Kokako management folder

THREATENED SPECIES OCCASIONAL PUBLICATION 19

Department of Conservation
Te Papa Atawhai

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By Ian Flux and John Innes

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Prepared by Ian Flux[1] and John Innes[2]

[1] Science & Research Unit, Department of Conservation, PO Box 10-420, Wellington
[2] Landcare Research, Private 3127, Hamilton

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Cover photo: North Island kokako, Puketi Forest, Northland, 1981.
Photo by Rogan Colbourne.

This folder has been prepared as a guide for authorised people involved in management of kokako, or management of areas containing kokako. In the main they will be Department of Conservation staff (including volunteers), or staff of organisations who work in partnership with the Department of Conservation. Any planned management project for kokako must be discussed with the recovery group leader and the appropriate land administrators; the necessary permits must be obtained.

The intensive integrated-management regime, which we advocate for kokako, has been widely adopted by managers of lowland forest communities. We hope and believe that kokako will increasingly be managed at sites which are nationally, or regionally, recognised for their wider conservation values. To this end all new management sites recommended by the current kokako recovery plan have been selected in consultation with regional managers and other species recovery groups. In the shorter term, however, it will be necessary to manage some sites particularly for kokako, to ensure population recovery and maintenance of maximum genetic diversity within the species.

The information contained is up to date at the time of publication. These are methods which have been widely used in kokako projects; we consider they are current "best practice". Technology will change, and experience and innovation will provide new methods over time. At some sites compromises may have to be reached if any conflicts arise between different management objectives. The kokako recovery group will endeavour to update sections of this document as it becomes necessary. Before planning any project based on advice given here, please check with the recovery group leader that you have the most recent update of this work.

CONTENTS

APPENDICES

1. Recovery plan issues and actions

The following issues and actions section is reprinted from the Kokako Recovery Plan (1999). This section is intended to provide the conceptual setting within which individual kokako management projects are contributing to the national recovery goal.

LONG-TERM GOAL

To improve the status of North Island kokako from endangered, by restoring the national population to ca 1,000 pairs by the year 2020, in sustainable communities throughout the North Island.

Separate populations shall average 50 pairs and shall be managed together with the diverse communities in which kokako were previously recorded.

1. Issue

Fewer than 400 pairs of kokako currently exist. Populations are small and isolated. Kokako occurred naturally throughout the North Island, and true recovery will involve their restoration to sites throughout this original range. Some populations have been reduced to such small numbers that harmful genetic bottlenecks may be occurring, and others declined to extinction. Translocation of birds from elsewhere may be required in both cases. Nationally, recovery will be achieved most efficiently if key sites for kokako management are clearly identified.

Action
Choose key mainland sites as places to manage or establish populations. Planning must identify a source or sources of kokako to translocate to new sites, and must consider the conservation of all current kokako genetic lineages.

2. Issue

There are still many uncertainties about the most effective ways to manage kokako for the next 20 years, especially in very large (>10,000 ha) forest blocks, and regarding translocations. Key research can increase efficiency of management practices. Kokako ecology at individual, population and community levels is not fully understood, nor are details of our management techniques and strategies.

Action
Undertake key research to underpin sustainable management. Research topics are detailed in the work plans.

3. Issue

Offshore island populations are usually safe from the predatory mammals that make kokako recovery on the mainland so expensive, but some details of the number and origins of translocated kokako required for the population to be successful are still uncertain.

Action

Monitor offshore island populations and be prepared to translocate further birds if necessary.

4. Issue

Some populations (e.g. Taranaki, western Waikato, Coromandel) are or may be reduced to one or two (predominantly male) birds. Left alone, extinction of the populations and loss of their particular genetic lineages are certain.

5. Issue

It is difficult to advocate for kokako management in the wild because many of the populations are in remote places so that wild kokako can be hard for the public to see or hear.

Action

Hold kokako in captivity for breeding and reintroduction in an attempt to preserve some of the genetic variation held within the remnant populations. Hold kokako in appropriately constructed and vegetated aviaries and promote them to support advocacy for active management of kokako in the wild.

6. Issue

Kokako conservation is everyone's responsibility. The New Zealand public have a right to full information about what we are doing, and many people (especially those living adjacent to management sites) wish to be actively involved in kokako projects. The long grind of pest control to achieve the 2020 vision of kokako restoration will only be sustainable if the interested public remain involved and informed about our work.

Action

Promote public interest and involvement in kokako conservation, by ensuring good public access to populations and using media to assure a free flow of information about kokako projects. Support and encourage partnerships between DOC and other like-minded groups which are prepared to work for kokako conservation.

2. Current recovery strategy

We start this planning period (1999–2020) knowing:

1. That the immediate cause of mainland kokako decline is recruitment failure due to predation by ship rats and possums at kokako nests
2. That these declines can be reversed, by intensive and sustained pest control using existing technology.

These two findings of the last 10 years' research and management are the key to future recovery for the whole population. The vision of 1000 pairs by 2020 CAN BE ACHIEVED BY METHODICAL APPLICATION OF WHAT WE ALREADY KNOW. Any future improvements to the efficiency or effectiveness of current pest control methods will only make the job easier.

The main strategy of this Plan is to apply pest control to at least 20 mainland sites (Table 1) so that, on average, there will be about 50 pairs in each. Some (Rotoehu, Otamatuna-Onepu) already have more than this but must be sustained or increased. Others (e.g. Trounson Kauri Park) are unlikely to ever reach 50 pairs, due to their smaller area. We hope that more sites than those listed in Table 1 *will* be managed, but the listed sites are the *required minimum* to be managed if the recovery vision is to be achieved. The sites are scattered evenly through different Conservancies, partly to spread the work load and partly because this reflects the natural range of the species.

Very large forest blocks such as Te Urewera National Park, the north block of Pureora Forest Park, and some forests in Northland are in some ways the 'final frontier' for kokako conservation. Recovery techniques for kokako were developed in small-medium sized blocks and their extension to very large areas is essentially experimental. However, large forests offer most to kokako conservation in the long term because the ecological community of which kokako are only a part is intrinsically large-scaled.

New populations, and the infusion of new genetic lineages to bottle-necked populations, can only be achieved by translocations (Table 2).

TABLE 1: KEY SITES WHICH ARE REQUIRED TO BE MANAGED SO THAT THE GOAL OF THE KOKAKO RECOVERY GROUP CAN BE MET BY 2020.

CONSERVANCY	SITE	ECOSYSTEM RESTORATION PROJECT	RECENT OR CURRENT KOKAKO MGMT	REQUIRES TRANSLOCATION (SOURCE)	NEW	PEST TARGET INDICES MET BY
Wellington	Kapiti Island	•				ongoing
	Mt Bruce Forest	•		• (central NI)	•	2002
Wanganui	Whitecliffs			•	•	2005
East Coast/Hawkes Bay	Otamatuna/Mangaone	•	•			ongoing
	Onepu	•	•		•	ongoing
	Ikawhenua	•				ongoing
	Boundary Stream	•		• (Nth. Urewera)	•	2001
Bay of Plenty	Rotoehu		•			2010
	Kaharoa/Onaia		•			2000
	Mokaihaha				•	2001
	Opuiaki				•	2005
Waikato	Mapara		•			2002
	Mangatutu	•	•			ongoing
	Waipapa/P'ariki	•				ongoing
	Moehau	•		• (Waikato/Coromandel)	•	2005
Tongariro/Taupo	Rangataua?	•		• (Waikato/Coromandel)	•	2010
Auckland	Hunua	•	•			ongoing
	Hauturu (LBI)					ongoing
	Tiritiri-matangi			• (Taranaki; captive bred)		ongoing
	Great Barrier Island	•		• (Little Barrier)	•	2005
Northland	Tutamoe/Mataraua		•			ongoing
	Trounson	•		• (Northland)		2010
	Puketi		Small scale	• (Tutamoe)	•	ongoing

TABLE 2: PLANNED KOKAKO TRANSLOCATIONS, 1999–2010

FROM	TO	BY	NUMBER
Taranaki/Coromandel	captivity	1999	3 adults
Mapara	captivity	2000	3 eggs/ch.
Taranaki, via Mt Bruce	Tiritiri Matangi I.	As available	Subad./ad.
Otorohanga			
Captivity or central N.I.	Mt Bruce Forest	2002	5 prs -
			Subad./ad.
Nth Urewera	Boundary Stream	2001	5 prs
Northland	Trounson	2010	5 prs
Tutamoe	Puketi	2000	4 fem. ch.
Tiritiri Matangi Is.	Taranaki	2005	5 prs
Little Barrier Is.	Great Barrier Is.	2005	5 prs
Waikato/C'mandel	Moehau	2005	5 prs
Waikato/Taranaki	Rangataua	2010	5 prs

3. Project design

Most remaining viable kokako populations are already managed in some form or other, so that we already know a lot about how to make projects successful. The following elements are prescriptive for kokako recovery projects. Management prescriptions for any individual site can be deduced from Table 1 and these prescriptions.

CONSULTATION WITH LOCAL COMMUNITY AND IWI

There should be adequate consultation with the local community and iwi so that affected locals and their neighbours know what you are planning to do, before you start. This includes translocations, when iwi at both ends of the transfer may wish to be involved. If possible, get locals to physically help with work on the project. Keep locals informed about what happens to any kokako taken away from their area, and discuss with the Recovery Group leader any pledges to return birds to the area in the future. Such pledges need to be clearly recorded in revisions of the Recovery Plan.

EXPERIMENTAL FRAMEWORK

Before you start, consider whether some aspect of the project can be treated as an experiment to improve its' value and increase efficiency of future projects. This could involve comparing different pest control techniques, different poison baits, identifying predators at kokako nests, or trialling a new kind of translocation release method. A valuable addition to current knowledge is to measure the percentage of kokako nests that successfully fledge young at certain, measured, ship rat and possum abundance. The latter need to be measured in particular ways (Gillies & Williams 2001; Warburton 1996). We especially need to know how successful nests are when ship rats are in the 5–30% (tunnels tracked) range and possums give a 5–30% trap catch rate, to refine draft targets for effective pest control. Get advice from both the Recovery Group leader and from a Conservancy or Regional scientist about your trial *before* starting it. Due regard needs to be given to sample size, non-treatment blocks, replication, statistics and so on, but don't be daunted! Even simple trials can be powerful if well designed.

COMMUNITY AND SPONSOR INVOLVEMENT

Both the local community and any sponsor(s) have the right to be involved with the project—afterall it's also their project in a sense. Besides, both, in their own ways, provide an opportunity for the project to be a lot more cost-effective. Consult with the Recovery Group leader before approaching ANY sponsor for a local project. Your arrangement may jeopardise a much larger sum of money from a national sponsor for the species. The local community may include neighbours, nearby

residents, inhabitants of the nearest town, and service clubs such as Rotary. Local iwi members may have their own particular perspective on the native bush area and its wildlife. What involvement do they want with the project?

PEST CONTROL TIMING

Poisoning operations to protect kokako must be undertaken during August to October (the later the better), so that ship rat populations are lowest at the time of kokako breeding from November onwards. Large-scale aerial operations, which target possums, will NOT benefit kokako if they are done earlier than August, because ship rat populations return to pre-poison levels within 3–5 months, even though possum populations take much longer. Much benefit may be possible for kokako and other forest birds if aerial operations for, say, Tb control can be conducted inside the August to October period.

PEST CONTROL TARGETS

Target post-control indices are 1% trap catch for possums (using the national standard trapping technique) and 1% tracking frequency for ship rats (using the standard kokako (RbM) system, which seems likely to be accepted as a national protocol) at 1 November. Post-control indices of <5% for each species are acceptable and greater values for either species mean an operation failure.

MINIMUM MONITORING (DOC AND VOLUNTEER/TRUST PROJECTS)

a) kokako

For DOC projects

The number of territorial adults in the entire biological population is to be counted annually as at 1 November up to a total of 25 pairs. Criteria for acceptance of records, and correct procedures for the whole count are described in Protocols and Procedures. After the population reaches 25 pairs, total counts should be undertaken at least each 3 years, and in the year in which a pest control pulse starts. Monitoring chick output is unnecessary, but would be very valuable if either ship rat or possum abundance is in the 5–30% categories as described above. Data on these three parameters (ship rat abundance, possum abundance, kokako chick output) taken in the same season will add valuably to existing data provided that standard indexing techniques are used.

For volunteer/Trust projects

The number of territorial adults in the entire biological population is to be counted during the six weeks prior to 1 November at least every 3 years, by DOC or a contractor who reports to DOC, independent to the personnel running the project.

b) pest-mammals

For all projects: Ship rat and possum abundance must be monitored in all blocks annually by 1 November using standard techniques.

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4. Kokako surveys

TYPES OF KOKAKO SURVEY

So-called 'walk-through' surveys are done to determine kokako distribution and approximate density in very large forest areas. Observers survey on ridges or compass routes by playing tapes at intervals, and they visit each location only once, hence 'walk-through'. Territory mapping means going back several times to follow particular pairs or singles, to map their territories. This clarifies exactly how many are present. Roll-calls are repeated visits (usually weekly) to a particular group of territories, to verify that all occupants have survived a pest control operation, usually aerial poisoning. Clear and formal guidelines were established during the 'Research-by-management' programme for annual counts of both adult and juvenile kokako, because these were key measures of the success of the pest control programme. The adult census is a count of adults done by territory mapping by November 1, and juvenile surveys look for fledged juveniles with adults each autumn.

Playing tapes of kokako calls and song is the basic tool of most kokako survey. The technique was pioneered by John Kendrick, Ian Crook and others, in Wildlife Service days (Crook, Merton & Moran 1971).

