Conservation of kakerori (*Pomarea dimidiata*) in the Cook Islands in 2003/04

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ABSTRACT

In 1989, the kakerori (*Pomarea dimidiata*) was one of the 10 rarest bird species in the world, with a declining population of just 29 birds. During each breeding season since then, rats have been poisoned within the 155 ha of forested hill country they occupy in the Takitumu Conservation Area in south-eastern Rarotonga. As a result, the kakerori population has rebounded, with a minimum of 292 birds found on Rarotonga in August 2003. In 2001/02, the emphasis of management shifted from the 'recovery' of kakerori to a programme aimed at 'sustaining' the population at 250–300 individuals. The major changes were an experimental reduction in rat poisoning effort to a level where recruitment of kakerori balances annual mortality, and a series of transfers to establish an insurance population on the island of Atiu. In 2003/04, all bait stations were filled fortnightly, rather than the previous mix of weekly and fortnightly refills. This reduced labour costs by 30% to 32 person days, and used a total of 39 kg of Talon® (active ingredient brodifacoum), which was only 13% of the maximum annual poison use over the same area during the 'recovery' phase of the programme. Breeding success was high (0.91 fledglings/breeding territory), even in the unpoisoned areas, and a record total of 80 fledglings was detected. The fortnightly poisoning regime offers promise as an effective, cheaper and less toxin-intensive method than that used previously, and so we recommend maintaining this regime in 2004/05, so that the longer-term effects can be assessed. A third and final batch of 10 young kakerori was transferred to Atiu Island in August 2003. This 'insurance' population is becoming well established; the five breeding pairs monitored in 2003/04 each raised two fledglings, and a minimum of 15 birds was found in May–June 2004 in the small part of the island that was searched.

Keywords: kakerori, *Pomarea dimidiata*, sustainable management, translocation, rat control, Rarotonga, Atiu, Cook Islands.

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1. Introduction

1.1 KAKERORI

In a review of bird conservation problems in the South Pacific, commissioned by the South Pacific Regional Environment Programme (SPREP) and the International Council for Bird Preservation (now BirdLife International) in the early 1980s, Hay (1986) identified the kakerori, or Rarotonga monarch (*Pomarea dimidiata*) as one of the species most urgently in need of conservation management (Robertson et al. 1994).

The kakerori is a small (22 g) forest passerine, endemic to Rarotonga. Kakerori exhibit an interesting variety of plumages, and it was not until birds were individually colour-banded that it was shown that males and females undergo the same set changes in colouration: all yearlings are orange, with a yellow base to their bill; all 2-year-olds are orange, with a dark-blue base to the bill; 3-year-olds are a variable 'mixed' colour, ranging from some females that are blotchy grey and orange, through to a few males that are entirely grey; all birds 4 or more years old are entirely grey (Robertson et al. 1993; H. Robertson and E. Saul, unpubl. data).

Most 1- and 2-year-old kakerori form loose flocks on the ridgetops, away from occupied territories; however, some join adults as 'helpers' to defend a territory and to raise young. Most territories are in valleys, especially those sheltered from the prevailing south-east trade winds. Adult kakerori are strongly territorial and remain on their territory throughout the year. They breed from October to February, though most eggs are laid in October and early November. They lay 1–2 eggs in a bulky nest, often placed on a forked branch overhanging a creek. Replacement clutches are laid if nests fail, but kakerori usually do not re-lay after successfully fledging young (Saul et al. 1998).

1.2 POPULATION TRENDS BEFORE MANAGEMENT (–1989)

In the mid-1800s, kakerori were reported as being common throughout the island of Rarotonga, but by the early 1900s they were thought to have become extinct. In the 1970s, a small population was rediscovered in the rugged interior of the island. David Todd found 21 birds in 1983, and estimated the total population to be about 25 birds (Hay 1986); however, this estimate was probably pessimistic, because a wider and more thorough search in 1987 found 38 birds (Robertson et al. 1994). Subsequent annual censuses identified 36 birds in 1988, and then 29 in 1989, thus confirming that the conservation status of kakerori was 'critically endangered' (Collar et al. 1994). At that rate of population decline, a population viability analysis showed that there was a 50% chance that kakerori would be extinct by 1998, with a 90% chance by 2002.

