 Notornis, 2005, Vol. 52: 150-157
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Failed attempts to reintroduce bellbirds (*Anthornis melanura*) to Waiheke Island, Hauraki Gulf, 1988-91

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Abstract New Zealand bellbirds (*Anthornis melanura*) disappeared suddenly from the northern New Zealand mainland and several large northern islands in the late 19th century. During the past 75 years, several unsuccessful attempts were made to reintroduce them. Between 1988 and 1991, four translocations (111 birds) were made to Waiheke Island near Auckland, sourced from Kaingaroa (21 birds) and Cuvier Island (90 birds). The birds were conspicuous immediately after release but became progressively less visible within six months and the translocations failed. While the cause(s) of failure are unknown, predation by mammalian predators, especially ship rats (*Rattus rattus*) is likely to have been a critical factor. Other possible reasons for failure of bellbird translocations are discussed, along with the reasons why original bellbird populations disappeared from northern New Zealand and subsequently failed to re-establish.

Lee, M. 2005. Failed attempts to reintroduce bellbirds (*Anthornis melanura*) to Waiheke Island, Hauraki Gulf, 1988-91. *Notornis 52(3)*: 150-157.

Keywords *Anthornis melanura*; bellbird; Waiheke Island; reintroduction; translocations; ship rat; *Rattus*

INTRODUCTION

The bellbird or korimako (*Anthornis melanura*) was once probably the most ubiquitous of New Zealand's honeyeaters (Meliphagidae). Reported as common by early European observers, it suddenly and mysteriously disappeared from much of the country between the early 1860s and about 1900 (Oliver 1955; Turbott 1979). The decline reportedly started in the north and moved progressively southwards, with a low point recorded in Canterbury about 1910 (Stead 1932; Oliver 1955). Subsequently, bellbirds recovered somewhat in southern and central parts of the country, but until recently, have been absent from the Auckland and Northland mainland and from the larger northern offshore islands such as Great Barrier (27,761 ha) and Waiheke (9333 ha) (island areas after Taylor 1989). Despite their extinction on the northern mainland, bellbirds have remained common on a number of other northern outlying and offshore islands e.g., Three Kings, Poor Knights, Hen and Chickens, Mokohinau, Little Barrier, Cuvier, Mercury, The Aldermen and Mayor Islands (Oliver 1955; Craig & Douglas 1984).

On some other northern islands however, a process of gradual extinction has continued until comparatively recently. For example, bellbirds were reported on Motukawanui (380 ha) in the Cavalli Islands until the 1950s (Sibson 1953; Craig & Douglas 1984), at about which time they also disappeared from Kawau Island (2050 ha) (Oliver 1955). On Motuihe Island (195 ha), near Auckland, bellbirds were reported as "quite numerous" by Bull (1940). A small population apparently survived until the 1960s, with the last few birds being recorded in 1969 (T. Lovegrove pers. comm.). Motuihe Island was probably the source of bellbirds which occasionally visited the Auckland suburbs of St. Heliers and Grafton until the mid-20th century (Turbott 1953).

Bellbirds occurred on Rakitu (Arid) Island (328 ha) near Great Barrier Island, being recorded there in low numbers in 1981 (Bellingham *et al*. 1982), but not subsequently (A. J. Beauchamp and R. Chambers pers. comm.). On Great Mercury (Ahuahu) Island (1860 ha) bellbirds are still recorded occasionally (T. Hatch pers. comm.), but these are probably vagrants from the other islands in the Mercury group where bellbirds are common.

In contrast, on Tiritiri Matangi Island (197 ha) in the Hauraki Gulf, less than 20 pairs of bellbirds survived for about one hundred years in a grove of exotic brush wattle (*Paraserianthes lophantha*) and a few pockets of native bush not destroyed by grazing and regular burn-offs (Craig 1991). With the ending of pastoral farming and large scale replanting of native forest cover and the removal of kiore (*Rattus exulans*) in 1993, bellbirds increased by 90.6% (Graham & Veitch 2002) and are now estimated to number about 600 (Parker 2003).