4.1 WALK-THROUGH SURVEYS

Walk-through surveys give information on kokako distribution (presence/absence) and are a rough guide to abundance, but they will reveal only large changes in both. They can be done in any month in the year, although results are harder to interpret during November to April when birds may be breeding or moulting. Survey is most effective from ridges, and people working together are more effective than people working alone. Surveys start at dawn, and proceed along pre-planned routes that traverse the area of interest, until early afternoon. Surveying is only done in reasonable weather because wind and rain both cause observers to miss birds.

The basic technique

Listen for kokako all the time. If none is heard, stop each 200-300 m to listen for song. If there is no singing, play some *local dialect* tape, in the following sequence:

a) 3 mew calls, followed by a 5 minute listening period
b) 3 mew calls, followed by a 5 minute listening period
c) 30 seconds of local song, followed by a 5 minute listening period

No good research supports this particular sequence being better than others, but using it may enable better comparisons between surveys. Mew calls are perceived to be less dialectical than song.

If you have access to good recording equipment, you can record local dialect for playback every few (e.g. four) territories (Hudson & King 1993). Hudson and King listed conditions for poor response as rain, strong winds, fog with cold mist, sudden temperature drop, lateness in the day (after 10 a.m. summer and 1 p.m. winter).

Conditions for good response were clear and still early mornings, light warm drizzle, and light winds.

All birds heard or seen are mapped. A useful way to record observations is simply to photocopy the relevant NZMS 260 map, and annotate with Pr = pair seen, S = single seen, H = bird(s) heard. Remember to show the route taken and all playback stations, even if no birds are located. This involves making careful decisions about how many birds are actually present and where they are, which is helped by having two observers at slightly different places, or enabling one to move in to the birds while the other stays on station. Walk-through surveys in seven study areas in the King Country during 1986-88 located on average 70% of kokako subsequently confirmed by territory mapping. It is useful to count and map the number of *territories* in an area, even if the actual number of kokako occupying them is less known.

4.2 TERRITORY MAPPING

Kokako territories are mapped when more precise information is needed on kokako numbers. It enables determination of the number and location of most territories present, plus whether these are occupied by pairs or singles. Note that the total number of territorial kokako present can then be calculated, but not the number of non-territorial subadults and adults, which prevents calculation of the total population.

Birds located by walk-through survey are found and followed until a clear picture is found of their territory location. Routes taken by the kokako must be accurately recorded on a suitable map or 'follow sheet'. All neighbouring birds also have to be clearly identified. More than one person is usually necessary to identify neighbours. Most birds can be located by their calls when their territories are known, without playing tapes. It usually takes 1-5 visits of nearly 3 hours each to map a territory. This will increase when territories are very large (e.g. Taranaki), terrain is difficult (e.g. Kaharoa), or high numbers of birds are densely packed (e.g. Mapara). It took 1–12 visits per territory (average 4) to map the dense population at Mapara. The effort taken to accurately map birds varies from 0.5 to 4.7 person-weeks per territory (Rasch *et al*. 1986; Speed *et al.* 1987,1988; Bradfield *et al.* 1988; Williams 1990)

4.3 ROLL CALLS

Roll calls (Rasch *et al*. 1986) are used to monitor the survival of individual adult territorial kokako during aerial poisoning operations. Kokako are selected for roll calling after walk-through surveys in the poisoning area. The monitoring sequence is then:

1. Map territories of all kokako. Usually four visits per territory are enough.
2. Relocate all territorial adult kokako at least once per week (=roll call), for 3 weeks or longer until the poison drop occurs.
3. Within a week, recommence roll calls. Continue for at least 3 roll calls, or until most baits are non-toxic.

A minimum of three roll calls prior to the poison drop verifies that individuals can be relocated. If a kokako can be found regularly before the poison drop, then it should be able to be found afterwards also. Any disappearance after the poison drop which cannot otherwise be explained (e.g. by expected natural mortality) is assumed to be due to death by poisoning (see Section 11).

Roll calls were first tested using13 kokako in the Pikiariki Ecological Area, Pureora, in May 1985, in the absence of any poisoning. All adult kokako were located each week for 4 weeks, but one juvenile could not be found after the first roll call, probably because it left its parents' territory then. It took 1-5 days to locate all 12 adults, each week.

4.4 ADULT CENSUS

Field criteria for accepting records in counts of adult kokako

(John Innes, Hazel Speed)

The adult census is a count of territorial adults done by territory mapping by November 1 each year. It is one of the key measures of a population, and is likely to be used as a yardstick of success if the population is managed.

At present there is no practical choice but to count kokako in populations in which not all birds are banded, using territory mapping techniques. The main concerns are to ensure that counts in different areas (or in the same area at different times) are comparable and to have some awareness of the likely magnitude of error between the estimated and actual populations. Also, these objectives demand clear criteria for including particular kokako in counts to maximise comparability between counts.

Perceived causes of error in kokako adult counts:

i. Double-mapping. Recording a territorial single or pair in separate localities as separate birds (belonging to more than one territory), when in fact they are the same individuals (in one territory). This is
   - likely to be the biggest error source in past counts
   - resolved in the field by repeated, long follows and especially by stake-outs and banding
   - reduced by accurately recording follows on standard follow sheets. Past surveys can also be roughly assessed for this error if good follow sheets and times are available.

ii. Clumping (reverse of (i) above). Mapping one or two birds in one territory when in fact there were more individuals from separate territories. This is resolved in the field with the same methods as (i).

iii. Mobile subadults. Danger here is multiple mapping (as for (i)). The present criteria mean that subadults moving a lot are not necessarily a problem, unless they are followed in the same place on two separate days or sing full song. As with the roll-call methodology, errors will clearly be minimised by having robust criteria for indicating territoriality, and by reducing the duration of the survey so that the mobile birds have less chance of being found in different places.

Birds with juvenile appearance (lilac wattles; brownish plumage) and abnormal song or with no full song should not be counted in surveys of territorial adults.

iv. Change of search area. Comparable counts in any forest involve searching the same area each time. This means including all corners of the block, and areas between known territories. Searching must not be confined to previously known territories. If an area is too big to cope with, do a thorough count in a subsection of the area—don't do a skimpy effort over the bigger area.

Rules for counts of all territorial adults

i. Count to be undertaken in the second half of September and all of October only (maximum duration 6 weeks) and to apply at 1 November. Survey prior to the count period is desirable and normal, but only records verified as definite (see below) from the count period will constitute the count.

Comment

The 6-week duration is as short as we can practicably make the count period, given that bad weather could rule out 2 weeks of this easily. If the survey can be done in less time, then do so, since this will reduce the chance of errors due to birds moving between territories. Survey should be completed by October 20 if possible, to reduce the chance of pairs starting nesting during the survey period.

ii. A minimum of 2 people (for all or part of the time) is required for stake-outs to verify whether birds are the same or different. As many skilled observers as possible should be used for each count.

Comment

Observers must be reasonably skilled and suitably cautious or their dubious observations will cost the survey time. In our experience, to correctly identify bands methodically on kokako takes at least a month of full-time practise. Observers with less than this experience are commonly and unavoidably used in surveys, and their contribution is valuable, but the survey organiser should be aware of possible errors and check them.

iii. The following should be noted by each observer:

- Daily survey routes, on appropriate maps are collated in one place by one person.
- Times and localities with *and without* kokako. Places without are recorded as walk routes and places where played tape got no response (usually, 'TNR' = Tape No Response).
- Whether kokako were heard or seen. Heard birds are best recorded as a direction rather than a location, unless the observer is very sure about how far away the bird was. Song and calls can be very deceptive to place accurately. Note the time—someone else may have been with the birds at the time.
- Plumage condition, wattle appearance, calls and song of each located kokako. It is just as important to record these if they are "normal". Missing feathers; big, small or lilac wattles; curious calls, song or behaviour (bird easy or difficult to follow) are all important clues to identify individuals, especially if unbanded. Simple features (missing tail feathers; chunk out of a wattle) can readily tease apart two sightings or suggest that two sightings were in fact of the same bird. This can be verified if necessary by stake-outs.

- Presence or absence of bands, radio transmitters, radio transmitter harnesses etc. If banded, note colours of bands on both legs (remember the LEFT leg is the BIRD'S LEFT, which is on the right side if it's facing you).

iv. The following are field criteria for acceptance of birds into the count total:
   a. For banded or distinctive kokako which are known from at least three observations to be territorial in this place in the previous year…
      - confirmed ID of bands or the distinctive character within the known territory
      - *and* a follow of at least 15 minutes.
   b. For newly banded individuals (e.g. last year's young); unbanded, indistinctive kokako (including pairs with an unbanded, indistinctive member); previously-known, banded or distinctive birds in a new location…
      - follows on at least two separate days of at least 10 minutes duration each at the same location (so that follow routes cross each other);
      - *or* one follow of at least 30 minutes in which one member of the pair expresses full song.

   Comment

   Follow times given are easily achieved at, e.g. Rotoehu and Mapara, but much less so at Kaharoa or Little Barrier Island. We could increase them, but the criteria may become impracticable at Kaharoa and other habitats with widespread impassable terrain features.

v. The following are field criteria for *possible* records:
   a. Any follow of an unbanded, indistinctive, kokako, which doesn't reach criteria in 4b
   b. Any bird, which is heard giving any call or song, in a place where there is *no doubt* that it is not an already known individual.

   Possible records must be followed up by more survey effort. Resolution of the true number of kokako present is best achieved by stake-outs, with simultaneous searching in the doubt areas by at least 2 (preferably more) observers.

vi. Coverage of the survey area

   All parts of the survey area must be searched by listening (from dawn onwards) and, if no song is heard, by tape-playing. Tape-playing should use a good quality recording of local dialect; playing should be followed by at least 5 minutes of listening and watching at each station; stations should be within at most 300 m of all parts of the block, less if line-of-sight ridge-top listening stations can't be found.

4.5 JUVENILE SURVEYS

A second key parameter, which measures kokako population health, is juvenile output. Young kokako remain in their parents' territory for weeks-months after fledging. Juvenile surveys are carried out by visiting known pairs, in the latter part of the breeding season, to see whether or not they have juveniles with them. We use the parameter *proportion of pairs which fledge chicks* because it can be

difficult to accurately determine the actual number of young which fledged from a clutch. Remember that this parameter includes data from pairs which do not even attempt to breed, and yet other pairs may make up to four breeding attempts each season, so that it is *not* a measure of the proportion of breeding attempts that are successful.

Definitions of terms

1. '*Chick*' or '*nestling*' to apply to the time in the nest (i.e. from hatching to fledging).
2. '*Juvenile*' to apply to the time from when the chick leaves the nest to when it leaves the parents' territory. This is when we survey for young.
3. '*Subadult*' to apply to the time when the young bird departs the parents' territory to when it establishes its own.

Evidence for accepting kokako juveniles

1. Definite evidence, i.e. characteristic of juveniles only. Any one of these observations is acceptable evidence of a juvenile.
   a. Very small (pea-sized) pink-lilac wattles, sometimes concave.
   b. Short tail (cf. adult length). Emergent down on thighs, head or neck. Brown tinge to plumage (all observations to apply).
   c. Third (or more) bird(s) travels with adults for at least 5 minutes or 100 m *and* is fed by them. 'Travels with' means all birds travelling within metres of each other without overt aggression such as chasing.
   d. Third (or more) bird is stashed/cached by parents, *and* parents are seen to return to feed it. Stashed bird must remain in sight while parents feed and then leave.
2. **Probable evidence**, i.e. none by itself is sufficient to accept a juvenile, but (a) *and* either of (b) or (c) together means that a juvenile record is accepted.
   a. Adult size and behaviour but wattles lilac.
   b. Abnormal (variable pitch, squeaky, incomplete) mews or song (c.f. adults). Song attempts sound warbled, and may degenerate into squeaks or mutters. *Or* 'buzz' call when being fed.
   c. Previous observations in the territory which suggest that a full nesting cycle has been completed, namely:
      i. single bird encountered (other is incubating or brooding) where normally there were two, lasting ca 35 days
      ii. then, repeated sightings of one or two birds (especially carrying food) in a particular vicinity (feeding chicks), for a further 15 days. NO carrying of nesting material at this stage.
3. **Indicative evidence**, which suggests that further observation is warranted:
   a. Sustained hesitant or clumsy movement
   b. Small (pea-sized) blue wattles
   c. Brownish tinge to plumage
   d. Prior indication from previous visits of breeding in the territory, but inadequate to be confident that a full nesting cycle was completed
   e. Inappropriate feeding attempts (e.g. of dead twigs)
   f. Low 'keening' note given by adults when chicks are present

Recommended juvenile survey method

1. Follows of each pair must in total reach 2 hours. Follows up to a 4 hours total are desirable but not essential. Follow effort beyond this time should only occur if evidence suggests that a juvenile is present.

2. Individual follows must be 15 minutes at least to contribute to the 2-hour total. A 'follow' begins when birds are seen and ends when their locality is unknown. It is accepted that visual contact with birds is intermittent during a follow.

3. Total contact time (by observer, date and time) with each pair is to be noted. Record the number of contact-minutes needed to locate the juvenile(s).

4. Survey timing must recognise that juveniles may fledge between late December and April. Two separate surveys may be necessary.