1.3 RECOVERY PHASE (1989–2001)

A conservation management proposal put forward to the Cook Islands Conservation Service (now renamed as the Cook Islands Environment Service) and South Pacific Regional Environment Programme (SPREP) identified ship rats (*Rattus rattus*) as the main predators at nests, and cats (*Felis catus*) as predators of adults and recently-fledged juveniles. The proposed plan recommended an experimental recovery programme targeting these predators, supported by scientific study aimed at assessing the effectiveness of this work (Hay & Robertson 1988; Robertson et al. 1994). The plan was implemented by the Cook Islands Environment Service through to 1995, when it was updated, and more emphasis was placed on establishing an 'insurance' population on another island in the southern Cook Islands (Saul 1995). In 1996, the management of the recovery programme was passed to the Takitumu Conservation Area Co-ordinating Committee. This body comprises representatives of the three customary land-owning families which care for the 155-ha Takitumu Conservation Area (TCA) in south-eastern Rarotonga, the home for the majority of kakerori (Fig. 1). The TCA was established as part of the South Pacific Biodiversity Conservation Programme with the aim of protecting and enhancing the TCA's biodiversity values at the same time as generating income for the landowners through the sustainable development of an ecotourism venture.

In spring 1989, an experimental programme of rat poisoning and nest protection started in one of the four main catchments used by kakerori. The breeding success there was much greater than in the untreated areas, so the area under protection gradually increased. Since 1992, rats have been poisoned each spring over most or all of the TCA (Robertson et al. 1998).

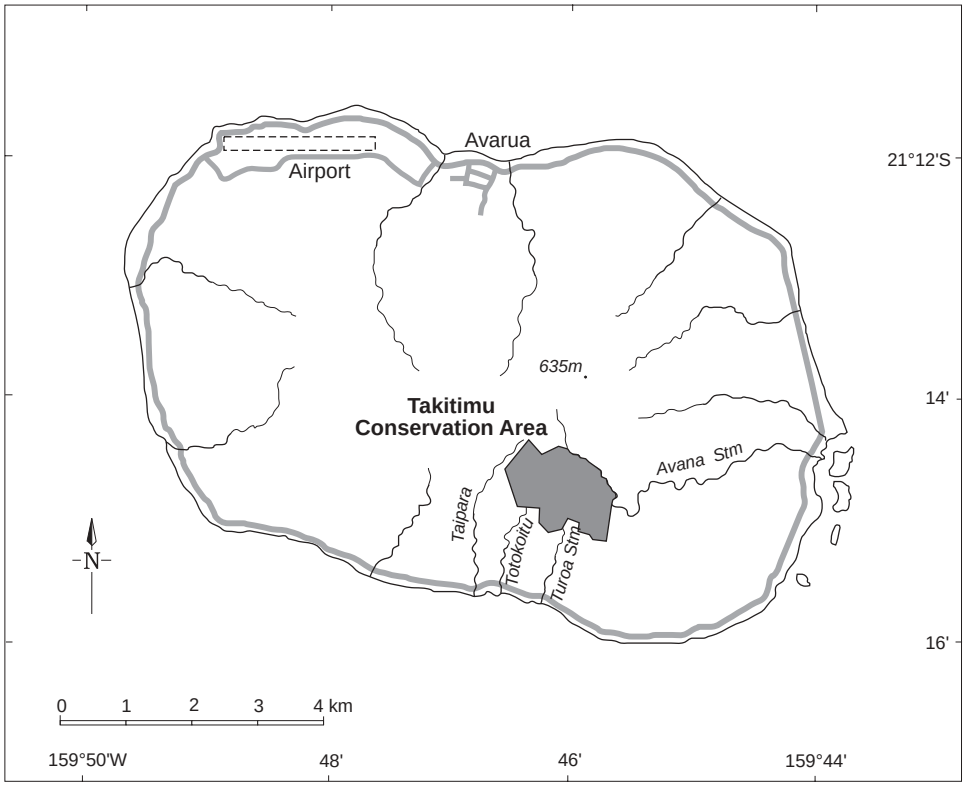


Figure 1. Map of Rarotonga showing the location of the Takitumu Conservation Area.

The effectiveness of predator control has been measured by recording annual breeding productivity in protected and unprotected areas (Robertson et al. 1998; Saul et al. 1998); recording the annual survivorship of individually colour-banded kakerori; and undertaking an annual pre-breeding census each August. The census is made easier by the adult birds generally remaining in the same territory year after year (Saul et al. 1998); and the progressive changes in bill colour and plumage of kakerori during their first four years of life (Robertson et al. 1993). These features aid the estimation of survival of unbanded birds.