Bellbirds are reported to have disappeared from the Hunua Ranges, south of Auckland, by the

Received June 2004; revised May 2005*; accepted 20 July 2005 • Editor M. Williams*

1880s (McKenzie 1979). In the early 1940s, bellbirds reappeared in the district, spreading as far north as Clevedon in 1948 and then suddenly disappeared again (Russell St. Paul pers. comm., see also Craig & Douglas 1984). A small remnant population remained near the summit of Mt. Kohukohunui (Lovegrove 1975) and on the eastern side of the Hunua Ranges around Waharau and Matingarahi (T. Lovegrove pers. comm.) and, as a result of predator control around Kohukohunui since 1994, bellbird numbers in the Hunua Ranges have increased (T. Lovegrove pers. comm.). It has been suggested that the wide expanse of open country between Auckland and the South Waikato and Coromandel Ranges, where bellbirds still occur, may have inhibited their northward movement. The effects of this physical barrier may be compounded by differential dispersal behaviour of the sexes, in which males appear to move greater distances than females (Craig & Douglas 1984).

From time to time, bellbirds, apparently from offshore islands, have attempted to establish on the Northland mainland. For example, a small population, probably from Little Barrier Island (3083 ha), was observed in the Dome Valley near Warkworth north of Auckland from 1951 to 1953 before disappearing (E.G. Turbott pers. comm.). In early January 2005, bellbirds suddenly arrived *en masse* at Tawharanui Regional Park near Leigh, north of Auckland. The estimated 100+ birds (T. Lovegrove pers. comm.) probably originated from Little Barrier Island where, in June 2004, an operation to eradicate kiore had taken place.

The failure of bellbirds to re-establish on the northern mainland during the 20th century prompted a number of attempts to reintroduce them. The first was in February 1932, when the Auckland Zoological Society released 15 birds, caught on Little Barrier Island, into native forest near the Huia Dam in the Waitakere Ranges, west of Auckland. The birds dispersed at least as far as the Karekare Valley (6.5 km distant), and sporadic sightings continued until 1946 (Turbott 1953). A second mainland release, of 22 birds (10 males, 12 females) from Tiritiri Matangi and Cuvier Islands, was made in March 1983, at Shakespear Regional Park on the Whangaparaoa Peninsula, north of Auckland by John Craig of the University of Auckland. Although one nest was reported the following spring, the birds gradually dispersed and some colour-banded birds returned to Tiritiri Matangi Island (J. Craig pers. comm.).

In February 1983, seven bellbirds were transferred from Mamaku near Rotorua to privately owned Moturoa Island (157 ha) in the Bay of Islands, by John Ralph. They were seen for several weeks after release but then disappeared (P. Asquith pers. comm.).

Bellbird transfers to Waiheke Island

Waiheke Island (36° 48′S, 175° 05′E), in the inner Hauraki Gulf 19 km from Auckland, has significant areas of relatively intact, diverse, native forest, including northern coastal hardwood and kauri (*Agathis australis*) forest, as well as extensive regenerating shrublands of kanuka (*Kunzea ericoides*) and manuka (*Leptospermum scoparium*). It has relatively high numbers of the more common native birds, like tui (*Prosthemadera novaeseelandiae*) and kereru (*Hemiphaga novaeseelandiae*), and even a small resident population of threatened North Island kaka (*Nestor meridionalis septentrionalis*) (Lee 1996). There are no historic records of bellbird presence.