5. The criteria listed above are to be used to accept or reject observations as sufficient evidence to count a juvenile.

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5. How to find and monitor nests

KOKAKO NESTING BIOLOGY

Kokako nest on average 16m (range 2–31) above the ground, in many different tree species, but usually with dense overhead cover. One to three eggs are laid in September to April, especially November to January. Usually only the female builds the nest, incubates eggs and broods young, although the male feeds the female at or near the nest while she is incubating and brooding. Both parents feed the chicks. Incubation takes about 18 days, and time to fledging is 30–35 days (Innes & Hay 1995). In 'good years', some kokako pairs fledge two or even three clutches, and pairs will reattempt nesting up to three times after initial failure, which is usually by predation (see Section 10).

FINDING KOKAKO NESTS

For the first five or so weeks of nesting, the female is mostly at the nest while the male isn't. *The main job, then, is to locate the female and follow her to the nest.*

- Get to know where PAIRS of kokako occur. Otherwise the single birds you follow will be just that—singles.
- The onset of nesting is characterised by increased frequency of courtship feeding, and 'archangel' displays, especially by the male, in which wings and tail are fanned out and the bird bobs up and down on one spot, as if bowing. Twigs may be passed between male and female. Nest building takes about 5 days. The female carries twigs, then leaves, moss and rotten wood, and finally tree-fern scales as nest-building progresses.
- Follows in pairs' territories during the breeding season should be a minimum of 35 minutes long. If the female is incubating she will rarely leave the nest for more than 25 minutes (usually 2–15 minutes). If you follow a pair together for 35 minutes, then they will not be nesting. *If your follow is of a single bird when you know there should be a pair, or if your follow is marked by unusual disappearances and appearances of birds, or if the pair seem furtive and business-like,* then you are on to something.
- The hard part is finding the actual nest-site. This can be tricky even once you've pinpointed the general area where two birds seem to separate or come together, or where you hear mysterious calls (a second bird which you are sure is present but you don't get to see) or where you have followed a bird carrying twigs. The best technique is to sit still in a good viewing spot, and wait for either the female to emerge from the nest (about once per hour) or the male to visit her (about every 35 minutes average at one nest, but this may be as long as 2 hours). *Once a male is seen carrying food, it will generally move quickly and purposefully towards the nest.*
- When chicks first hatch, the female spends as long (70–90% of her daylight hours) at the nest brooding the chicks as she did incubating. This then steadily

declines as the chicks grow. At one Pureora nest, the female stopped brooding completely when the chicks were 21 days old. The total number of feeding visits made by the parents increases steadily to >3 per hour as the chicks grow. At this stage of nesting, the pair will repeatedly be in the same general area; they will be seen carrying food rather than swallowing it, and they will be very business-like in their movements. Both birds may then be followed to the nest, and chicks may be heard begging when they are fed.

Note that the male's visits to the nest are always brief, usually less than 10 seconds. Most nests are found by following the male to the female rather than to the nest itself.

Radio transmitters on female kokako are the best way to find all nests quickly.

MONITORING KOKAKO NESTS

- Once located, visit each nest at least once per week. More frequent visits are desirable if you wish to examine failed nests quickly after their failure. This will enable more accurate description of the nest scene which may hold clues to the original failure event, before scavengers obscure the original picture.
- The nest can be considered to be active if you see adults entering or leaving the nest, or you see kokako movements on the nest, or a tail protruding over the edge, or you hear chick calls.
- The nest can be considered to have failed if no activity is seen at the nest in a 2-hour observation period.
- If you can do so safely and legally, climb to the nest and carefully note any clues that may identify the cause of failure (see Section 10).
- Record key findings on a nest record sheet. A standard nest record sheet is appended. Individual nests should be identified by SEASON and NUMBER (allocated in chronological order). Nest record sheets should be filed safely for later reference.

REFERENCE

Innes, J., Hay, R. 1995: The nesting of the North Island kokako (*Callaeas cinerea wilsoni*) – review of accounts from 1880 to 1989. *Notornis* 42: 79–93.

6. How to determine stage of nesting and age chicks

Usually estimation of nestling age will involve weekly monitoring of the nest. Parental involvement at the nest will vary but, as a general rule, the following guide will help select the correct time to band nestlings.

- Female sitting tightly. Leaves nest for periods up to 20 minutes every 90 to 120 minutes. Male visits every 30 to 90 minutes.
  Incubation or… Brooding, First 5 to 7 days after hatching
- Female leaves nest for longer periods, often with every second visit of the male. Male visits every 20 to 40 minutes
  Chicks aged 7 to 10 days
- Female rarely brooding. Both parents visiting nest every 15 to 30 minutes
  Chicks aged between 10 and 20 days (*recommended age for banding*)
- Both parents frequently (every 20 minutes) feeding young, female sometimes making more visits than the male.
  Chicks 20 to 30 days
- Chicks seen flapping and moving about in and around nest.
  Chicks 30 to 35 days… near to fledge

In some circumstances kokako parenting WILL differ; it may be necessary to approach the nest and assess the chick size. If the black face-mask is well developed or the tail is greater than 75mm the chicks may be too big, approach with great caution! Chicks reach ideal banding size between 10 and 20 days (90 to 150 grams) as shown in the following graph from a well-fed (and successful) Mapara nest. At this age primary feathers will be between 10 and 80mm long and the tail will be 8 to 65mm long.

7. Banding and other handling procedures

Kokako will need to be caught and handled for a variety of reasons. At this stage of kokako recovery it is desirable to band every kokako handled with both metal and plastic colour-bands as individually identifiable birds will greatly increase what we can learn from future observations. Fitting radio transmitters, taking blood and feather sampling are also covered. All these manipulations will require permitting and Ethics approval. Ensure that training is provided well before these skills will be required. Keep all equipment clean and consider any disease risks if using equipment at more than one site.

CATCHING KOKAKO

The most commonly used methods will be mist-netting of adults and capture of nestlings. Other trapping devices may become available but must be thoroughly tested on common species, and the recovery group leader consulted, before being employed on kokako. When planning to catch kokako it is a good idea to have some fruit (banana, berry fruit, stonefruit) available. Birds will readily feed in the hand and this may help to calm/distract the bird during handling. Always try to handle and release the kokako as quickly as possible without rushing. A good aim is to release within half an hour of capture.

Avoid any rapid/noisy movements around the bird. Handlers in particular must steel themselves against pain… the instant reaction to withdraw your pierced hand rapidly might injure the kokako.

1. Mist-netting

Before requiring any person to use this technique they will require some training. Contact the holder of a kokako banding permit (usually the recovery group leader) to get details of how to obtain sufficient training. A good start will be to accompany others mist-netting, OSNZ may run small passerine mist-netting sessions in your area.

Mist-nets are hoisted in canopy gaps within the forest and kokako lured through them using pre-recorded song. The idea is that as a kokako hits the net it becomes enveloped in a net pocket. Careful setting and adjusting of nets is required and this can only be taught through practical demonstration. (see attached gear checklist). Set nets should be attended and watched at all times, it is best if the direction of travel of any trapped bird is observed as this helps with rapid removal. No kokako mist-net should be attended by less than two people, three is strongly recommended.

Birds must be carefully disentangled from the net. Again, hands-on training is required with an experienced operator before anyone is expected to handle kokako. As the net reaches the ground one person should be ready to gently catch the bird by its upper legs. Identify the pocket of the net in which the bird is trapped. It is usually preferable for two people to disentangle a kokako; one person holds the

bird gently but securely by its upper legs whilst the second methodically removes the net. Start by removing net from around the birds feet and legs, next the wings and body and last, very carefully the head with special attention being paid to any mesh on the wattles or tongue. Transfer the kokako to a secure, but breathable, black, cotton, draw-string-bag. Keep in a cool place if the bird is not to be processed immediately. Do not keep in this way for greater than 30 minutes.

2. Capture of nestlings

(Finding nests is covered in Section 5.) This is certainly the easiest time to band kokako if you're confident at climbing. Refer to DOC tree-climbing guidelines and obtain training before attempting any kokako nest work.

Section 6 explains how to estimate the age of chicks. You should aim to do your banding between 10 and 20 days of age.

Make sure your climbing position allows you free access to all parts of the nest. If chicks are "jumpy", (moving a lot, standing upright, looking agitated) abandon your attempt or, where possible, cover with a black bag to subdue them. Remove gently from the nest to a black cloth bag. Move chicks one by one, remembering to disentangle their feet from the nest/other chicks. Lower to ground on a rope if the route is obstacle free or abseil to the ground with the chicks. In some situations (i.e. where the climbing route was difficult) it may be preferable to band the chicks in the tree. Check your watch and be sure to have the chicks back home within 60 minutes.

On returning chicks to the nest settle them back one by one. A warm hand or black cloth placed gently on top will help them settle. Leave as quickly as possible. Where particularly boisterous chicks are concerned we have left a simple dummy bird to "mind" them (made from a black bag, bound up, with moss inside it). If you do this ensure that there is nothing which could entangle the chicks and that it is light enough to be easily removed by the parents.

BANDING KOKAKO

All banding in New Zealand is controlled by the Banding Office of the Science and Research Unit of DOC. Bands and permitting (under the Wildlife Act, 1953), are arranged through them. Alternatively the recovery group leader can allow you to band kokako under their permit (using a written delegation of authority) providing they are satisfied that you have received adequate training. Banding schedules must be completed and returned to the Banding Office annually. This enables centralised records to be kept up to date.

Two types of bands are used:

- *Metal bands* must be size "E" stainless steel. When closed the two ends of the band should be firmly and evenly butted together.
- *Plastic bands* must be wrap-around bands made of 1mm thick, coloured, "Darvic". These should have 1 1/2 to 1 3/4 wraps and have an internal diameter equivalent to a closed "E" band (6.5 to 7 mm). Plastic bands are formed from a strip of "Darvic" 51mm ¥ 8mm that is heated in boiling water then coiled into a 10.5mm diameter mould. Care should be taken to remove sharp edges and

corners from the plastic and to ensure that the coils are tight (meet surface to surface).

These thick plastic bands are fitted to the bird by opening them just wide enough to fit over the leg and spiralling them back to their original shape. The outside end of the spiral is glued with a tiny drop of super glue and held firmly for 20 seconds.

Thinner plastic wrap-around bands, with up to 3 coils, have been used in the past. Some problems with these have occurred due to the erosion of inside coils producing a larger internal diameter, these can slip over the birds foot. Whenever handling kokako check for wear on bands and replace if required.

When banding kokako it is safer and easier for one person to band whilst another holds the bird. The bander must also measure the bird and all details should be neatly recorded.

Detailed and systematic record keeping of both banding and recaptures is required and essential. A chart of available colour combinations should be updated after every banding. A standard kokako banding record sheet is appended. Copies of all record sheets should be provided to the recovery group leader and the National Banding Office should receive copies of banding schedules and recovery information.

TRANSMITTER APPLICATION

No one should attempt to fit a transmitter to a kokako without first having undergone training.

Transmitters used should be as light as possible. Those currently in use weigh less than 5g, including the harness, and have a life of about 10 months. Under no circumstances should the weight of the transmitter exceed 5% of the birds body weight (i.e. 9.5g for a small female).

Transmitter specifications currently used are:

Weight: 4g

Size: 30 x 13 x 6mm. 3mm internal diameter end tubes.

Pulse: width 22ms, rate 30ppm

Antenna: plastic coated whip. Flexible 0.7mm diameter wire.

Life: 10–12 months.

Frequencies: Be sure to check with any other telemetry users in your area to avoid selecting radio frequencies which are already in use.

Transmitter harnesses must include a weak link. A single strand of high-quality, pure cotton thread with a break strain of 750g is currently used. This must reliably release both the neck and body loops of the harness simultaneously. The harness itself is manufactured from a 2mm diameter soft, spun-polyester, braid. The design of the harness used for kokako is given as an appendix.

Transmitters should only be fitted to adults or to nestlings that are close to adult weight. When fitting the harness be sure to preen the harness cords neatly against the skin before final adjustment and fixing. When fitted a pencil should fit easily

between the transmitter and the birds' back and the transmitter itself should be more or less concealed beneath the feathers.

If transmitters are to be attached to juvenile kokako it may be necessary to "train" the nestlings with repeated visits to the nest. Sufficiently large nestlings will otherwise be prone to jump from the nest on your approach. Weigh the nestling before proceeding, do not place a transmitter on any kokako lighter than 180 g. Remember that the kokako may grow to 250g so some extra slack is required in the harness… but be sure the harness is not so loose as to be a danger.

TAKING A BLOOD SAMPLE

Only tiny quantities of blood are required for modern genetic techniques. In most situations 50ml (one droplet) of blood is sufficient. Before collecting blood from a kokako training from a vet experienced with small birds is required.

Blood is collected from the brachial vein at the first joint of the wing. Wear fresh gloves and avoid contacting any of the collecting apparatus… no-one wants to analyse your DNA. The area is swabbed thoroughly with alcohol to reduce the possibility of infection. A tiny puncture is made with a (26G) hypodermic needle and the blood collected into capillary tubes. Apply a clean swab to the wound and hold firmly in place until there is no further bleeding, or at least two full minutes. Clean off any excess blood. Blood is then transferred into a storage solution or ultra-frozen(–70C) until required. Be sure to label all samples immediately using a pencil or other indelible labelling device.

COLLECTING FAECAL SAMPLES

From time to time faecal samples may be collected for disease screening programmes. Only collect fresh droppings that have not been in contact with other birds, the ground, or the handler. Use a fresh scoop for each dropping. Place into tubes provided and refrigerate as soon as possible. Instructions on storage and storage media may differ depending on what set of organisms is being investigated. Currently, for Coccidial egg counts, we are storing samples in dilute sulphuric acid.

REFERENCES

Flux, I. 1994 A modified harness design for attaching transmitters to birds. Ecological Management 2: 55–56.

