enough densities to not be significant predators. Therefore, a regular intensive ship-rat control programme will need to be established and maintained, no matter which site is chosen. Some initial monitoring of ship rats should be done before control is initiated. At Waitaanga, Egmont and Moki–Makino, it would be possible to also monitor ship rats in a control (non-treatment) area (as in Powlesland et al. 1998), which would provide valuable information about the effectiveness of any control programme.

Control of ship rats should be done concurrently with possum control, utilising the same lines and bait stations, with traps placed near bait stations. This set-up has proven to be effective at Otamatuna. For both predator species, an A-line system, as used in parts of Te Urewera, offers a potentially effective and cheaper option than more intensive grid systems (Beaven et al. 2000). However, the use of A-lines presupposes that their value in Te Urewera is not a peculiarly local phenomenon. Data on kokako from Te Urewera needs closer scrutiny before the A-line system is adopted for a translocation programme in Taranaki although it is clearly promising as a technique. During population establishment in Taranaki, intensive control using a grid system could be established initially with the opportunity to 'pull back' to an A-line system in the future.

At Te Urewera, core areas are managed intensively for kokako and this system is attractive for Waitaanga, Moki–Makino, and Egmont (Whitecliffs is small enough to consider control over the whole area). The big difference is that the core areas at Te Urewera were chosen because kokako were already there and it does not necessarily follow that kokako would remain in core areas in Taranaki sites. Moki–Makino and Waitaanga are both large forest blocks and kokako could move out of any predator controlled areas. At Egmont, the suggested core area is seen as the most likely kokako habitat, though there is no guarantee kokako would remain there. At Whitecliffs, it is possible that kokako could cross the main highway at Mount Messenger and so leave the predator control area. This possibility could be reduced by releasing birds away from this potential corridor.

Another option is to undertake a pilot predator control programme in the intended release area to confirm that sufficient control is possible in the chosen location. If this is successful, it could then be extended **after** kokako establish territories, which would ensure the right core area is being protected. While this option is not the conservative one, it would ensure resources are directed to the best place and could save a substantial amount of money. This system takes advantage of the fact that adult kokako are not particularly vulnerable to predation when they are not nesting.

5.3 TRANSLOCATION TECHNIQUE

Two translocation techniques are considered suitable or potentially suitable for kokako release. The traditional technique is the 'hard release' technique, described in Flux & Innes (2001). This has proven to be effective, particularly on islands, but is largely untested in large mainland forest blocks (J. Innes pers. comm.). The aviary technique, being trialled at Boundary Stream, is intended to reduce the possibility that kokako will leave the management area.

There are problems associated with the aviary technique in Taranaki. Apart from the cost of building and managing the aviaries, the remote location of all sites would mean establishing new staff or contract positions for several years to provide care and security for the caged kokako. This would be less of a problem at Egmont and, to a lesser extent Whitecliffs, but represents a major commitment and a great expense for an unproven technique.

The hard release technique, on the other hand, has been demonstrated to be successful, is considerably cheaper, and requires no additional infrastructure. It would be the only realistic technique to use at Waitaanga and Moki–Makino and the better of the two techniques at Whitecliffs and Egmont.

Because of an expectation from Ngati Tama and the public, any offspring of birds taken from Taranaki in the 1990s should eventually be translocated to Taranaki. Currently there is only a single offspring of Taranaki birds in captivity, although this could change if the remaining wild birds are taken into captivity and breed successfully. If Waitaanga or Moki–Makino are chosen as translocation sites an attempt should be made to have existing wild males breed with translocated females although the chances of success may well be limited.

Kokako have never been translocated to very large areas before (Innes & Flux 1999), so a translocation to a large Taranaki forest would be experimental. Two approaches are possible: release a small number of birds initially and, depending on the results, follow this up with a larger series of releases or release a large initial group of birds (e.g. 20–50 individuals). The former is conservative, and it is difficult to draw conclusions because the sample size is small and chance events can have a major impact on the results. Therefore, an initial release of a larger number of birds is favoured, if they are available for translocation.