During the recovery phase, the population of kakerori increased every year from the original 29 birds in August 1989 to 255 in August 2001 (Fig. 2). In 2000, BirdLife International downgraded the threat ranking of kakerori from 'critically endangered' to 'endangered' (BirdLife International 2000); making kakerori one of a very few species worldwide to have had their threat status downgraded as a result of conservation management rather than improved knowledge (Alison Stattersfield, BirdLife International, pers. comm.).

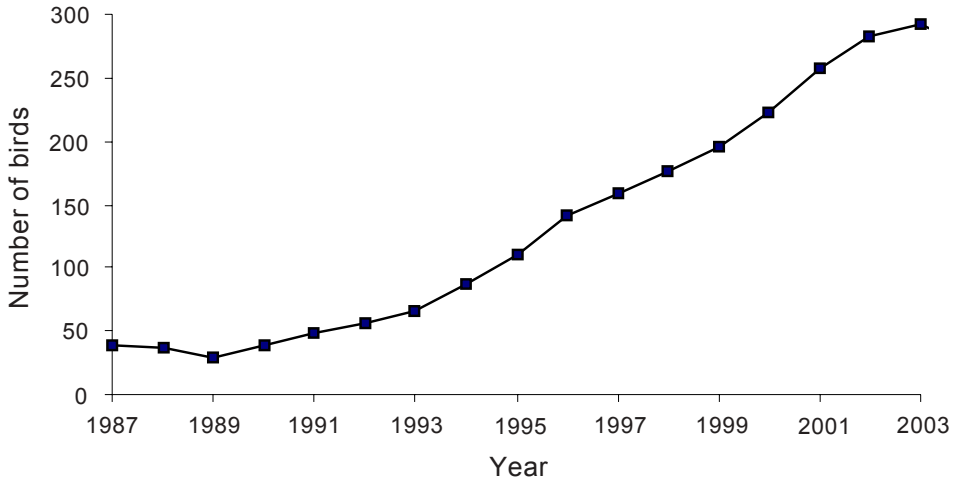


Figure 2. Annual pre-breeding census of kakerori, 1987 to 2003.

1.4 SUSTAINABLE MANAGEMENT PHASE (2001–)

In spring 2001 (with funding support from the Avifauna Programme of SPREP, and then the Pacific Initiative for the Environment, a programme of the New Zealand Agency for International Development), the emphasis of management in the TCA shifted from the 'recovery' of kakerori to a programme aimed at 'sustaining' the population on Rarotonga. The key work during this phase has been two-fold; firstly, the experimental reduction in rat poisoning effort in the TCA to a level where recruitment of kakerori balances annual mortality and so maintains the population at 250–300 birds, and secondly, the establishment of a secure 'insurance' population away from Rarotonga.

A population of 250–300 birds on Rarotonga, while small by international standards, is probably sufficiently large to withstand normal demographic perturbations and maintain adequate genetic diversity, given that the population passed through a bottleneck with just 13 females alive in 1989. Nevertheless, this population, occupying less than 200 ha on one island, is at

significant risk of substantial decline or extirpation from a major catastrophic event. The most obvious risks are tropical cyclones, new avian diseases (e.g. mosquito-borne *Plasmodium* haematozoa) or new predators (e.g. brown tree snake *Boiga irregularis*). After careful consideration of factors such as island size and topography, habitat availability, predators, competitors, disease risk, and community attitudes, Atiu was chosen as the best island for the establishment of an insurance population. If successful, this second population should lower the risk of extinction of kakerori, and allow birds to be returned to Rarotonga if they should ever die out there.

In August 2001, the first 10 young kakerori were translocated to Atiu, and another 10 young birds were transferred in August 2002 (out of a population of 282 birds). Initial indications were that the transfers had been moderately successful, with successful breeding being recorded on Atiu in spring 2002 (Robertson & Saul 2004).

In the 2002/03 season, the rat poisoning effort on Rarotonga was reduced from that used during the 'recovery' phase, by replacing poison in most bait stations (all except those in the Turoa Valley) fortnightly rather than weekly. This reduced programme saved both time and poison compared with the previous regime, yet resulted in a similar number of fledglings (63) to previous seasons (Robertson & Saul 2004).

This report outlines the monitoring and management programme in the second full season of the 'sustainable management phase' on Rarotonga, including the third and final transfer of 10 young kakerori to Atiu.