Waiheke Island is one of the largest areas in New Zealand to have remained free of brushtail possums (*Trichosurus vulpecula*). Additionally, it lacks ferrets (*Mustela furo*) and weasels (*M. nivalis*). However, in other respects Waiheke Island is similar to the mainland with its suite of small mammals comprising ship rat (*Rattus rattus*), Norway rat (*R. norvegicus*), house mouse (*Mus musculus*), stoat (*Mustela erminea*), feral cat (*Felis catus*), hedgehog (*Erinacus europaeus*), and rabbit (*Orytolagus cuniculus*). However, because of the quality and extent of the forest habitat and the absence of possums (bellbird numbers on Kapiti Island almost doubled between 1982 and 1986 following possum removal but in the presence of kiore and Norway rats (Brockie 1992), it was thought that a translocation of bellbirds to Waiheke would have a reasonable chance of success.

This paper describes four attempts to re-establish bellbirds on Waiheke Island between 1988 and 1991 and seeks to evaluate their outcomes.

METHODS

Between June 1988 and February 1991, four bellbird translocations to Waiheke Island, (total 111 birds) were carried out variously by Department of Conservation (DoC), University of Auckland staff, and volunteers from the Royal Forest and Bird Protection Society. Capture, captive maintenance, transfer and release methods broadly followed those of Lovegrove & Veitch (1994).

Translocations from Kaingaroa

Eleven birds (6 ♂♂, 5 ♀♀) were captured in June 1988 by DoC protected species officers Geordie Murman and Paul Jansen in the Matahina Forest (northern Kaingaroa), east of Mount Edgecumbe. The birds were held in an aviary at Ngongotaha for several days and transported to Waiheke by car and ferry. They were released directly into the Forest and Bird Goodwin-Te Haahi Reserve near Te Matuku Bay (Fig.1).

In May 1989, 10 bellbirds (6 ♂♂, 4 ♀♀) were captured using mist nets and taped calls in the Matahina Forest by Forest and Bird volunteers (including the author) under the direction of Paul Jansen. The birds were held in an aviary at Ngongotaha for two weeks and then flown to Waiheke Island to be released into a grove of flowering kohekohe (*Dysoxylum spectabile*) within the Forest and Bird Onetangi Reserve (Fig. 1).

Translocations from Cuvier Island

Two consignments of bellbirds from Cuvier Island (170 ha, 36° 25'S, 175° 47'E) were taken to Waiheke Island in 1990/91. In August 1990, in a joint effort between University of Auckland staff and a small volunteer party led by the author, 30 bellbirds (15 ♂♂, 15 ♀♀) were caught over two days and placed in a holding aviary. After three days, the birds were flown to Waiheke Island where they were released into a temporary aviary (3.6 x 2m) at Omiha (Rocky Bay) (Fig. 1). After being held there for five days, the birds were released in three groups during fine, settled weather. Supplementary feeding with Complan mix and sugar water was provided at two tree-top feeding stations for two weeks after the birds were released.

From 1-8 February 1991, 60 birds (28 ♂♂, 32 ♀♀) were caught on Cuvier Island and transferred to Waiheke Island where they were held in three widely-dispersed aviaries (see Fig. 1). One female died in the holding aviary at Onetangi. The surviving 59 were released in batches after four - seven days of captivity.

RESULTS

Translocations from Kaingaroa 1988-89

Numerous post-release surveys provided only three reliable sightings of the Kaingaroa bellbirds (Fig. 1): one week after the initial release near Palm Beach, about 8 km from the release site; a few weeks later in Waikoupou Bay, 5 km from the release site; and a female, banded in 1988, seen in February 1991 outside the Te Matuku Bay holding aviary, about 1 km from its original release site (pers. obs.). No birds from the 1989 release were subsequently seen, though a resident living near the Onetangi release site reported hearing bellbirds for some weeks after the release.