MISTNETTING GEAR

Personal safety

Compass

Map

First-aid

Epirb (personal locator beacon) and radio/cell-phone

Warm clothing/rain gear

Snack

Netting

Nets

Speakers

Sound system

Amplifier

Tape deck (in case of disc failure)

Holding boxes

Endless ropes

Cradle ropes

Spare cords/ropes

Carabiners

Slasher?/saw?

Blood sampling

Eppendorf tubes with buffer

Capillary tubes

Alchohol swabs

Hypodermic needles

Syringe (for needle handle)

Paper labels

Pencil (do not label in pen!)

Cotton wool

Bird handling

Black bags (2)

Banding kit (bands, pliers, circlip pliers, colour bands, glue, colour combination key, individual banding sheets, scissors, paper envelopes)

Measuring kit (ruler, scales, callipers)

Transmitter kit when required (transmitters [harnessed], nylon thread, needles, melting tool, battery)

Fruit for feeding birds

Faecal sampling

Vacuum tubes

Sterile scoop/implement

Paper labels/pencil

8. Nest protection

Predation at nests by possums and ship rats is the key cause of kokako decline, and the future of kokako on the mainland depends on good nest protection. If there are 10 pairs or fewer and if kokako protection is the sole aim of the project, then it may be more economical to find individual nests and protect each one by trapping and poisoning. However if there are more than 10 pairs and/or the project aims to restore the forest community, then general large-scale reduction of pests is more appropriate.

LARGE SCALE PEST CONTROL

1. Target pest abundance indices

In 'Research-by-management' (RbM) blocks during 1989-97, kokako nest success (% nesting attempts fledging young) exceeded 50% only when possum abundance indices at 1 November were less than 1 possum per 100 trap-nights and when rat tracking rates averaged less than 5% during October to February (Fig. 1). *Managers wishing to recover kokako populations should aim at residual indices of 1 possum per 100 trap-nights and a 1% ship rat tracking index at 1 November each year, for several years* (Innes *et al.*, 1999). Operations achieving post-control indices exceeding 5 possums per 100 trap-nights or 5% rat tracking rates should be regarded as failures in terms of kokako recovery.

This recommendation was derived using the following indexing techniques:

a. Possums

Number of possums trapped per 100 trap-nights, calculated from minimum 100 leghold traps set unlured for three fine nights on wooden ramps. The index was corrected for sprung traps after Nelson and Clark (1973). The national protocol monitoring system is now widely substituted, it is likely to give similar indicies though this has not been verified.

b. Ship rats

Percentage of tracking tunnels tracked by rats. We used the chemical tracking system of King and Edgar (1977). Up to 200 tunnels were set for one night in lines of 25 with tunnels at 50 m spacing, baited with peanut butter, before and during (each 6–8 weeks) the kokako breeding season.

Identical lines in non-treatment blocks provided experimental controls for both species.

Data from RbM blocks suggest that nest success rates decline rapidly when possum or ship-rat indices are greater than those recommended above (Fig. 1).

This means that limited pest control resources are better put into intensive pest control at smaller or fewer sites, rather than spreading them thinly over large or more sites.

Fig. 1 a. Percentage of nesting attempts fledging young each year vs mean possum indices at 1 Nov.

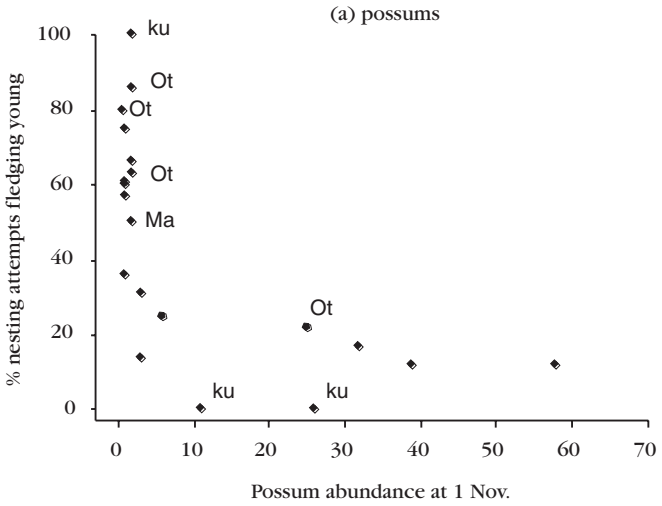
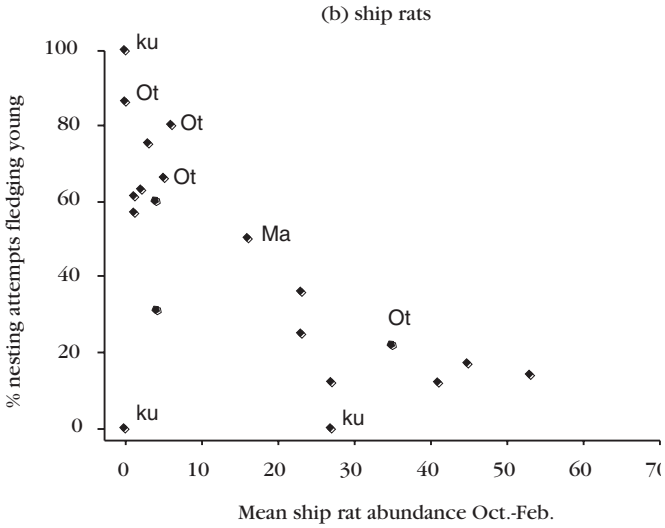


Fig. 1 b. Percentage of nesting attempts fledging young each year vs mean ship rat indices Oct.-Feb.



2. Pest control methods

Use best current practice (check this with the leader of the kokako recovery group). Effective techniques in the past have included:

- Aerial drops of 1080, brodifacoum or pindone, with and without non-toxic pre-feeds (see Section 11).
- Bait stations at 100–150 m spacings, with 1080 preceded by non-toxic pre-feed, or brodifacoum without pre-feed.
- Ground hunters using traps and cyanide to kill possums. Their effectiveness against ship rats has never been trialled.

REFERENCES

Innes, J., Hay, J., Flux, I., Bradfield, P. Speed, H., Jansen, P. 1999: Successful recovery of North Island kokako *Callaeas cinerea wilsoni* populations, by adaptive management. *Biological Conservation* 87: 201–214.

King, C., Edgar, R. 1977: Techniques for trapping and tracking stoats (*Mustela erminea*): a review and a new system. *New Zealand Journal of Zoology* 4: 193–212.

Nelson, L., Clark, F. 1973: Correction for sprung traps in catch/effort calculations of trapping results. *Journal of Mammalogy* 54: 295–298.

9. Nest climbing and filming guidelines

Monitoring kokako nesting attempts using video surveillance cameras is becoming a widely used technique. Such recording provides us with unequivocal evidence of the causes of nest failure, identity of predators, timing of attacks and the nature of any sign that those agents leave. Operators must be careful that the cameras, lighting or process of fitting the equipment does not in any way endanger the kokako or nest. To get most from the exercise, cameras are best fitted as early in incubation as possible. (See Sections 5 and 6.)

FITTING CAMERAS

In the past much nest filming was carried out using telephoto lenses and focussed infra-red/infra-red laser illumination. This meant that cameras could be situated in separate trees, distant from nests. In some locations such systems will be preferred but many nests of kokako are so well concealed that this is not an option. Compact cameras situated about 1.5m from nests have been used. Such proximity allows for a much cheaper, less power-hungry, lighting system, and better resolution. Interchangeable lens cameras allow greater flexibility in the positioning of the camera.

The video camera and lighting system used should conform to the DOC standard for such equipment. The electronics laboratory at Science and Research Unit, Wellington can provide details and advice on the set up (contact Murray Douglas/ Video users group); this is likely to change as new technologies become available. Cameras should be connected by cables of at least 30 m in length to allow batteries and tapes to be changed without disrupting the birds. Ensure that the light source used does not emit visible light (which might attract predators) and try to conceal the camera with a dull, camouflaged, cover, to avoid it from attracting unwanted attention. Tilt the camera downward and/or fit a rain-hood to prevent water from hitting the lens cover. When fitting the camera try to fit the cable so as not to provide a direct access-way to the nest!

The camera is securely attached to a branch as far as practicable from the nest using either a "G-clamp" or bracket fitted with long "Velcro" straps. This bracket connects to the camera by an adjustable ball clamp. The field of view is adjusted as instructed by a person operating the monitor. Try to get a picture that includes some of the nest surrounds. The nest should occupy $^1/_3$ to $^1/_2$ of the picture. If possible, position so that eggs are visible.

Zip ties are used to quickly secure the cable.

CLIMBING TO NESTS

Before you attempt (or ask anyone else) to climb to a kokako nest over 3m high you will need official training in tree-climbing. See DOC tree-climbing code of practice.

Plan the entire operation *before* you leave the ground. Ensure that all the equipment is laid out, tested and ready to operate and that everyone is clear as to their tasks. It is critical, at the egg stage, that birds are not kept off the nest for greater than 20 minutes. Do not disturb birds in cold or rainy weather.

Watch the nest for some time to determine activity; try to time your climb for when the (female) has been sitting for some time so that the eggs are well warmed. Allow her to sit for as long as possible during the climb (some birds may sit tight throughout the proceedings) but don't give her a sudden fright by sneaking up!

Assess the climb, think both of your safety *and* that of the nest. Kokako nests at ends of branches or amongst vines are particularly vulnerable as your movements, though distant from the nest, may dislodge or damage it. Long vines that pass through, or near, a nest, can make things very difficult!

If the climb is time consuming and the bird has left the nest, consider setting up the climb then returning after a couple of hours to fit the camera.

Actual climbing techniques are many and varied… limited only by a requirement for safety and your imagination. Direct rope climbs (SRT) are usually the quickest and most secure. Sub-canopy trees with very supple branches may be approached from above using belay or abseil techniques. Lash or stay smaller branches to increase their stability if required. With low growing, supple, trees a ladder may be the only option.

SERVICING RECORDERS

Most recorders, in current usage, will require daily changes of batteries and tapes. For safety and simplicity go for sealed "gel" batteries. Use a recommended charger and keep a log of battery usage and recharged voltages so that you are aware when capacity begins to drop with age.

The recording unit and batteries will have been placed as far from the nest as possible, nevertheless, minimize possible impacts by keeping duration of visits and noise to a minimum. Don't stop to eat or drink near nests! Always take a monitor and check that the camera position is correct and that the date/time functions are still correctly set. Label tapes clearly and ensure they're fully rewound. In wet weather carry a towel, keep equipment as clean and dry as possible.

10. Predation sign: examining and interpreting failed nests

Most kokako nesting attempts on the mainland fail because of predation, usually by introduced mammals (especially ship rats and possums) but also native birds (especially harriers). Accurate identification of predators is important for continually re-focusing pest control programmes.

DETECTING A FAILED NEST

See Section 5 for a description of the basic breeding cycle. The nest has probably failed if:

- At any stage of nesting, both pair members are followed together for more than one hour and their activities are not focussed on the nest area. During incubation, the nest has almost certainly failed if the pair are together for half an hour.
- No activity is seen at the nest for 2 hours. Normally, the female gets off for a few minutes every 60–90 minutes, and the male visits every hour or two, although the latter varies a lot.
- Eggshell fragments, feathers or dead chicks are found under the nest. Kokako remove hatched eggshell from the nest and drop it nearby. Hatched shells are distinctive because the shell break margin is smooth, and the break is transverse around the middle of the egg.

EXAMINING A FAILED NEST

The search for clues starts *before* climbing to the nest. Look on the ground under the nest, and within a 20m. radius, for eggshell, chicks, feathers and any sign of a dragged carcass. The latter may be characteristic of a mustelid predation. Especially, check out snag surfaces such as tree-fern trunks and rata vines or bark. Also check under logs and other possible caching sites.

Then climb to the nest with a notebook, a large plastic bag to put the entire nest in, small pottles for eggshell and chick pieces, and a camera. Look for snagged/fallen feathers as you climb up the tree. At the nest, take a photo if possible. Wide-angle shots are best because the scale of sign on the nest is then clearer. Photos should be stapled to nest record sheets to enable re-examination of diagnostic sign, and they are powerful advocacy tools. Don't move/touch anything until you've recorded what you see. Everything is significant. Look for faeces and feathers on upper surfaces of the nest and adjacent vegetation. Is the nest lining 'snuffled' so that eggshell pieces are worked down into the soft lining? Note how many eggs or chicks are present, and what damage has been done to them. Put eggshell pieces into small pottles for safe transport. Then take the whole nest (including any remains adhering to it) for later examination by putting it all into a plastic bag. Write a few notes while still up the tree if you are comfortable and safe while doing so.

Later, carefully examine the top surfaces of the nest for sign, especially ship rat faeces that are small, dark and inconspicuous (get someone else to check them if you are unsure, weta faeces may look quite similar!). Then tease the nest remains apart on a smooth table. Look especially for eggshell fragments snuffled into the lining and keep looking for rat droppings.

- *Keep all eggshell remains in pottles labelled with the date, location, pair name and nest number*. Store rat faeces with the eggshell or in another small, labelled, pottle attached by a rubber band. Ensure samples are quite dry before storing.
- *Keep chick remains in glass jars in 70% alcohol.* (See Section 12 for dealing with abandoned eggs and dead chicks and adults).
- *Record all data about each nest onto a standard form (see attached example).*

The idea behind keeping these specimens is that others may learn from what you found. Let the recovery group leader and principal kokako scientist know what you have collected so that this can be centrally recorded.