2. Objectives in 2003/04

The objectives of the 2003/04 field season were:

- Conduct the annual pre-breeding 'roll-call' and territory mapping of kakerori on Rarotonga in August 2003.
- Mist-net and colour-band as many kakerori as possible on Rarotonga in August 2003 to help to establish the recruitment rate in 2002/03, and help to record the annual survival rate of adults.
- Reduce the annual rat poisoning effort by replacing the single bait in each bait station fortnightly in the Turoa, Totokoitu and Lower Avana Valleys, and around the perimeter of these three valleys.
- Compare the breeding success (percentage of successful pairs), and number of fledglings produced in those territories subject to poisoning, with those with no rat poisoning.
- Transfer a third and final batch of 10 young kakerori to Atiu in August 2003.
- Monitor the survival and breeding of kakerori on Atiu.
- Report results back to the Cook Islands community.

3. Methods, results and discussion

3.1 KAKERORI CENSUS

The rat control programme in 2002/03 proved to have been more successful than was necessary to simply maintain the population. The population on Rarotonga grew 7.4% from 272 birds (after the translocation of the second batch of 10 youngsters to Atiu) in August 2002 to 292 birds (before the translocation of the final batch of 10 youngsters) in August 2003 (Fig. 2). As the population continues to increase, the annual census is becoming increasingly difficult, and the population estimate more conservative. A total of 23 birds were retrospectively added to the provisional August 2002 census of 259 birds (Robertson & Saul 2004); four of these 'new' birds were already known from a site outside the TCA (which is now included in the census), 14 were unbanded 2-year-olds that had been missed or undercounted as yearlings the previous year, and the other five were older birds that had been missed in the previous census.

In August 2003, at least 54 yearlings out of the minimum of 63 fledglings recorded in summer 2002/03 were recruited into the population, a slight decrease from the record 63 yearlings recorded the previous season. After eight yearlings (and two 2-year-olds) were transferred to Atiu, a minimum of 46 yearlings remained in the population of 282 birds.

Apparent adult survival (87.5%) was lower than the long-term average of 91% (since conservation management began in 1989). This decrease in survival is not entirely surprising, given that more individuals are now living outside the managed areas and so do not receive protection from predators.

The overall survivorship of adult kakerori remains remarkably high, and life expectancy of an adult is 11.6 years. The last remaining bird of the eight colour-banded by Rod Hay and Gerald McCormack in 1984 (a male) is now at least 23 years old, and bred successfully in 2003/04.

The territory mapping revealed that kakerori had expanded their range in 2003. They were found in several small valleys on the Avana side of the Totokoitu-Avana Ridge, and several youngsters had established territories in the lower part of the main Avana Valley (well below the water intake). However, an isolated pair that had nested on the seaward side of the Lower Avana / Titikaveka Ridge had moved to the Lower Avana Valley to be alongside other breeding pairs.

3.2 MIST-NETTING AND COLOUR BANDING

During the August census, we set mist-nets on most days, and caught a total of 34 different kakerori. We individually colour-banded 31 new birds: 16 yearlings, nine 2-year-olds, two 3-year-olds, three 4-year-olds and a 5-year-old—but of these, eight yearlings and two 2-year-olds were transferred to Atiu (see below). These new captures brought the total number of colour-banded birds on Rarotonga up to 129, but the percentage of the population that is banded dropped to 45%. The emphasis in recent years of transferring captured

youngsters to Atiu has meant that the percentage of banded birds remaining within the TCA has dropped steadily. The focus over the next few years should be to raise this percentage to over 50%, and so improve the accuracy of our population estimates.

3.3 RAT POISONING

As we had expended more effort controlling predators during the 'recovery phase' of the programme than was necessary to simply 'sustain' the population of kakerori, we designed an experiment to test the effect of reducing poisoning effort from the standard regime of weekly poisoning for 15 weeks in three valleys and around their perimeter. The experimental regime introduced in 2002/03 of weekly poisoning in one valley and fortnightly elsewhere, reduced both the effort and the amount of toxin used (Robertson & Saul 2004). Since productivity under this regime was still greater than that needed to maintain the kakerori population, we further reduced effort in 2003/04 by using only fortnightly replenishment of poison baits in bait stations through the whole area treated in 2002/03.