Translocations from Cuvier Island, 1990 - 1991

Almost immediately after the releases (28-30 August), numerous sightings of bellbirds were reported by residents over a wide area of Waiheke Island. These sightings included: 30 August, one in a kowhai (*Sophora microphylla*) at Omiha, less than 0.5 km from the release site; 2 September, one in a puriri (*Vitex lucens*) near urban Oneroa, 6 km away; 11 September, one in a pohutukawa (*Metrosideros excelsa*) at Onetangi, 3.5 km from the release site; 23 September, a male in a coral tree (*Erythrina x sykesii*) near Onetangi, about 4 km from the release site (pers. obs.). In addition, over subsequent weeks bellbirds were heard and seen regularly at Pearl Bay, Orapiu, 8.5 km away. In total, 19 separate sightings were reported from September 1990 to January 1991 (Fig. 1).

Monitoring of the tree-top feeding stations revealed that only 50% of the birds were returning to the feeding stations one week after the last aviary release (unpubl. data). Recently-liberated birds were observed in the vicinity of the release aviary moving through the kanuka branches gleaning honeydew. In February 1991, supplementary food was provided at tree-top feeding stations but this was discontinued after one week because the birds did not visit as frequently as those released the previous winter. The birds dispersed rapidly and progressively fewer birds were recorded at the supplementary feeding stations, a pattern also noted in the August release.

Monitoring of the bellbirds consisted mostly of reports from the public, who provided numerous and widespread sightings at first. Seven sightings were recorded in the month after the second release of Cuvier birds. Reports from the public then declined to none during the winter of 1991. Eight sightings occurred over the subsequent spring/summer period (1991/92), but none in the winter of 1992.

Between 29 August and 17 September 1992, I completed 10 hours of monitoring, using a playback tape, at ten sites across the island including at the three release sites, an extensive area of flowering kowhai, by the Okahuiti wetland near Ostend, in the Kuakarau coastal forest block (now scenic reserve) at Omiha, the Whakanewha block (now Whakanewha Regional Park), and at Man of War Bay. No bellbirds were seen or heard.

A more intensive island-wide survey, which totalled 133.5 person/hours of effort and in which taped bellbird calls were used, was carried out on 30-31 October, 1993. No bellbirds were seen or heard (J. Staniland unpubl. data). In March 1996, I carried out a two-hour survey of the Man of War Bay kauri block using taped calls, after reports of suspected bellbird calls, but found only tui and kaka.

Reports of bellbirds progressively declined and ended approximately five years after the last release.

DISCUSSION

While the methods used in all four translocations resulted in the successful capture, captive maintenance, transfer and eventual release of 110 bellbirds onto Waiheke Island, and the releases included two which were direct (hard), and two which were delayed (soft), the translocations eventually failed.