DIAGNOSTIC PREDATOR SIGN

Despite 10 years of research, many predations still cannot be credited to a particular predator species, because some predators leave the same or similar sign, and because sign left after a predation may be, subsequently, disturbed by scavengers of the same or a different species. However most predators occasionally leave diagnostic sign. The following accounts are based on Redhead (1969), King & Moody (1982), King (1989, 1990), Major (1991), Brown *et al*. (1993), Marchant & Higgins (1993), Laurance & Grant (1994), James & Clout (1996), Innes *et al*. (1996) and Brown (1997). Key aspects of each species' predation sign are italicised in the following accounts.

1. Ship-rat

Frequent predator of eggs, after harrassing the sitting female off the clutch at night, usually in the first 10 days of incubation. Will also take chicks to at least 10 days old. Frequent scavenger at nests after predation by other species.

Characteristic sign on eggs

Ship rats make a hole in the egg sufficient to get at the contents, resulting in *one or two large shell pieces with many smaller fragments*. The *large pieces have jagged edges* but few, if any, clear incisor marks. The nest bowl is usually 'snuffled', meaning that the rat pursues some egg contents down into the nest lining, resulting in a disturbed lining and shell fragments up to 4 cm under its surface. Rats are also known to cleanly remove eggs or chicks from nests, although this has been verified only with species smaller than kokako.

Characteristic sign on chicks

Ship rats partially eat chicks, leaving *gnawed (in contrast to cleanly broken) bone and/or flesh. Rat faeces often left on or around the nest.*

2. Possum

Frequent predator of eggs, chicks and probably adults, although latter has not yet been filmed. Sitting females usually vacate nest as possum approaches. Possums videoed at kokako nests always eat eggs but may ignore chicks, or even bite them without feeding on them.

Characteristic sign on eggs

Possums eat eggs roughly, leaving *no large shell pieces*. Shell that does remain has *crushed rather than jagged margins*. Some *grossly infolded shell 'pellets'* may be formed in the possum's mouth and then spat out. Like rats, may 'snuffle' the nest lining to root out spilled egg contents.

Characteristic sign on chicks

Possums leave partially eaten carcass with torn flesh and cleanly broken (not chewed) bones. Exposed upper surfaces of the chick are roughly bitten or eaten. Carcass may be partially skinned and there may be *one or several feather 'pellets'* (ca 15 x 5 mm,) produced by the possum in its upper palate, then spat out. Chicks may be found injured or dead in the nest or some distance from it, either up the tree or on the ground.

3. Kahu

Kahu (harriers) are frequent predators of chicks and occasionally eggs especially in exposed nests with poor overhead cover. Adult kokako always urgently flee harriers, so presumably are vulnerable to attack themselves. Kahu are NOT confined to open country or forest-margins, but are widespread in remote forest interiors where they are less conspicuous.

Characteristic sign on eggs

Leave *large shell fragments with clean shell break margins*. Lift head frequently to look around while feeding, leaving strings of albumen pulled out from the broken egg.

Characteristic sign on chicks

Have been filmed cleanly removing kokako chicks in about 4 seconds, and also taking more than 1 hour to pluck and eat a chick in the nest. Plucking or 'pluming' occurs by harrier ripping beak-fulls of feathers off the chick and disposing of them with a sideways flick of the head. *Many torn feathers* are thus deposited on the nest and surrounding vegetation in a semicircle around the feeding bird, and many are blown or fall around the nest and down the tree. This continues until an area of muscle is exposed for eating, when the flesh is torn off in the same fashion as the feathers. Bones may be broken and eaten.

4. Ruru

Ruru (morepork) have never been filmed at a kokako nest. They were filmed (by Kerry Brown) removing chicks, cleanly, from robin nests. Kokako have been seen driving ruru away from the vicinity of a nest, suggesting that ruru (unlike kahu) do not threaten adult kokako.

5. Stoat

So far, only one mustelid predation has been filmed at a kokako nest (at Mapara, 1996–97), from the ca 25 nests filmed, and a stoat was seen carrying a dead kokako chick near a Hunua nest (1997/98).

Characteristic sign on eggs

Badly needs clarification. Generally, clean removal. Sign which captive stoats left on hen eggs was indistinguishable from that of ship rats (E. Spurr, pers. comm.). Tooth-marks on eggshell may correspond to canines on stoat skull (see photo, King & Moody 1982, p. 72).

Characteristic sign on chicks

Chicks and adult birds are killed quickly by a bite at the back of the neck. Kills are then dragged to the nearest cover, and may be cached for future use. Part clutches may be taken.

Note that all of the predator species above can access all nests, easily. Ship rats, possums and stoats are all magnificent climbers.

Clean removal of eggs or chicks remains the most difficult sign to interpret, because several predator species may do it. *Progress will come only from using time-lapse video cameras at nests. Do it! We need another 50 predation events to be filmed.*

Detailed accounts of predation remains should be written on the appropriate nest record sheet (see Section 5) and forwarded to Kokako Recovery Group Leader or principal kokako scientist.

Note also that when introduced predators are controlled in managed blocks, we should expect to see predation by native species increase in importance. Potential native predators include falcon, harrier, morepork, long-tailed cuckoo and kingfisher. Characteristic predation behaviour and sign of these species is virtually unknown.

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11. Policies for acceptable poison bait types and for allowable poison by-kill

BACKGROUND

Kokako are at risk during pest poisoning operations if they eat poison baits or eat invertebrates that have eaten baits. Across all forest birds in New Zealand, kokako were regarded by Spurr (1979) as having a high risk of non-recovery if their numbers are heavily reduced in *any* way because they have poor reproductive potential and poor dispersal. The risk of poisoning is probably higher in aerial operations because kokako are more likely to encounter baits. Kokako well-being is currently dependant on large-scale predator control (Innes *et al.* 1996), usually involving poisoning of some kind (Speed 1993 a and b, Innes *et al.* 1995, Bradfield & Flux 1996) so that it is inevitable for the foreseeable future that kokako will continue to be exposed to poisons. Which baits are acceptable and which are not? And how is survival best monitored? What loss of *individual* kokako, if any, is allowable if the health of the *population* is to be sustained? This paper summarises the considerable research and monitoring that has been undertaken on kokako survival through pest control operations, and outlines current Recovery Group policy for managers undertaking pest control in forests containing kokako. It is more detailed than most other inserts, and is fully referenced because most of the background research is otherwise unpublished and difficult to source.

REACTIONS TO NON-TOXIC BAITS

During 1985–86, Innes & Williams (1990) presented green, non-toxic, cinnamon-lured, pollard baits to kokako by placing baits on wooden feeding platforms up trees; by dropping them from a helicopter to mimic an actual operation, and by throwing them tied together with cotton (= "bolas") up trees near feeding kokako. In total, 180 encounters (bird within 2m of bait) were observed involving 20 kokako. Only two kokako were seen to peck at, but not swallow, baits, at Rotoehu Forest in 1986, perhaps because large green kohekohe fruit were 78% of natural diet at the time. The cinnamon flavour may have repelled the kokako. In a trial with captive kokako at Mt Bruce, Spurr (1993) found that one, of four, kokako ate baits. She ate plain unlured baits on the first day, and cinnamon flavoured baits on the second day, and she ate more cereal baits than carrot baits. Spurr concluded that baits were not very attractive to kokako, and that fresh cinnamon had some repellent effect. Fish-based Wanganui pollard baits (without glitter marker) were also presented to four Mt Bruce kokako in June 1994; only 3 of 64 baits were removed, perhaps by mice (Morgan *et al*. 1996). *These studies suggest that kokako may eat baits but that they are not very attractive, and that cinnamon is probably an effective repellent but its repellence fades with time.*

KOKAKO SURVIVAL THROUGH AERIAL POISONING OPERATIONS

As at March 1998, 366 kokako (including six juveniles) have been monitored through 31 aerial poisoning operations since 1986, although the number exposed to aerial poisoning or known to have survived it is greater (Speed *et al.* 1988). Of the monitored kokako, four disappeared at the time of poisoning; one corpse was found with 1080 verified present, and another bird was seen with possible sub-lethal poisoning symptoms. The 'roll call' method of assessing kokako survival cannot distinguish between natural and poison deaths. Assuming that disappearances WERE due to 1080 poisoning, an overall estimate of maximum kokako mortality in an aerial poisoning operation is 1.4% (5/366 x 100%), with a 5% chance that it will exceed 4%. The one verified death, plus two other disappearances and the possible sub-lethal poisoning all occurred in one operation at Rotoehu Forest in 1994 (Robbins & Speed, unpub. data). This operation trialled a fishmeal bait for feral cats that had glitter in it as a biomarker. Fishmeal baits were rejected by captive kokako at Mount Bruce before the Rotoehu operation occurred, but the Mount Bruce baits had no glitter. The one bird that died at Rotoehu had a colour band clamped over one foot. This may have made the bird less discriminating about what it ate, but this is speculative.

Of 22 monitored operations, eight were in winter (June, July, August); 11 were in spring (September, October, November); two were in summer (December, January, February) and there was one in autumn. Only two used carrot bait, the remainder used cereal-based bait. Virtually all used 1080 poison, with cinnamon lure/mask and green dye.

Brodifacoum has been applied aerially over kokako only on Kapiti Island in two operations in September and October 1996, in conventional cereal bait but without cinnamon. All three kokako with radio transmitters fitted survived the operations, but two untransmittered birds were last seen the day before the first drop, and a further two were last seen ca 3 weeks before the first drop. It is likely that some of these birds were poisoned. This loss is mitigated by the eradication of Norway rats and kiore from Kapiti Island, but it implicates the absence of cinnamon as a contribution to the kokako disappearances. Kokako were considered by Eason & Spurr (1995) to be at risk of primary poisoning by brodifacoum because they are omnivorous and may eat cereal baits. There may be a risk of secondary poisoning because kokako may eat invertebrates that have eaten baits, this risk can only accurately be assessed in field trials.

There is a small risk of kokako death in aerial 1080 operations. The fact that 4 of the 9 kokako disappearances at the time of poisoning were in operations with baits lacking cinnamon (and in one case, with glitter in the baits as a biomarker) suggests that cinnamon should be used in all future aerial operations over kokako.

KOKAKO SURVIVAL THROUGH BAIT STATION, CYANIDE AND TRAPPING OPERATIONS

1080 and brodifacoum have been used in bait stations for possum and ship rat control in kokako blocks in all DOC conservancies since 1993/94. Hundreds of

kokako are known to have survived these operations, but this was not formally monitored because the risks of kokako encountering baits were perceived to be very low. Only two kokako, ('Hika' at Rotoehu 1995/96, 'Moelik' at Mapara 1996/97), have been collected dead during a bait station operation and both these birds tested negative for brodifacoum. It may seem unnecessary to monitor kokako survival through a ground operation, but kokako are known to have died in gin traps in the past in the Oropi area and in the Urewera (P. Jansen, G. Murman, pers. comm.). In winter 1988, 41 kokako were monitored through a cyanide and gin trap operation at Mapara; all survived (Innes *et al*. 1988).

The risks to kokako of ground-based operations involving bait stations, cyanide or trapping are very low.

Kokako benefit from poisoning and trapping operations

In an 8-year trial at Mapara, Rotoehu and Kaharoa forests, pest control significantly increased kokako chick output and eventually adult density in all three blocks. The percentage of nesting attempts at Mapara and Rotoehu which fledged at least one young was 14% without pest control and 49% with it (Innes *et al.* 1999), however pest control had to be effective to obtain these gains. Kokako nesting success (% pairs fledging young) exceeded 50% only when possum abundance indices at 1 November (start of kokako nesting) were less than 1 possum per 100 trap-nights and when ship rat tracking rates averaged less than 5% during October to February, using particular indexing techniques. These data also suggest that kokako will get little or no benefit from pest control which is only moderately successful (ship rat tracking rate exceeds 5% *or* possum trapping rate exceeds 5 per 100 trap nights) at 1 November.

Issues related to allowable poison by-kill of kokako (based on Stephens 1996):

1. Kokako are an endangered species, and possums and ship rats can be controlled in ways that do not threaten kokako. Therefore the death of one kokako which is verified to be caused by poisoning breaches the threshold acceptable bykill unless nett gains are expected to accrue from improved breeding success *in that particular operation*.

2. However, roll-calling is an imperfect technique with or without banded birds. Kokako have been known to disappear from a territory and re-appear months or even years later somewhere else, but this is rare. Most sudden disappearances are either because the female is nesting (October to February, occasionally to April) or the kokako has died (any month).

3. There is a chance that one or more monitored kokako will die from natural causes during the poisoning operation. Total adult disappearance (assumed to be mortality) rates at Rotoehu and Mapara were calculated as 0.18 and 0.16 birds *per annum* respectively (I. Flux, P Bradfield, J. Innes, unpub. data). These can be used to calculate the number of kokako which are expected to die/disappear during the monitoring period.