The pattern of bait take varied considerably between the three valleys, and the bait take on the perimeter was also different (Fig. 3). As recorded in 2002, poison bait take in the Totokoitu Valley remained high throughout the entire season except for late November. In the Turoa Valley, in the Lower Avana Valley, and on the perimeter, the less than 80% bait take in the first two fortnights was low compared with the 80–100% weekly bait take recorded in the first 2–3 weeks in most previous years (Robertson et al. 1998). The bait take dropped as the season progressed, except for a modest increase in late November and December in the Lower Avana Valley. In the past, this increase in bait take towards the end of the season has been associated with an influx of kiore (*Rattus exulans*) at that time of year. Why the Totokoitu Valley results were so different from those in the other valleys was not clear. One possibility was that rats there had developed immunity to the toxin after 15 years of annual exposure, so 30 live-capture traps were set for 10 nights and two kiore were caught. Each rat was given one poison bait and *ad libidum* coconut meat and water. Both rats died (within a week) of internal haemorrhaging, typical of brodifacoum poisoning, and so showed no resistance to the toxin.

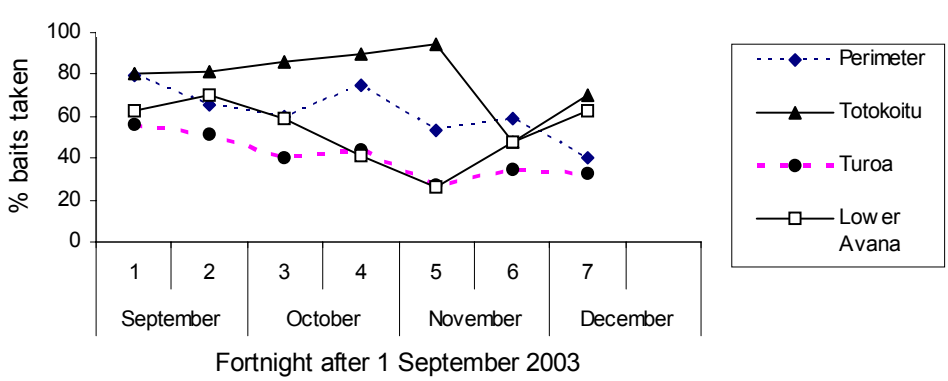


Figure 3. Fortnightly bait removal by rats in three valleys of the Takitimu Conservation Area, and around their perimeter, in late 2003.

The reduced baiting regime used in 2003/04 took 4 person days per fortnight, compared with 7 days per fortnight for the weekly regime used in the 'recovery phase', a reduction in effort of 43%. The total amount of bait taken by rats in 2003/04 was 38.5 kg, compared with 42.9 kg in 2002/03 and 52.2 kg in 2001/02, the last year of standard weekly baiting throughout the same management area. This 26% decrease is less than the 50% expected from halving the baiting frequency, but arose because more baits had to be used to replace uneaten mouldy baits each fortnight. The amount of bait used in 2003/04 was only 13% of the 303.5 kg used over the same geographical area during the peak year (1991) of baiting, when three baits were placed in each bait station (rather than just one now) for most of the season, and bait station density was greater (Robertson et al. 1998).

3.4 BREEDING SUCCESS

Breeding success of kakerori was monitored by Ed Saul and three volunteers from the University of Alberta, Canada. Breeding success was moderately good throughout the TCA in the 2003/04 season, with a record minimum of 80 fledglings detected in summer. Unexpectedly, the breeding success, expressed as the number of fledglings per known breeding territory (with at least one nest completed), was not significantly better ($\chi^2 = 1.96$, $p = 0.38$) in poisoned areas (0.93) than in unpoisoned areas (0.87). However, the infrequent monitoring visits to many unprotected territories remote from the poison lines meant that failed breeding attempts by some pairs undoubtedly went undetected, whereas the discovery of fledglings rather than nests in these territories biased the figures in favour of successful breeding attempts. Breeding success, as measured by the minimum percentage of all territorial pairs that were successful, was also higher, but not significantly so ($\chi^2 = 2.45$, $p = 0.12$), in the poisoned area (0.58) than in the unpoisoned area (0.42).

These data suggest that productivity per breeding pair in unpoisoned areas was much higher than usual (0.46 fledglings/ breeding pair; Saul et al. 1988), and perhaps resulted from the lower than usual numbers of rats in the TCA, as shown by the relatively low initial bait take on three of the four poison lines (Fig. 3).