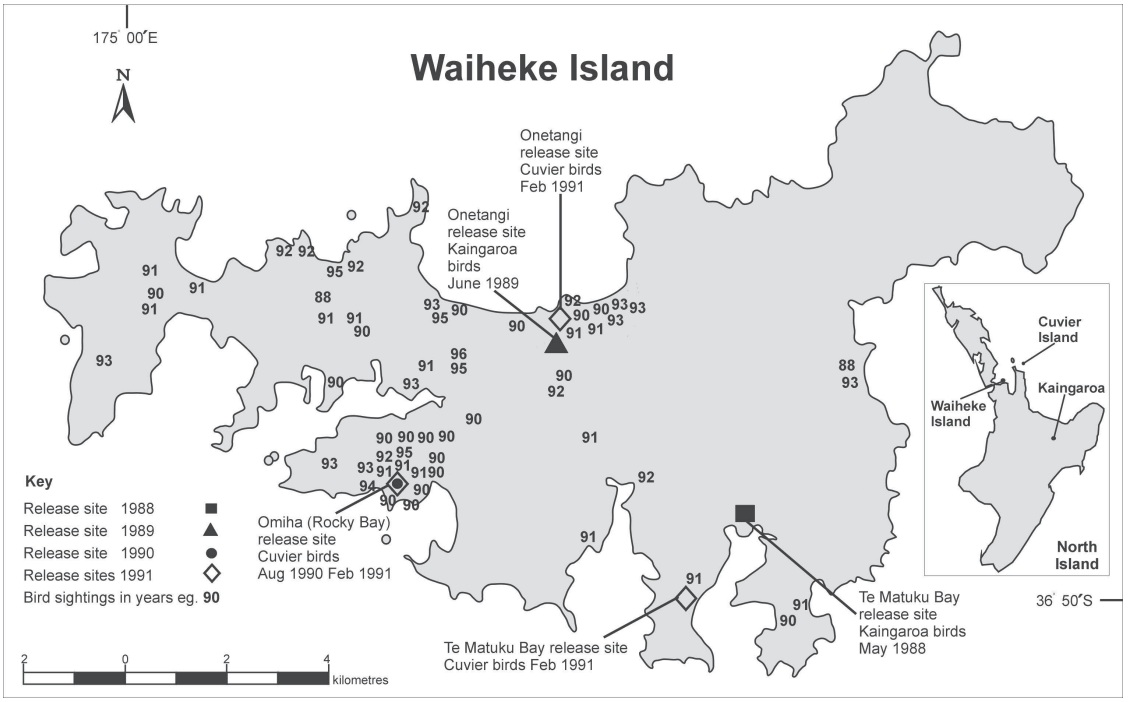

Figure 1. Waiheke Island showing locations of bellbird release sites, 1988 – 1991, and subsequent sightings. Release sites: 1988 - (black square); 1989 - (black triangle); 1990 – (black circle); 1991 – (outlined diamond – Omiha site indicated as black circle within a diamond). Figures at sighting locations indicate the year in which sighting was made.

Possible reasons for failure of the translocations

Newly-released bellbirds on Waiheke were observed using a wide variety of food sources, including the flowers and fruit of puriri, kowhai, pohutukawa, rewarewa (*Knightia excelsa*) and karamu (*Coprosma robusta*), and flowers of exotic species such as coral tree, *Banksia* spp. and *Eucalyptus* spp. They quickly exploited the flowers of unfamiliar exotic weeds e.g., Japanese honeysuckle (*Lonicera japonica*), moth plant (*Araujia sericifera*), evening primrose (*Oenothera glazioviana*), *Aloe vera,* and various unidentified wildflowers. The birds also were seen foraging for honeydew (*Kilahia* sp) on the bark of kanuka, and for caterpillars. In February, cicadas (*Amphipsalta* spp.) were pursued on the wing (pers. obs.). From these observations it is assumed there was sufficient food to sustain a bellbird population on Waiheke. Thus, the most likely reasons for the failure of bellbirds to establish may include, singly or in combination, dispersal from the island, post-release stress (predisposing birds to disease), and predation.

Dispersal

Bellbirds are known to be strongly philopatric (Craig & Douglas 1984) and it is possible that some of the translocated birds attempted to return 'home'. This is believed to have happened when Tiritiri Matangi bellbirds were released on the Whangaparaoa Peninsula (J. Craig pers. comm.). Although it is not known whether the Cuvier Island-sourced birds attempted to return home, which would entail crossing a number of sea-gaps including the 15km from Great Mercury Island to Cuvier Island, male bellbirds from Poor Knights and Little Barrier Islands have been known to visit the Northland mainland, travelling similar distances over the sea (Craig & Douglas 1984). Similarly, recent arrivals of bellbirds at Tawharanui are presumed to be across-water dispersers from Little Barrier Island. Rapid dispersal of released bellbirds occurred at Karori Wildlife Sanctuary, Wellington, in August 2001 (Empson 2003).

That dispersal might have been an important factor in the Waiheke releases is suggested by the number of widely-spaced sightings from across the island very soon after release (Fig.1). If a significant number did leave the island, this could have contributed to a loss of critical mass within the founding population.

Post-release stress

Unexplained losses, accounting for 10-80% of releasees, are a feature of many bird translocations.