5.4 POTENTIAL BENEFITS FOR OTHER SPECIES

There are potential benefits for other species across all four sites, with Waitaanga probably holding the greatest number of threatened species likely to benefit from possum and ship rat control, and Whitecliffs the fewest. These species include threatened taxa such as kereru, yellow-crowned kakariki, striped skink, *Dactylanthus taylori,* and mistletoe species. There may be no benefit or potentially deleterious effects on lizards and invertebrates if mouse numbers increase as a result of ship rat control. Prey switching by stoats could also become a problem.

Existing stoat control programmes in Egmont National Park to benefit kiwi and blue duck may also benefit kokako. Kiwi are present in all proposed sites and any future stoat control operations at any site could take advantage of tracks and staff used for kokako management, which would greatly reduce the cost of such a programme.

5.5 SITE CHOICE

All four sites suggested for initial reintroduction of kokako to Taranaki would be ecologically suitable. There are advantages and disadvantages to each site. It is important to realise that the selection of one particular site does not necessarily preclude the use of other sites in the future. As predator control techniques become more refined and efficient and the source populations increase in size, it should eventually be possible to reintroduce kokako to much of their former range.

With reintroduction being ecological feasible at all sites, the choice of a site will be affected by the cost of reintroduction and maintenance, practicality of predator control and translocation techniques, synergy with other species programmes and benefits to other species, and the views of iwi, who have an expectation that birds will be returned to Taranaki. These issues are summarised by site below.

5.5.1 Whitecliffs Conservation Area

Costs: The cheapest site as it is small, easily accessed from New Plymouth Area Office, and has some tracks already in place.

Practicality: It is the only site where possum and rat control could be established across the whole site. The forest is a reasonably discrete block, access is relatively easy, some tracks are in place and either soft or hard release could be considered, though maintaining an aviary would be more difficult than in Egmont National Park.

Benefits to other species: The site has a number of species that would potentially benefit from predator control, although fewer threatened species that the other sites. No existing species programmes are in place, but if control lines were also used for mustelid control there would be benefits for the kiwi population.

Iwi: The site is within the rohe of Ngati Tama and parts of it are being returned to Ngati Tama ownership as part of a Deed of Settlement between the Crown and Ngati Tama.

Whitecliffs Conservation Area has public access via the Whitecliffs Walkway.

5.5.2 Waitaanga Conservation Area

Costs: The site would be the most expensive in which to conduct a reintroduction programme.

Practicality: Access is more difficult than the other three sites as Waitaanga is the most remote. A soft release would not be feasible. The forest is a large block with the potential for birds to disperse out of an area of predator control.

Benefits to other species: The site probably has the largest number of species which would benefit from ship rat and possum control, including the largest range of threatened species (e.g. yellow-crowned kakariki, kereru, striped skink, *Dactylanthus taylori* and mistletoe spp.) If control lines were also used for mustelid control there would be benefits for the kiwi population. At least two kokako are still present.

Iwi: The site is within the rohe of Ngati Tama.

5.5.3 Moki–Makino Conservation Area

Costs: Initial set up costs are slightly lower than the Waitaanga, but higher than Egmont or Whitecliffs.

Practicality: Access is nearly as difficult as the Waitaanga. A soft release would not be feasible. The forest is a large block with the potential for birds to disperse out of an area of predator control.

Benefits to other species: The site has a number of species which would benefit from ship rat and possum control, but fewer threatened species than Waitaanga, a similar number to Egmont, and more than Whitecliffs. If lines were also used for mustelid control there would be benefits for the kiwi population. A very small number of kokako may still be present.

Iwi: The site is within the rohe of Ngati Tama.

5.5.4 Egmont National Park

Costs: The site is the second cheapest option next to Whitecliffs. Existing species protection programmes mean that some infrastructure is in place which is likely to further reduce set-up and maintenance costs.

Practicality: Access is good, terrain is less demanding at lower altitudes than the other sites and 80 km of mustelid control lines are already in place. Either soft or hard release could be considered. The forest is a large block with the potential for birds to disperse out of an area of predator control.