3.5 ATIU TRANSFERS

Between 15 and 19 August 2003, eight yearlings (five females and three males) and two 2-year-olds (one female and one male) were mist-netted in the TCA and transferred to Atiu in four batches of 1–6 birds. Seven birds were caught in the late afternoon, held overnight in transfer boxes with fruitfly larvae as food, and flown to Atiu on a scheduled flight the following morning. Three birds were caught in the early morning and transferred the same day. Unfortunately, during a consignment of six birds in three boxes, one box containing two birds was not off-loaded from the plane and returned to Rarotonga. A special charter flight had to be arranged to drop the birds off 4 hours after the other birds had arrived. These two birds were released close to a pair breeding near the airport after being held for 8 hours and 22 hours; the remainder were released 4–20 hours after capture in the vicinity of the Atiu Villas, near the centre of the 2600-ha island.

None of the 30 birds released on Atiu in 2001–2003 has reappeared on Rarotonga.

3.6 ATIU MONITORING

George Matearíki has monitored kakerori on Atiu since the 2001 release, and has also solicited the local community for records of birds seen around the island. Two pairs from the original 2001 release were monitored in the 2002/03 season, and both pairs raised two fledglings, thus proving that conditions on Atiu are suitable for kakerori to breed. Of particular interest was the observation that nests were brown rather than the distinctive green (caused by the use of live endemic *Aerobryopsis* moss) on Rarotonga, because they were made mainly from other plant material and dead mosses. This behavioural adaptability augers well for the future of kakerori on Atiu. In January 2003, a third pair was found, but not specifically identified, and by May 2003 George Matearíki had found a minimum of six unbanded (i.e. island-bred) birds.

In August–September 2003, Eric vanderWerf, Matt Burt, Diana Dombroski and George Matearíki carried out searches for kakerori on Atiu. They found five pairs, a lone female and two unbanded yearlings. These five pairs (four birds from the 2001 transfer, four from 2002 and two from 2003) each raised two fledglings in the 2003/04 season.

In May 2004, Ed Saul saw nine of these ten paired birds, plus a new banded male from the 2002 transfer with an unseen partner, and he received three reliable reports of at least one other 'grey' (therefore presumably banded) bird distant from any of the known pairs. In June 2004, Rose Collen and Helen Gummer spent five days searching for kakerori on Atiu, and located seven birds, including a new bird from the 2003 release and an unbanded yearling. This means that at least 15 individuals were detected in May–June 2004 (Fig. 4), although two were not actually sighted. This is likely to be a significant underestimate of the true size of the population on the island, because only a small part of its 2700 ha was searched: much suitable habitat on Atiu is hard to access because the makatea (raised coral) is very difficult to traverse, and there are few roads or foot tracks in these rough areas.

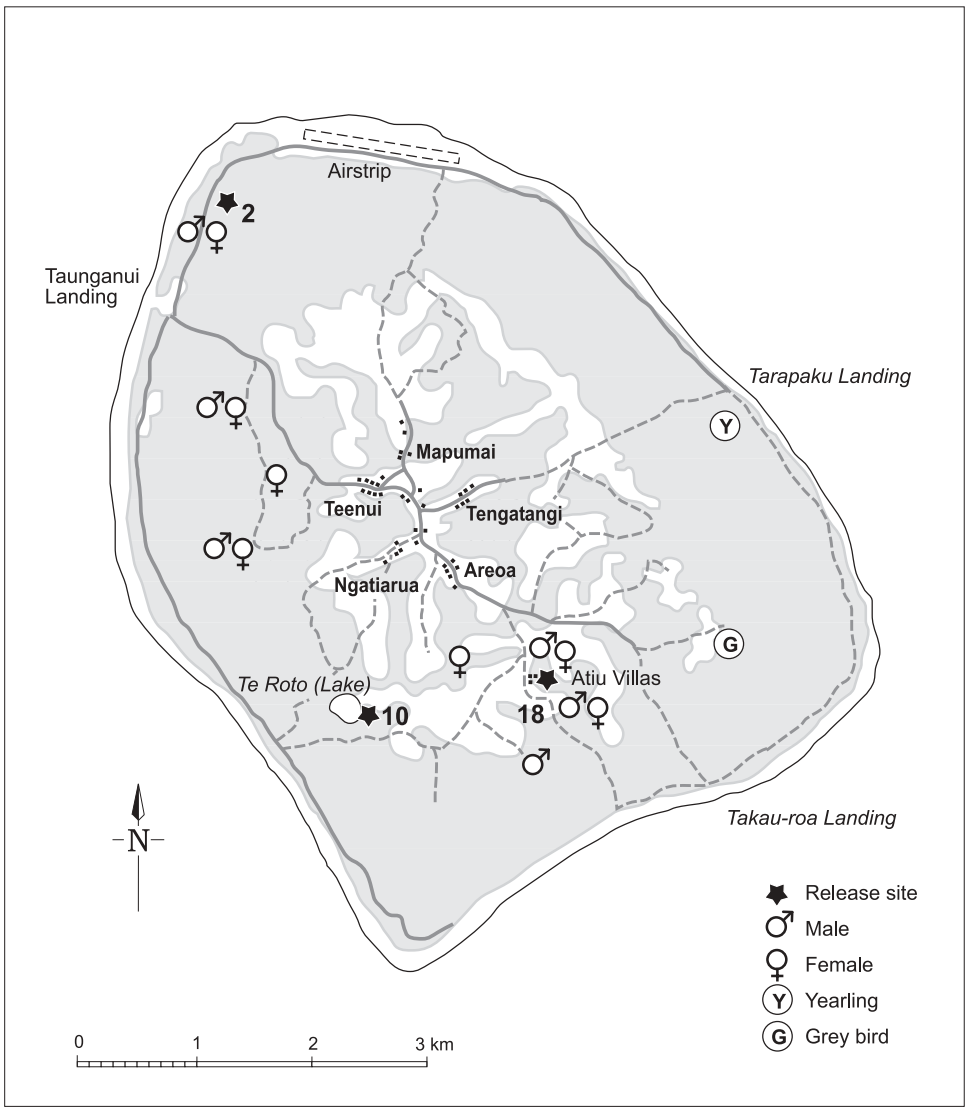
The good survival of released birds, together with the excellent productivity in 2003/04 of the five pairs, living in a variety of habitats, indicates that this new 'insurance' population is becoming well established, despite having to live with kiore and cats, and without *Aerobryopsis* moss, their main nesting material on Rarotonga.