For example, 66% of the hihi or stitchbirds (*Notiomystis cincta*) introduced to predator-free Tiritiri Matangi Island in 1995 and 1996 disappeared (R. & B. Walter pers. comm.). Hihi released on Mokoia, Hen, Cuvier, and Kapiti Islands have also suffered sharp declines in populations, despite meticulously prepared and executed transfers and habitats largely free of exotic predators at the release sites (Alley *et al*. 1999).

Alley *et al.* (1999) followed, over two years, the fates of 65 hihi released on Mokoia Island. During this time 31 birds died. Six of nine birds examined *post mortem* had the fungal pathogen *Aspergillus* and eight others displayed clinical signs of fungal infection before disappearing. Alley *et al.* (1999) suggested that stress-induced immunosupression was a principal factor in the infection. Some evidence was also found to suggest that aspergillosis may also be contagious in hihi. These findings suggest that similar native passerines, such as bellbird, may also be susceptible to fungal infection when in a stressed condition. Post-release stress, therefore, could have caused losses in the founder population.

Predation

Although the Kaingaroa bellbirds came from an environment with a full suite of avian and mammalian predators, 90 (82%) of the founding birds came from Cuvier Island, an environment with few natural predators. At that time, Cuvier Island had only one terrestrial mammal (kiore) and no moreporks (*Ninox novaeseelandiae*) (T. Lovegrove, pers. comm.). Thus, the bulk of the founding birds had no experience of the numerous potential predators on Waiheke Island and predation could have been a significant factor in the failure of the translocation.

Naïveté in island bird populations

The choice of Cuvier Island as a source of birds for translocation may have been a mistake given the apparent differing behavioural characteristics of bellbird populations on islands and the mainland. Sagar (1985) found that bellbirds on the Poor Knights Islands were long lived, had delayed sexual maturity, assumed adult breeding plumage only in their second year, had a short breeding season, and laid single, small clutches. These are reproductive characteristics of K-selected birds. Bellbirds on the mainland, (and on islands relatively close to the mainland such as Kapiti and Tiritiri Matangi) on the other hand, mature earlier, breed in their first year, have a longer breeding season and produce more and larger clutches (Sagar 1985; Bartle & Sagar 1987; Anderson & Craig 2003). These are characteristics of r-selected birds. Anderson & Craig (2003) argue these differing characteristics are not necessarily genetically derived but are likely to be behavioural responses to differing environmental conditions.

In a recent survey of 80 bellbird nests in the South Island, none was lower than 3-4 m from the ground and multiple nesting attempts were common (A.W. Robertson pers. comm). However, island bellbird populations are known for their high proportion of ground and cavity nests. For example, Sagar (1985) found 21.4% of bellbird nests built on the ground on the Poor Knights Islands and Lovegrove (1992) observed similar ground or near-ground nesting behaviour by bellbirds on Hen and Cuvier Islands.

The behavioural differences of mainland and island birds have been demonstrated by McLean & Rhodes (1991), who compared robins on stoat and ship rat-free Motuara Island, Marlborough Sounds with those at Kaikoura on the South Island mainland. This work suggests that mainland birds have learned to recognize predators and to some extent cope with them. Such behavioural differences may be subtle and difficult to measure. McLean's work suggests that predator-aware birds are essentially more alert, they are more cautious on the ground and they respond to predation at nests by escaping from the predator and re-nesting quickly. Moreover, they also tend to have a higher (*r*-selected type) reproductive output. Nothing was found to indicate that predator-aware adult birds were better than naïve birds at protecting nests, but their alertness suggested that they would be less likely to be preyed upon at nests than island birds (I. McLean pers. comm.).

A number of anecdotal reports from Waiheke observers indicated that newly-released bellbirds spent much time on or near the ground foraging amongst wild flowers. The Cuvier Island bellbirds on Waiheke also exhibited other naïve behaviours, e.g. crashing into windows, alighting on a balcony hand-rail, and eating slices of kiwi-fruit on a dish left over from a meal, all of which could have made them vulnerable to other predators such as cats and stoats.