Benefits to other species: The site has a number of species which would benefit from ship rat and possum control, although fewer threatened species than Waitaanga and more than Whitecliffs. Examples include kereru, fernbird, *Powelliphanta* "Egmont" and *Dactylanthus taylori*. Existing mustelid control is in place for blue duck, north island brown kiwi and *Powelliphanta* "Egmont".

Iwi: The site is not within the rohe of Ngati Tama, but falls with the rohe of several Taranaki iwi. Mount Taranaki (Egmont) is of special significance to Taranaki iwi.

Egmont National Park is easily accessed by the public and receives 350 000–400 000 visitors a year (D. Rodgers pers comm.) so the advocacy values of any translocation would be high.

Using current predator control and translocation methods, current evidence strongly suggests that kokako could be successfully translocated to Taranaki. To be successful, it is essential that a long term commitment is made to this project. That such commitment can lead to increased populations of kokako has been proven at sites such as Mapara, and Te Urewera. Te Urewera is as rugged and remote as the proposed Taranaki translocation sites.

6. Recommendations

This study has shown that kokako can be successfully restored to a Taranaki location, and the author suggests the translocation should proceed. Costs are high and a commitment to intensive management, mainly involving predator control, needs to be made for several years, possibly as long as a decade, before reducing to a pulsed effort. The Wanganui Conservancy and Kokako Recovery Group should discuss the options presented in the report and select a site for restoration, in consultation with iwi, particularly Ngati Tama, and seek funding for such a programme.

A hard release technique is recommended because of the uncertainty of the aviary technique. As far as possible, this should involve Taranaki birds or their offspring although, given that there are few of these available, any translocation will need to be supplemented with birds from elsewhere.

No translocation should be undertaken until it has been shown that possum densities can be reduced below a 5% RTC and ship rat densities below a 5% tracking rate, over at least 1000 ha of the release site, between November and

February. Ideally, a target of 1% should be aimed at in both cases. Target RTCs should be met by 1 November in each treatment year. Monitoring of rodents should begin as soon as practical after a commitment to a translocation is made. If one of the larger sites is chosen (Waitaanga, Moki–Makino, or Egmont) and agreement can be reached with the kokako recovery group, predator control over a larger area should not be put into place until released kokako have settled in their chosen location. If Whitecliffs is chosen as a translocation site, protection of the whole area can be undertaken immediately.

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Appendix 1

BASIS FOR THE COST CALCULATIONS FOR RAT AND POSSUM CONTROL

Establishment costs

Basic equipment prices were provided by Pest Management Services in Waikanae:

- $4 for Victor snap traps
- $8 for T-Rex snap traps
- $21 for Victor no. 1 possum leg hold traps
- $17 for Duke leg hold traps
- Philproof bait stations, as used elsewhere, are $8.80 each, while larger Killmore bait stations are $8 each

Basic wire mesh and plastic trap covers as used at Otamatuna could be made for around $2 each.

It is not envisaged that possum leg hold traps would be left out at all times. Many hundreds are already in use throughout the conservancy, and could be available for the kokako project. However, it will be necessary to purchase more for the kokako project. It is hard to be sure how many would be needed, but at least 1000 should be budgeted for at a cost of $17 000, if Moki–Makino, Waitaanga, or Egmont are chosen as the release site, and 500 at a cost of $8500, if Whitecliffs is the release site.

Maintenance costs

An indication of potential costs is given by Beaven et al. (2000). Their most cost-effective regime at Te Urewera in the 1998/99 season, which used a combination of performance and prescriptive-based contractors using Pindone, Feratox, leg-hold traps and cyanide successfully controlled predators in 3956 ha at a cost of $83 700, or $21 per hectare. This reduced possum RTC to 2.4% and ship rat tracking rates to 14% in December and 5% by mid January. A more intensive programme at Onepu, using snap traps, leg-hold traps and Feratox, cost $67 per hectare over 300 ha, but reduced possum RTC to 1%. Ship rats were not monitored by tracking tunnels at Onepu, but catch-rate data presented suggests it would have been very low. It would be reasonable to budget somewhere between these two figures, but closer to the lower figure (about $30 per hectare per year) for predator control in the proposed Taranaki sites.