3.7 ADVOCACY

We, and the Canadian volunteers, have worked closely with the TCA project, and its ecotourism business. We were interviewed on Cook Islands television and by the Cook Island News about the transfer of kakerori to Atiu, the August census results, and the success of the breeding season. We are finalising the text for five posters (on kakerori, the Kakerori Recovery Programme, the Takitumu Conservation Area Project, rat control, and kakerori transfers to Atiu) to be placed in the visitor shelter in the TCA.

On Atiu, George Matearíki runs ecotours which now include a visit to the territory of one particularly cooperative pair of kakerori.

Figure 4. Map of Atiu showing location of kakerori seen in May–June 2004.



4. Conclusions and recommendations

The 2001/02 season marked a major turning point in the Kakerori Recovery Programme, from one aimed principally at 'recovery' to one aimed at 'sustainability'. A key element of this shift has been the experimental reduction in management effort on Rarotonga, which set out to find a level which maintains the kakerori population at 250–300 individuals, and enables the programme to be both physically and economically sustainable in the long term.

The progressive reduction over the past two seasons in the frequency of replenishing poison baits has reduced both the effort and the amount of toxin used. Judging by the continued population growth of kakerori, and the record production of fledglings in the 2003/04 breeding season, fortnightly poisoning is not only effective, but is also a cheaper and less toxin-intensive method of protecting kakerori than that used previously.

To assess the long-term sustainability of the kakerori population under this regime, we recommend that fortnightly poisoning of rats is continued in 2004/05, but that it start a week earlier than in 2003/04, because the breeding season seems to have been starting slightly earlier (in mid- rather than late-October) in recent years, perhaps as a result of a gradual increase in the average age, and hence experience, of breeding birds (H. Robertson and E. Saul unpubl. data). This poisoning programme will again protect about 80% of all breeding pairs.

Because we are now unable to monitor the breeding attempts of all pairs, we recommend that, in the 2004/05 breeding season, all breeding attempts of a pre-selected sample of only 20 pairs be monitored closely in each of the poisoned and unpoisoned areas. This should provide an unbiased estimate of breeding success in these areas. Towards the end of the breeding season, an attempt should be made to record the number of fledglings in all territories to provide an estimate of overall productivity.

The other main element in the move to 'sustainable' management of kakerori on Rarotonga has been the establishment of an 'insurance' population on Atiu, should some environmental catastrophe strike Rarotonga. The transfers are now complete, and there is no immediate need to transfer more kakerori to Atiu, given that this population seems to be becoming well established. We recommend that the breeding productivity of the Atiu population continues to be monitored for at least another year, and that thorough searches for banded and unbanded birds are done as opportunities arise. All records of kakerori on Atiu should be collated by the TCA Project team.