Disappearance of bellbirds from northern New Zealand

The disappearance of bellbirds released on Waiheke prompts the question of what caused the original disappearance of bellbirds from northern New Zealand in the late 19th century.

One popular explanation (in the 20th century) was avian disease (Myers 1923; Turbott 1953, 1979; Lack 1954; Oliver 1955; Falla *et al.* 1975; Cemmick & Veitch 1987; Gill & Martinson 1991; Brockie 1992). A contagious disease certainly could explain the sudden, calamitous 19th century population decline, but conclusive evidence to support this theory is lacking. The widespread loss of other taxa during the same period, points to a more broadly-based ecological disturbance.

The role of ship rats

There is strong correlational evidence to suggest that the spread of ship rats was a significant factor in the original decline of bellbirds. Ship rats are known to be efficient predators of eggs and chicks and are opportunistic killers of nesting adult birds (Innes 1990). This rat arrived in northern New Zealand in the mid 19th century (Atkinson 1973) and its rapid spread in the early 1860s coincided with the sudden collapse, and in some cases extinction, of populations of other North Island forest birds including hihi, saddleback (*Philesturnus carunculatus*), parakeets (*Cyanoramphus* spp.), bush wren (*Xenicus longipes*) and piopio (*Turnagra capensis*) (Atkinson 1973, 1985). Other small passerines such as robin (*Petroica australis*), rifleman (*Acanthisitta chloris granti*) and whitehead *(Mohoua albicilla*) largely disappeared from the northern North Island while persisting further south. Many of the species that disappeared or declined abruptly on the mainland (notably bellbirds) remained common on some nearby offshore islands that remained free of ship rats.

The role of rats in the sudden disappearance of bellbirds was first suggested by Reischek (1887) and Buller (Turbott 1979). Buller was later to change his mind on this point when in 1893 he discovered both "introduced" rats and bellbirds common on Motutaiko Island (18 ha) in Lake Taupo (Turbott 1953). He wrote (Buller 1895)

> "…..on landing to hear on all sides the silvery notes of the korimako. As is well known this little songster, which formerly was so abundant everywhere, has for a long time past been practically extinct in the North Island. At the time of this visit to Motutaiko it had not been heard of for several years on the mainland, although it was known to exist on certain islands off the coast, such as the Little Barrier in the Hauraki Gulf, and the Island of Kapiti in Cook Strait; and the generally-accepted theory had been that the chief factor in its extermination was the introduced rat. That certainly was my own belief. But a fact now came to my knowledge which seemed to tell very much against that theory. It was this: The island on which I so unexpectedly met with the Bell-Bird is famous for its rat. It is covered with pohutukawa trees and koromiko scrub, and the whole island swarms with rats. The ground is in places almost honeycombed with their burrows, for in one spot I counted no less than five holes in a radius of eighteen inches. So numerous were they that Topi Turoa had found it necessary to turn some cats adrift on the island to reduce their numbers before he could put in a crop of potatoes on one of the slopes; and wind-bound boats lying in the little sandy cove at night have, it is said, been invaded by multitudes of rats and had all their provisions carried off."

As Atkinson (1973) pointed out, there was considerable confusion regarding the identification and behaviours of the various rat species in New Zealand at that time. On Motutaiko, Buller failed to differentiate between the "introduced" Norway rat (which he appears to describe) and ship rat. Norway rats (and kiore) have coexisted with bellbirds on some islands, notably until recently on Kapiti and Mayor Islands, without significantly affecting bellbird population viability. In contrast the invasion of Big South Cape and Solomon Islands, near Stewart Island, by ship rats in 1962 demonstrated that an irruption of ship rats decimated native bird populations, including bellbirds (Atkinson & Bell 1973; Atkinson 1978; Bell 1978), causing what Atkinson (1985) described as a "rat induced catastrophe."