KOKAKO RECOVERY GROUP CURRENT POLICY

- Kokako survival through aerial 1080 operations need not be monitored if standard cereal-based baits are used, and the baits are green-dyed and cinnamon lured, and if the operation is between May and December inclusive. However we strongly recommend that operations be undertaken during August to October, to reduce ship rat numbers before the onset of most nesting in November.
- Kokako survival through aerial 1080 operations should be monitored if the planned baits or lures are different to those in past operations, or if operations are conducted outside the May-December period. Particular caution is needed if baits lack cinnamon. Operations with carrot baits need to be monitored further until the sample size of known survivors is satisfactory.
- Given the possible deaths of 4/13 monitored kokako on Kapiti Island, kokako survival through aerial brodifacoum operations should be monitored until the sample size of known survivors is satisfactory. Monitoring should allow for detection of secondary poisoning.
- At least 80% of all individual kokako exposed to any aerially applied *experimental* poison bait should be monitored. Monitoring should be by radio telemetry, or by territory mapping followed by 'roll-calling' (Rasch *et al.* 1986). Roll-calling consists of locating each kokako at least once per week for 3 weeks prior to the operation, and again afterwards to verify their suvival. Any kokako that suddenly becomes undetectable after a poison drop is considered to have died from poisoning, although finding a carcass and assaying for the poison is the only way to confirm it.
- Standard Department of Conservation bait quality specifications should apply also to experimental baits.
- In an experimental operation where there is no nett gain to kokako population health, the death of one kokako, (verified to be caused by poisoning) breaches the threshold acceptable by-kill. Further repeats of that operation should be banned or carefully monitored. Some kokako deaths are allowable (but undesirable) if there is nett gain of kokako as a result of the operation. The threshold may be higher again during mammal eradications on offshore islands where the kokako gain can reasonably be regarded as permanent, and anywhere where gains to the ecological community of which kokako are part are deemed to be more important than losses to the kokako population. Also, because roll-calling is an imperfect technique, kokako disappearances during roll calls may occur for other reasons. Thus, acceptable by-kill of kokako based on roll calls should be derived, with scientific, public relations and policy advice, for each separate operation, with due regard to likely background mortality rates, and to gains due to the kokako population by improved nesting success after that particular operation.

POISONING: DECISION MAKING

At any given point of time there is a finite chance that a kokako will die. What level of disappearance of kokako after a poison drop can be expected from "natural" causes as opposed to poisoning? Claire Cameron of the Department of Mathematics and Statistics, University of Otago, Dunedin has provided us with the following calculations to aid in decision making.

We must make one, somewhat arbitrary decision, which is where we draw the line. We suggest that any outcome which has a probability of 0.01 or less of having occurred by chance should be treated as an outcome attributable to poisoning.

The following examples use monitored kokako populations of two sizes and over three time spans. It is hoped that the calculations given here will bracket most situations where a poisoning operation which might impact on kokako is being monitored.

Calculation

- Kokako population (n=30, n=45)
- Annual mortality rate (p=0.075 average, p=0.15 worst case).
- Each bird can be individually identified by banding, transmitter or location.
- A "roll-call" technique is used to monitor them.
- They are monitored over a month to six weeks—three weeks prior to a drop and one to three weeks after to determine presence.

The Binomial Distribution is the source of the probabilities. Since the birds are monitored for one to three weeks after the drop, it was decided that a two-week mortality rate was required as we are interested in Kokako death after the poison drop—not for a whole year. That is, the time available for detection of a death after the drop is one to three weeks—so a halfway point in time was chosen. The bold assumption that the mortality rate is constant over the year was made. Without this assumption, an estimate of two-weekly mortality rate could not be made.

So, for the average:

Probability(annual mortality) = 0.075
Probability(annual survival) = 0.925

$$\text{P(annual survival)} = \text{Pr(two-week survival)}^{26}$$
$$0.925 = \text{Pr(two-week survival)}^{26}$$

$$\text{P(two-week survival)} = \sqrt[26]{0.925} = 0.9970$$
$$\text{P(two-week mortality)} = 1-0.9970 = 0.003$$

In the same way, for the worst case scenario:

Probability(annual mortality) = 0.15
Probability(annual survival) = 0.85

$$\text{P(two-week survival)} = \sqrt[26]{0.85} = 0.9938$$
$$\text{P(two-week mortality)} = 0.0062$$

Results

Kokako analysis for a mortality rate calculated for a two-week period

TABLE 1: PROBABILITY OF x DEATHS OUT OF n BIRDS GIVEN A FORTNIGHTLY MORTALITY RATE OF p

	n=30 p=0.003 (ANNUALLY 0.075)	n=30 p=0.0062 (ANNUALLY 0.15)	n=45 p=0.003 (ANNUALLY 0.075)	n=45 p=0.0062 (ANNUALLY 0.15)
x	P(X = x)	P(X = x)	P(X = x)	P(X = x)
0	0.9138	0.8298	0.8735	0.7559
1	0.0825	0.1553	0.1183	0.2122
2	0.0036	0.0140	0.0078	0.0291
3	0.0001	0.0008	0.0003	0.0026
4	0.0000	0.0000	0.0000	0.0002

Referring to Table 1, in the case of 0.075 annual mortality with 30 birds, there is less than a 9% chance of losing 1 bird or more over a two-week period (0.37% chance of losing two or more). With 45 birds, it is more likely that one bird or more will be lost (12.64%).

In the case of 0.15 annual mortality and 30 birds it is not unexpected that one bird would be lost over a two-week period (15.53%) but it is unlikely that two or more would be lost (less than 2%). With 45 birds there is a 21.22% chance that one bird would be lost over a two-week period but it is unlikely that two or more would go (3.19%).

Suppose the mortality rate is 0.15 (worst case scenario), we can look at the power of the test as being the probability of losing two or more birds given a certain mortality rate increase due to the poison. Tables 2a and 2b show that even when the annual mortality is increased *markedly* there is a low probability of detecting 2 or more deaths. The annual mortality rate must increase to 90% for there to be a 90% chance of there being a loss of two birds when there are 45 birds in the population. This mortality rate needs to increase to 97% for the same power with 30 birds.

TABLE 2a: TWO-WEEK RESULT—POWER CALCULATION WHEN n = 45

NO. OF DEATHS	ANNUAL MORTALITY (TWO WEEKLY)				
	0.20 (0.0085)	0.30 (0.0136)	0.50 (0.0263)	0.80 (0.0600)	0.90 (0.0848)
0	0.6810	0.5400	0.3014	0.0618	0.0185
1	0.2627	0.3350	0.3663	0.1774	0.0773
2	0.0496	0.1016	0.2177	0.2491	0.1576
3	0.0061	0.0201	0.0843	0.2279	0.2093
4	0.0005	0.0029	0.0239	0.1528	0.2037
5	0.0000	0.0003	0.0053	0.0800	0.1547
6	0.0000	0.0000	0.0010	0.0340	0.0956
7	0.0000	0.0000	0.0001	0.0121	0.0493
8	0.0000	0.0000	0.0000	0.0037	0.0217
9	0.0000	0.0000	0.0000	0.0010	0.0083
10	0.0000	0.0000	0.0000	0.0002	0.0028
11	0.0000	0.0000	0.0000	0.0000	0.0008
12	0.0000	0.0000	0.0000	0.0000	0.0002
13	0.0000	0.0000	0.0000	0.0000	0.0001
Power	0.0562	0.1249	0.3323	0.7608	0.9042

TABLE 2b: TWO-WEEK RESULT—POWER CALCULATION WHEN n = 30

NO. OF DEATHS	ANNUAL MORTALITY (TWO WEEKLY)					
	0.20 (0.0085)	0.30 (0.0136)	0.50 (0.0263)	0.80 (0.0600)	0.90 (0.0848)	0.97 (0.1262)
0	0.7741	0.6631	0.4495	0.1563	0.0701	0.0175
1	0.1991	0.2743	0.3643	0.2992	0.1948	0.0757
2	0.0247	0.0548	0.1427	0.2769	0.2617	0.1585
3	0.0020	0.0071	0.0360	0.1650	0.2263	0.2137
4	0.0001	0.0007	0.0066	0.0711	0.1415	0.2083
5	0.0000	0.0000	0.0009	0.0236	0.0682	0.1565
6	0.0000	0.0000	0.0001	0.0063	0.0263	0.0942
7	0.0000	0.0000	0.0000	0.0014	0.0084	0.0466
8	0.0000	0.0000	0.0000	0.0003	0.0022	0.0194
9	0.0000	0.0000	0.0000	0.0000	0.0005	0.0068
10	0.0000	0.0000	0.0000	0.0000	0.0001	0.0021
11	0.0000	0.0000	0.0000	0.0000	0.0000	0.0005
12	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Power	0.0268	0.626	0.1863	0.5445	0.7351	0.9068

Kokako analysis for a mortality rate calculated for a four-week period

This analysis follows on from the preceding (two-week) example. Four- and six-week mortality probabilities will be useful for monitoring situations where the weather or circumstances extend the period over which roll-call monitoring is conducted.

Calculations for the mortality rates are as before except the thirteenth root of the survival rate is found for the four-week calculations and the eighth and two-third root for six weeks.

TABLE 3: PROBABILITY OF x DEATHS OUT OF n BIRDS GIVEN A FOUR-WEEKLY MORTALITY RATE OF p.

The probabilities of losing one or more bird in a four-week period is greater than

	N=30 P=0.0060 (ANNUALLY 0.075)	N=30 P=0.0124 (ANNUALLY 0.15)	N=45 P=0.0060 (ANNUALLY 0.075)	N=45 P=0.0124 (ANNUALLY 0.15)
x	P(X = x)	P(X = x)	P(X = x)	P(X = x)
0	0.8348	0.6878	0.7628	0.5704
1	0.1512	0.2591	0.2072	0.3223
2	0.0132	0.0472	0.0275	0.0890
3	0.0007	0.0055	0.0024	0.0160
4	0.0000	0.0005	0.0002	0.0021
5	0.0000	0.0000	0.0000	0.0002

two weeks (as one would expect). Table 3 shows, in the 0.075 case with 30 birds, there is a 16.5% chance of losing one or more birds. With 45 birds that probability is 23.7%. So, in fact, it wouldn't be unexpected to lose 1 or more in a four-week period. The probabilities of losing two or more is still small (0.014 for 30 birds and 0.03 for 45).

In the worst case scenario (annual mortality of 0.15), the probability of losing one or more is even greater (as expected): 31.2% for 30 birds and 43.0% for 45 birds. Clearly, it is reasonably likely (in the worst case) that one or more birds could be lost in a four-week period. Again the probability of two or more being lost in that time is small (3%) for a group of 30. For 45 birds the probability of 2 or more being lost is 10.7%.

TABLE 4A: FOUR-WEEK RESULT—POWER CALCULATIONS WHEN N = 45

NO. OF DEATHS	ANNUAL MORTALITY (FOUR WEEKLY)				
	0.20 (0.0170)	0.30 (0.0271)	0.50 (0.0519)	0.80 (0.1164)	0.90 (0.1623)
0	0.4623	0.2904	0.0909	0.0038	0.0003
1	0.3598	0.3641	0.2239	0.0226	0.0030
2	0.1369	0.2231	0.2696	0.0655	0.0129
3	0.0339	0.0891	0.2115	0.1238	0.0327
4	0.0062	0.0261	0.1216	0.1712	0.0726
5	0.0009	0.0060	0.0546	0.1849	0.1154
6	0.0001	0.0011	0.0199	0.1624	0.1490
7	0.0000	0.0002	0.0061	0.1192	0.1609
8	0.0000	0.0000	0.0016	0.0746	0.1480
9	0.0000	0.0000	0.0004	0.0404	0.1179
10	0.0000	0.0000	0.0001	0.0192	0.0822
11	0.0000	0.0000	0.0000	0.0080	0.0507
12	0.0000	0.0000	0.0000	0.0030	0.0278
13	0.0000	0.0000	0.0000	0.0010	0.0137
14	0.0000	0.0000	0.0000	0.0003	0.0061
15	0.0000	0.0000	0.0000	0.0001	0.0024
16	0.0000	0.0000	0.0000	0.0000	0.0009
17	0.0000	0.0000	0.0000	0.0000	0.0003
18	0.0000	0.0000	0.0000	0.0000	0.0001
Power	0.5377	0.3455	0.6852	0.9736	0.9967

TABLE 4B: FOUR-WEEK RESULT—POWER CALCULATIONS WHEN n = 30

NO. OF DEATHS	ANNUAL MORTALITY (TWO WEEKLY)				
	0.20 (0.0170)	0.30 (0.0271)	0.50 (0.0519)	0.80 (0.1164)	0.90 (0.1623)
0	0.5979	0.4386	0.2021	0.0244	0.0049
1	0.3102	0.3665	0.3319	0.0965	0.0286
2	0.0778	0.1480	0.2635	0.1843	0.0805
3	0.0126	0.0385	0.1346	0.2266	0.1455
4	0.0015	0.0072	0.0497	0.2015	0.1905
5	0.0001	0.0010	0.0142	0.1380	0.1917
6	0.0000	0.0001	0.0032	0.0758	0.1548
7	0.0000	0.0000	0.0006	0.0342	0.1028
8	0.0000	0.0000	0.0001	0.0130	0.0573
9	0.0000	0.0000	0.0000	0.0042	0.0271
10	0.0000	0.0000	0.0000	0.0012	0.0110
11	0.0000	0.0000	0.0000	0.0003	0.0039
12	0.0000	0.0000	0.0000	0.0001	0.0012
13	0.0000	0.0000	0.0000	0.0000	0.0003
14	0.0000	0.0000	0.0000	0.0000	0.0001
Power	0.0919	0.1949	0.466	0.8791	0.9665

The power calculations again show (Table 4) that the mortality rate would have to be increased substantially (80% annual mortality for n=45 and 90% for n=30) for it to be likely that two or more birds would be lost in a four-week period.This would signal an increase in mortality due to the poison effect.

Kokako analysis for a mortality rate calculated for a six-week period

TABLE 5: PROBABILITY OF x DEATHS OUT OF n BIRDS GIVEN A SIX-WEEKLY MORTALITY RATE OF p.