Kakerori are still not legally protected. The vulnerability of these birds was highlighted by the discovery last year that an American museum collector killed and exported two kakerori in 1984 without receiving any permission to do so (Ana Tiraa, pers. comm.). The TCA Project should continue to make efforts to get the kakerori, and other threatened wildlife in the Cook Islands, legally protected by the Cook Islands Environment Service by listing it in a schedule under the Environment Act.

5. Acknowledgements

The Department of Conservation, New Zealand, allowed Hugh Robertson to take special leave on pay to assist with the field project in August 2003. The Pacific Initiative for the Environment of the New Zealand Agency for International Development supported the research efforts on Rarotonga, the third and final transfer to Atiu, and costs of monitoring the birds on Atiu. The TCA Project contributed substantially by covering vehicle running costs, poison bait supply, and some of George Matearikiʼs expenses on Atiu. The TCA Project also provided accommodation and safety equipment for volunteers helping with the field programme on Rarotonga.

Diana Dombroski helped with the annual census and colour-banding of kakerori, and the transfer of birds to Atiu. Euan Smith of Air Rarotonga arranged for the kakerori to be taken to Atiu free of charge, and provided free return flights for some of the people involved in monitoring work there. Staff of the Totokoitu Research Station supplied fruit-fly larvae as in-flight meals for kakerori on their way to Atiu. Amy Forsyth, Annette Potvin and Paul Jasche from the University of Alberta in Edmonton, Canada, provided invaluable field assistance with rat-poisoning and the monitoring of nesting attempts for much of the field season on Rarotonga. George Matearíki monitored the breeding attempts of birds on Atiu, and Roger Malcolm of Atiu Villas assisted with the transfers and release of birds. Diana Dombroski, Eric vanderWerf, Matt Burt, Rose Collen and Helen Gummer worked with George Matearíki to search for kakerori on Atiu.

Ian Karika, manager of the TCA Project, assisted in many ways with technical support, fund-raising, and especially with the Atiu transfers and the continuing refurbishment of a somewhat 'tired' house into a comfortable field base for the volunteers.

Chris Edkins drew the maps, and Ralph Powlesland, Ian Karika, Greg Sherley, Sue Hallas and two referees improved the manuscript.

6. References

BirdLife International 2000: Threatened Birds of the World. Birdlife International, Cambridge and Lynx Edicions, Barcelona.

Collar, N.J.; Crosby, M.J.; Stattersfield, A.J. 1994: Birds to Watch 2: the world list of threatened birds. BirdLife International, Cambridge.

Hay, J.R. 1986: Bird Conservation in the Pacific Islands. Study report No. 7 International Council for Bird Preservation, Cambridge.

Hay, J.R.; Robertson, H.A. 1988: Ecology of kakerori (*Pomarea dimidiata*)—a draft recovery plan. Ecology Division Report. Ecology Division, DSIR, Lower Hutt, New Zealand.

Robertson, H.A.; Hay, J.R.; Saul, E.K. 1993: Age and sex determination of kakerori *Pomarea dimidiata*. *Notornis 40*: 179–187.

Robertson, H.A.; Hay, J.R.; Saul, E.K.; McCormack, G.V. 1994: Recovery of the kakerori: an endangered forest bird of the Cook Islands. *Conservation Biology 8*: 1078–1086.

Robertson, H.A.; Saul, E.K. 2004: Conservation of kakerori (*Pomarea dimidiata*) on the Cook Islands in 2002/03. *DOC Science Internal Series 167*. Department of Conservation, Wellington, New Zealand.

Robertson, H.A.; Saul, E.K.; Tiraa, A. 1998: Rat control in Rarotonga: some lessons for mainland islands in New Zealand. *Ecological Management 6*: 1–12.

Saul, E.K. 1995: Towards 2000: a management plan for the kakerori's next 5 years. Unpubl. report, Cook Islands Environment Service, Rarotonga, Cook Islands.

Saul, E.K.; Robertson, H.A.; Tiraa, A. 1998: Breeding biology of the kakerori (*Pomarea dimidiata*) on Rarotonga, Cook Islands. *Notornis 45*: 255–269.

Sherley, G. 2001: Bird conservation priorities and a draft avifauna conservation strategy for the Pacific Islands Region. SPREP, Apia.