Ship rats and bellbirds - an inverse population ratio?

If vulnerability to predators was a significant factor in the failure of the Waiheke translocations, how do bellbirds outside of northern New Zealand survive alongside these same predators?

One explanation may be that numbers of ship rats in northern New Zealand forests, especially where there are no bellbirds, are higher than in habitats further south where bellbirds persist (see Brockie 1992). Although the relative densities of ship rats throughout the country have not been compared simultaneously they are known to be relatively higher in northern New Zealand (Craig 1983; Dowding & Murphy 1994; Clout *et al*. 1995; Lee 1999; Innes *et al*. 1999). In contrast, in the lower North Island and in the South Island, ship rats are generally recorded in lower numbers (Brockie 1992). However, this apparent north/south ship rat population gradient is also complicated by a number of factors including different habitat types, seasonal variations, and, especially in the South Island, periodic environmental events such as masting years of podocarp and beech (*Nothofagus* spp.) forests (Innes 1990) and the consequent impact of stoats (A.W. Robertson pers. comm.).

Ship rats are less common, or absent, in higher altitude forests and more common in lowland coastal forests (Innes 1990). For instance ship rats are generally found in very low numbers in higher altitude South Island beech forests (Murphy and Kelly 2001). In contrast, northern New Zealand coastal forests containing puriri and taraire (*Beilschmiedia tarairi*) provide food in winter, sufficient to sustain a higher year-round population of ship rats (P. Thomson pers. comm.). This, and the milder climate in northern New Zealand, may

be conducive to a longer rat-breeding season and thus support a high population density of ship rats during the critical spring bird nesting period.

Bellbird densities, as determined from 5-minute bird counts from across New Zealand, show a strong south to north population gradient (excluding islands and managed mainland forests), with bellbirds more numerous in the south of the country (Murphy & Kelly 2001). The persistence of bellbirds at higher altitudes in the northern-most extremities of their present range on the mainland, the Coromandel and Hunua Ranges, may be due to an altitudinal cline in ship rats densities noted by Innes (1990), which was also identified in the South Island by Murphy and Kelly (2001).

Conclusions

The reasons for the failures of bellbird translocations to Waiheke Island in the 1980s and early 1990s are likely to be the same as those which led to the failure of other attempts to reintroduce native birds to the northern mainland e.g. North Island weka (*Gallirallus australis greyi*), North Island brown kiwi (*Apteryx mantelli*) and red-crowned parakeet (*Cyanoramphus novaezelandiae*) (MacMillan 1990), brown teal (*Anas chlorotis*) (Greene 1996), weka (Beauchamp *et al*. 2000), and saddlebacks (to Moturoa Island; P. Asquith pers. comm.). All these translocations were made to sites where there had been insufficient habitat repair (Lovegrove 1996) and significant numbers of predators were still present. This would demonstrate that the original disappearances of many of these species were not due to isolated or stochastic events (such as the widely-held theory of avian disease) and that the causal factors for the original local extinctions, exotic predators, especially ship rats, are still present. Furthermore, the reasons for the failure of bellbirds to re-establish naturally on the northern New Zealand mainland would appear to be more than the differential movement of the sexes as suggested by Craig and Douglas (1984). What has become better understood over the last 15 years is the role of exotic predators, rather than disease or the quality of the forest vegetation, as the critical factor influencing the survival of native taxa.

ACKNOWLEDGEMENTS

I would especially like to thank Tim Lovegrove for his invaluable assistance, encouragement, and provision of reference material, also to Phil Thomson for his helpful insights and advice. I would like to thank John Craig, E.G. (Graeme) Turbott and Mick Clout for reviewing the manuscript and making helpful suggestions, and *Notornis* editor and referees whose critiques further improved this paper.

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