	N=30 P=0.0090 (ANNUALLY 0.075)	N=30 P=0.0186 (ANNUALLY 0.15)	N=45 P=0.0090 (ANNUALLY 0.075)	N=45 P=0.0186 (ANNUALLY 0.15)
x	P(X = x)	P(X = x)	P(X = x)	P(X = x)
0	0.7624	0.5694	0.6658	0.4296
1	0.2077	0.3237	0.2721	0.3664
2	0.0274	0.0890	0.0544	0.1528
3	0.0023	0.0157	0.0071	0.0415
4	0.0001	0.0020	0.0007	0.0083
5	0.0000	0.0002	0.0001	0.0013
6	0.0000	0.0000	0.0000	0.0002

In the annual mortality of 0.075 case, it is quite likely that one or more Kokako will disappear (23.8% for 30 birds, 33.4% for 45). The probability of losing two or more is small in this case (3% for 30, 6% for 45).

In the worst case scenario the probabilities of losing one or more birds in six weeks is 0.4306 for 30 birds and 0.5704 for 45. The chances of losing two or more are now relatively high: 10.7% for 30 birds and 20.4% for 45. For that reason, it makes more sense for the power to be calculated as the probability of three or more Kokako disappearing.

TABLE 6A: SIX-WEEK RESULT—POWER CALCULATIONS WHEN N = 45

NO. OF DEATHS	ANNUAL MORTALITY (SIX WEEKLY)					
	0.20 (0.0254)	0.30 (0.0403)	0.50 (0.0769)	0.65 (0.1141)	0.80 (0.1695)	0.90 (0.2333)
0	0.3142	0.1571	0.0273	0.0043	0.0002	0.0000
1	0.3685	0.2968	0.1023	0.0249	0.0022	0.0001
2	0.2113	0.2742	0.1876	0.0704	0.0097	0.0006
3	0.0789	0.1650	0.2240	0.1300	0.0283	0.0026
4	0.0216	0.0728	0.1959	0.1758	0.0606	0.0082
5	0.0046	0.0251	0.1338	0.1857	0.1015	0.0205
6	0.0008	0.0070	0.0743	0.1594	0.1381	0.0416
7	0.0001	0.0016	0.0345	0.1144	0.1570	0.0705
8	0.0000	0.0003	0.0137	0.0700	0.1522	0.1019
9	0.0000	0.0001	0.0047	0.0371	0.1277	0.1274
10	0.0000	0.0000	0.0014	0.0172	0.0938	0.1396
11	0.0000	0.0000	0.0004	0.0070	0.0609	0.1352
12	0.0000	0.0000	0.0001	0.0026	0.0352	0.1165
13	0.0000	0.0000	0.0000	0.0080	0.0183	0.0900
14	0.0000	0.0000	0.0000	0.0002	0.0085	0.0626
15	0.0000	0.0000	0.0000	0.0001	0.0036	0.0394
16	0.0000	0.0000	0.0000	0.0000	0.0014	0.0225
17	0.0000	0.0000	0.0000	0.0000	0.0005	0.0117
18	0.0000	0.0000	0.0000	0.0000	0.0002	0.0055
19	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024
20	0.0000	0.0000	0.0000	0.0000	0.0000	0.0009
21	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
22	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Power (2 or more) (α=0.0513)	0.3173	0.5461	0.8704	0.9708	0.9976	0.9999
Power (3 or more) (α=0.2041)	0.1060	0.2719	0.6828	0.9004	0.9879	0.9993

TABLE 6B: SIX-WEEK RESULT—POWER CALCULATIONS WHEN N = 30

NO. OF DEATHS	ANNUAL MORTALITY (SIX WEEKLY)					
	0.20 (0.0254)	0.30 (0.0403)	0.50 (0.0769)	0.65 (0.1141)	0.80 (0.1695)	0.90 (0.2333)
0	0.4622	0.2911	0.0907	0.0264	0.0038	0.0003
1	0.3613	0.3667	0.2266	0.1020	0.0233	0.0032
2	0.1366	0.2233	0.2737	0.1905	0.0689	0.0139
3	0.0332	0.0875	0.2128	0.2290	0.1313	0.0396
4	0.0058	0.0248	0.1197	0.1991	0.1809	0.0812
5	0.0008	0.0054	0.0518	0.1333	0.1919	0.1285
6	0.0001	0.0009	0.0180	0.0715	0.1632	0.1630
7	0.0000	0.0001	0.0051	0.0316	0.1142	0.1700
8	0.0000	0.0000	0.0012	0.0117	0.0670	0.1487
9	0.0000	0.0000	0.0003	0.0037	0.0334	0.1106
10	0.0000	0.0000	0.0000	0.0010	0.0143	0.0707
11	0.0000	0.0000	0.0000	0.0002	0.0053	0.0391
12	0.0000	0.0000	0.0000	0.0000	0.0017	0.0188
13	0.0000	0.0000	0.0000	0.0000	0.0005	0.0079
14	0.0000	0.0000	0.0000	0.0000	0.0001	0.0029
15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010
16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003
17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001
Power (2 or more) (α=0.1069)	0.5378	0.3422	0.6827	0.8716	0.9729	0.9965
Power (3 or more) (α=0.0179)	0.0399	0.1189	0.4090	0.6811	0.9040	0.9826

For 90% power in the 45 bird case, the annual mortality rate has to be 0.65. For similar power in the 30 bird case the annual rate has to be 0.80. So again, this is not a powerful test for detecting an increase in mortality.

A type 1 error (α) is included to indicate the probability of two or more dying (or three or more, depending on the case) when there has been no change in death rate (calculated from table 3). As the power increases so does the probability of a type 1 error.

Conclusion

Generally, except for the 6 week case, 2 or more birds disappearing from a sample of 30 or more kokako is a good indicator that something is wrong.

The probability of observing the loss of two or more (in those cases) is small even when there is a dramatic increase in the annual mortality rate.

The power of the test indicates that it would take an enormous increase in actual mortality rate for it to be likely that there would be a disappearance of two or more birds.

SUMMARY POINTS

- Kokako survival through any bait station, ground poisoning or trapping operation need not be monitored.
- Glitter as a biomarker should not be incorporated into baits for further aerial broadcast over kokako without preliminary acceptance trials on captive kokako, and field trials over small numbers of wild kokako.
- Because the half-life of brodifacoum is so long (it has never actually been calculated), all dead kokako found in areas where brodifacoum was used should be analysed for that poison. All kokako found dead within a month of 1080 being used in the area should be analysed for that poison. (See Section 12.)

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12. Dealing with dead or injured kokako (including eggs and chicks)

From time to time field workers will encounter dead kokako, or one may die whilst being handled. The handling techniques described in this manual have been widely tested and are considered to be safe and appropriate for the species. Nevertheless any handling of birds carries some risk so we should be prepared to deal with any casualties. Any incidents of sickness, injury or accidental death in kokako should be reported to the recovery group leader in order that a national overview of the importance of such events is maintained.

If an abnormally high death rate, of adults, eggs or chicks, is recognised or suspected, advise the Kokako Recovery Group Leader and/or principal kokako scientist.

1 INJURIES TO BIRDS

Mist-nets generally catch birds quite gently so it is rare for any injuries to result. Rarely the filament of the net may cause minor cuts; toes, wattles, tongue and head are probably the most vulnerable areas. Such cuts will usually quickly stop bleeding and heal on their own. With any larger cuts direct pressure and possibly some kind of wound closure (supa-glue, steri-strip) will assist to stop bleeding.

Any birds with major wounds, broken or dislocated bones should be referred to a vet for advice. Kokako should be euthanased if their injuries preclude the possibility of rehabilitation. In rare situations, where to keep the bird alive would only inflict more suffering, the decision to euthanase may be taken by the field operator. However, in most cases, the sick or injured kokako should be taken to a veterinarian and any decisions on that birds' future made in conjunction with the Kokako Recovery Group Leader.

In any cases where significant injury to a kokako resulted from "human interference" detailed notes must be kept and a short report of the incident must be sent to the Kokako Recovery Group Leader. This will help monitor any impact we have on the birds and improve our operating practices if required.

2 SICK KOKAKO

If any kokako appear in poor health during handling examine them with care and try to take samples where possible. If the symptoms are seen in more than one bird contact the Kokako Recovery Group Leader.

External/internal parasites may be preserved in alcohol. Faecal samples can be collected (without touching) into a clean tube, refrigerate. Skin or feather samples might also be collected and cloacal/choanal swabs if you have the equipment and training.

Abnormalities, deformities, skin lesions or growths should be photographed.

If the required skills and equipment is available, or if the bird must be held for some time cloacal and choanal swabs may also be required. Contact the Kokako Recovery Group Leader and the DOC contract vet for further advice.

3 DEAD KOKAKO

Dead kokako should always be collected, whether fresh or decayed. If there are any unusual circumstances associated with the death, particularly if several kokako die in similar circumstances, notify the Kokako Recovery Group Leader and/or principal kokako scientist immediately. All dead native birds are technically the property of the crown and should not be held in our possession without a permit. When a dead kokako is to be collected and sent anywhere note down full details including: your name, where the kokako was found [grid. ref.], the date, notes on the circumstances. Keep a record of these details and attach, by label, to the sample.

All captive kokako which die must be necropsied as soon as possible.

The Museum of New Zealand should receive all dead kokako directly *except* in the following situations:

1. There has been usage of toxins (e.g. for possum control), within the birds likely range, during the past 12 months. Store in refrigerator, contact the Kokako Recovery Group Leader and/or scientific advisor, send required samples ASAP. for analysis. If no one can be contacted for advice send entire bird to: Toxicology Services, Landcare Research, Lincoln. with instructions to analyse for any toxins which may have been accessed by that bird.
2. The bird has been preyed upon (particularly whilst nesting) yet the predator is uncertain. Freeze, contact Kokako Recovery Group Leader and/or principal kokako scientist. If not available, contact Science and Research Unit for advice on who could best conduct an examination/autopsy to identify the predator.
3. There is some suspicion that the kokako may have succumbed to a disease. Store in refrigerator, contact the DOC contract vet urgently for advice on sampling, storage and autopsy. Also alert Kokako Recovery Group Leader and/or principal kokako scientist.

None of the above requirements preclude use by the National Museum or other parties. Remember that much may be learned from the body if handled correctly. Genetic sampling, disease screening and toxicology can still leave a useful skin and skeleton.

The National Museum stores dried study skins, birds preserved in ethanol and skeletal material as well as eggs and nests. For these purposes handle specimens with care, pack carefully trying not to bend feathers or crush. Be sure to contact the Museum before dispatching to ensure they know it's coming. Where an autopsy or sampling from the body is required be sure to notify the person conducting the work that the body should be retained for the Museum if at all possible. In some circumstances the Museum may conduct the sampling and send on any required tissues.

4 EGGS AND CHICKS

Kokako will occasionally abandon a nest—before you touch any nest (or eggs) be sure that it has definitely been abandoned. Kokako have been known to build nests several days in advance of laying and some birds may not incubate eggs until the entire clutch is laid. Kokako may sit tight, as if incubating, on an empty nest prior to lay. Be particularly wary of removing eggs from newly laid clutches unless you are sure of the situation. If in any doubt, consult. Leave nest and return the next day to observe further.

Record all clutches observed. Date, how many eggs, parents, nest site description. Standard nest record forms are appended.

Abandoned eggs are also collected by the National Museum. Measure (max length by max. breadth) any eggs collected, using a well lubricated vernier caliper. Record results with Kokako Recovery Group Leader. You can hold eggs over a bright light to assess any embryo development; the embryo will appear as a dark spot. Send eggs, intact, to the National Museum, unless you are confident at blowing them. Store and transport cool, well padded and labeled with full details (species, map reference, date, collector).

If your site is remote, or eggs are already decaying it is preferable to blow them. Eggs should be blown via a single hole in the side of the egg. Create a hole, using a sharp needle or scalpel, large enough to allow removal of contents, a 2mm hole is sufficient for an infertile egg. Holding the egg with the hole lowermost, blow air very slowly into the egg with a hypodermic syringe, gently assist any lumps through the hole. Excess pressure will easily rupture the egg, take it slow! Wash with water and ethanol to remove any remnants. Dry, label and send to museum.

Treat any sick or dead chicks as for adults.

13. Kokako transfers

Transfers of kokako may be planned for a number of reasons: to start new populations on islands or at managed mainland sites, to increase numbers of kokako pairs (and thus the efficiency of management) in existing populations or to maintain genetic diversity within populations. No analysis of the different transfer techniques used for kokako has been made, however, the following technique has been widely and successfully used and has become accepted practice. To date we have only transferred sub-adults (5 months and over) and adults the techniques for which are covered in this section. In the future we may trial transfers of younger kokako or even eggs, this will require development of new protocols.

ARRANGING A TRANSFER

Any transfer must be supported, in principle, by the Kokako Recovery Group Leader and by the relevant Conservancy/Regional offices. A full SOP on transfers is pending and must be consulted.

Iwi and any other likely affected parties must be consulted early in the planning of any transfer. There may be reasons why Iwi at either end of the proposed transfer oppose the plan or they may offer some input into how the transfer proceeds. To date Iwi we have dealt with have all regarded kokako highly and supported us in the work we are doing, but this must not be taken for granted! Usually Iwi from either end may wish to be involved in the transfer; their involvement should be sought and welcomed and will add a valuable cultural dimension to the proceedings.

The receiving Conservancy representative should then ensure that all permitting requirements are met. Permits will need to be issued to cover: Capture, handling and holding of a protected species (Wildlife Act, 1953), bird-banding and fitting of radio-transmitters(Wildlife Regulations, 1955), ethical approval (Animals Protection Regulations, 1987), transfer of a protected species and release of a species into a reserve (Reserves Act, 1977). They should also ensure that the budget is adequate to allow for monitoring the kokako after release.

CAPTURE OF KOKAKO

(See Section 7.)

TRANSPORT OF KOKAKO

Kokako must be transported from the capture site to the holding aviary in a well ventilated and secure box. Folding cardboard pet-boxes ("Animobile", etc.) obtainable from veterinary outlets, are ideal. Prepare the box by covering the base with edible foliage/fruiting branchlets to provide the kokako with some distractions

(and food) during its journey, this will also keep the atmosphere moist. Feed the kokako with some fruit and/or jam-water prior to transport, particularly if it will be in the box for over an hour. Keep the box shaded and well ventilated at all times during transport and avoid any sharp movements or excessive noise... for instance try to avoid vegetation from scratching against the outside of the box!

HOLDING AVIARY

The kokako recovery group have a tent aviary (contact the Kokako Recovery Group Leader). This is a converted family tent with four flights separated by mesh screens. The tent-aviary should be thoroughly cleaned before use with a anti-viral disinfectant such as "Virkon". Allow time for the fabric to dry and air thoroughly.

Kokako appear to adapt quickly to life in an aviary and readily accept new foods. Nevertheless it is recommended that their stay in the aviary is for no longer than ten days.

Prepare the aviary with deep fresh leaf-litter and plenty of fresh vegetation to provide adequate humidity, food and cover. Suitable food species include *Coprosma* spp, mahoe, fivefinger and other *Pseudopanax* spp, pate, fuchsia, pigeonwood, hangehange, select fruiting branches when possible. Hounds-tongue fern and hanging spleenwort are also very popular. Keeping stems in water (which birds can't fall into!) will maintain their freshness, but replace regularly as required. Spray vegetation and tent frequently in hot weather to keep atmosphere cool and moist. Provide trays of water, jam-water and supplementary foods. For jam-water use an additive-free blackberry or blackberry and apple jam mixed one teaspoonful per cup with fresh water. Try to select organic, chemical free fruit if possible or wash or peel it. Apple, pear, peas, stonefruit, berryfruit, grapes, kiwifruit, orange, banana, fresh sweet corn or peas are all readily accepted. Wash food and water trays and replenish daily.

Try to feed the kokako from these trays prior to its release into the aviary, this seems to help the birds recognising a novel food source. Ensure that all birds are feeding freely before they are due to be transported.

Wherever possible allow one flight per bird, unless they were caught as a pair.

Use patience and care when catching birds in the aviary, no lunging tackles, you should catch them firmly but gently against the mesh and quickly get their legs into the standard grip.

TRANSFER BOXES

The recovery group have two wooden transfer boxes, each with four compartments. Similar boxes may be able to be borrowed from the National Wildlife Centre if required. These have good ventilation and padded walls to prevent the bird damaging itself.

Wash boxes thoroughly with hot soapy water and then sterilise with "Virkon" or a similar anti-viral disinfectant. Allow time to thoroughly dry and air. Tie a perch (20–

25mm diam.) firmly to the base of each box and secure fresh, edible foliage/fruiting branchlets within them.

DISEASE RISK

With any bird transfer there is a risk of spreading avian pathogens. When planning a transfer assess the level of risk to kokako and to other species at the proposed transfer site. Check out any known or perceived risks with relevant experts (DOC contract vet) and determine whether disease screening and/or quarantine are required.

TRANSPORT

Ensure that kokako are well fed and have drunk well before transport. Transfer from aviaries to boxes as close as possible to the departure time, one kokako per compartment. Remember to write kokako details (bands, tx. frequency, name) on stickers affixed to each door. Secure doors with a screw or strong tape. If the box(es) are to be transported by a carrier ensure that the box is labelled, "Live animals".

An experienced bird handler should always accompany the birds. They should carry with them extra food (banana, native fruits, etc.) and jam-water in case this is required at any point in the journey.

The boxes must be handled gently, shaded and stowed so that ventilation is unrestricted. Stowing in a quiet, dark place with minimum disturbance is ideal.

Kokako have been transported by many means of transport without problems. Where the time in the box will exceed 4 hours try to arrange a secure room, during the journey, where the kokako can be taken out and offered more food and liquids. Ensure, before you depart, that all sections of the journey are planned for and that any other transport operators have agreed to your timetable. Check weather forecast for any air or sea travel sections. Have a contingency plan and carry details of contact people you might require en-route (local DOC staff, vets, transport operators).

If using commercial airlines be sure to warn them well in advance of the intended cargo. Airport managers at both ends of their journey should be informed and asked to notify duty staff of the care required. Some aircraft have holds that are unsafe for small animals due to unacceptably low temperatures or pressure fluctuations. Be sure that airline handlers comply with your wishes, try to load birds last and so avoid any possibility of their ventilation being restricted by other cargo.

In helicopters carry in the cabin to avoid excessive noise.

In vehicles, tie boxes securely to avoid their moving during the journey. Keep sufficient windows open and ensure you have plenty of fuel for your planned journey. Never leave the birds unattended and avoid parking the vehicle in the sun. Travel in convoy with another vehicle or carry a cell-phone so that contact can be made in the event of any problems.

RECEPTION

Ensure that an aviary or secure room is available at the destination in case any kokako need to be kept under observation, or have experienced any problems during the journey.

Some kind of welcome ceremony has become usual. Often this involves the donating Iwi (who may travel with the birds) gifting the birds to the local receiving Iwi. Such ceremonies will vary considerably depending on the Iwi involved but will often involve some speeches from senior members of each Iwi and the singing of waiata. Be sure that all involved understand the importance of handling the bird boxes gently and quietly and, where a long journey has been involved, the importance of feeding and releasing the birds as soon as possible.

RELEASE

We have always used a direct ("hard") release. Remove the birds from boxes and encourage them to feed and take jam water. Transferred birds will usually carry radio-transmitters, check they are well seated on the birds back and still going. Ensure local staff have records of all the bird details. Then release onto a sloping tree, which will allow them to bound up toward the canopy. If you are transferring a pair allow them to feed and be released together. If birds seem in any way stressed, however, it would be best to feed them and then keep them under observation in an aviary.

FOLLOW UP

We are still learning about kokako transfers. The past 30 kokako transferred using the above techniques have all been resighted at least 1 month subsequent to release. Many are known to have formed pairs and some are now known to have successfully bred in their new homes. However we still know very little about the mechanics of settling kokako of different ages/sexes into a new area so it is important that we plan to monitor this process, record our observations centrally and so learn from experience. Consult the Kokako Recovery Group Leader for advice on suitable monitoring regimes.

Appendix 1

A MODIFIED HARNESS DESIGN FOR ATTACHING TRANSMITTERS TO BIRDS[1]

By Ian Flux

The backpack transmitter harness design described below is modified from a design published by Clout and Karl (1987) and is—in my experience with kokako—quicker and simpler to fit. Reduced handling time may reduce stress to the bird. The minor variation to the weak-link threading (described below) should prevent problems with either the neck or body loops remaining intact after breakage of the link.

Synthetic braided cord is used. The gauge selected will depend on the transmitter weight and the bird species concerned. A soft, non-abrasive cord is least likely to cause skin damage to the bird. For kokako I have used nylon and polyester braids of 1.5 mm diameter for 4 g radios and 2.5 mm for 10 g radios; no skin damage has been noted on recaptured birds.

1. Cut two lengths, one long enough to pass around the bird's neck with at least 5 cm to spare, and one long enough to pass around the body behind the wings AND loose enough to pull the wings through. Seal their ends with a hot wire or match. Mark the mid-point of each cord with a coloured pen.

2. Fit the shorter (neck) cord to the front attachment tube and the longer (body) cord to the rear of the attachment tube of the transmitter. Each cord is passed twice through the attachment tube to form loops at either end of the transmitter (Fig. 1–A).

   Now form eyelets at the end of each cord by turning the end 1.5 cm back on itself and binding firmly.

3. To enclose the weak-link thread, take two short lengths of soft plastic tubing. They should fit neatly inside one another; I use an outer tube with 5 mm external and 3 mm internal diameter, and an inner one of 3 mm and 2.2 mm. The outer tubing selected should neatly accommodate the two cord eyelets (Fig. 1–B). Cut the outer tube to an appropriate length (this depends on the species concerned). Cut the internal tube 6 mm shorter.

4. Slide the two tubes together. Use Vaseline if required. They should be flush at one end.

5. Using cotton thread(s) of the required breaking strain, form a loop through the inner tube. Pass the thread through all four harness end loops. Ease the two loops from one end of the transmitter into the end of the plastic tube until they rest against the inner tube. Draw the thread tight, bringing the two loops at the other end of the transmitter into the tube. Knot the thread securely at the accessible end of the inner tube. If the thread loop breaks, all four ends should fall free.

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[1] First published July 1994 in *Ecological Management 2* by Department of Conservation, P.O. Box 10-420, Wellington.

6. Push the inner tube gently until it is centered within the outer tube. (This will protect the weak-link thread from abrasion.)

7. Take the mid point of each cord and pull until each harness loop is centred. Push the mid point of each cord through a neatly fitting toggle of plastic or aluminium tubing.

Fitting to the bird

8. Pass the bird throughthe harness head first. Pull its wings forward, so that the rear loop lies behind the wings and the front loop lies in front of the wings.

9. Pull the mid point of each cord to draw the loops firmly around the bird. Preen the harness cords under the feathers. Adjust the cords so that the harness will not be tight during activity of the bird. (A pencil should slip below a fitted kokako transmitter, or a large finger below a kereru transmitter.) The wink-link tube should lie along the bird's keel.

10. Crimp and/or glue the toggles against the transmitter body to fix the harness. Melt off excess cord protruding from the toggle. (Nichrome wire heated by a 6V battery is a simple tool for cutting or sealing nylon cord neatly.)

    At this point, the sliding hoops should be completely secure. CHECK by pulling the cord ends at the toggle to ensure the loops are immobilised.

REFERENCE

Clout, M.N.; Karl, B.J. 1987: An improved radio transmitter harness and a weak link to prevent snagging. *Journal of Field Ornithology* 58(1): 73–77.

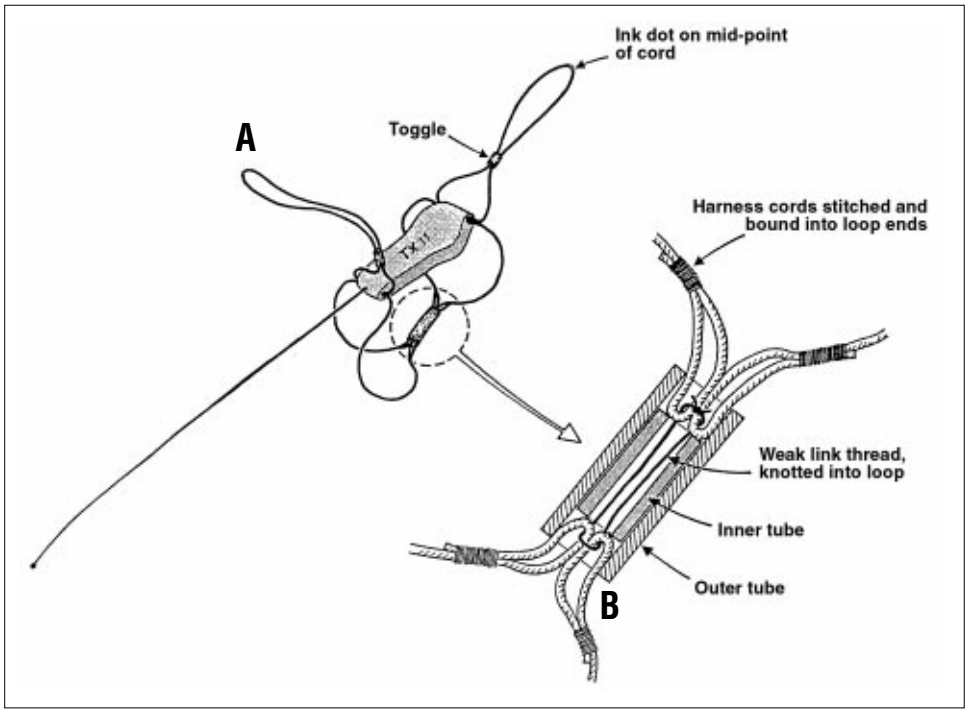


Figure 1.
A: Loop formed at either end of transmitter.
B: Cord eyelets fit within outer tube.

Appendix 2

KOKAKO NEST RECORD SHEET

KOKAKO NESTS	
PAIR:	DATE FOUND:
STAGE WHEN FOUND:	
HEIGHT above ground (m):	HEIGHT of host tree (m):
HEIGHT of canopy (m)	
LOCATION , a) in study area:	
b) host tree species:	c) on ridge top, face or gully?
d) inner branch (1/3), centre branch (1/3), outer branch (1/3)	
COVER AT NEST, a) ABOVE – dense (<70%), mod. (30–69%), sparse (<30%)	
b) SIDE – d., m., s.	c) BELOW – d., m., s.
VINES AT NEST? Y / N	
1st DATE INCUBATION KNOWN:	DATE CHICKS KNOWN HATCHED:
NEST FATE:	
FAILURE DATE:	
NESTING “ATTEMPT” – YES/NO	NEST FILMED – YES/NO
NOTES:	
RECORDED BY:	
DATE:	

Appendix 3

BANDING AND MEASUREMENT RECORD

NORTH ISLAND KOKAKO
BANDING AND MEASUREMENT RECORD

PLEASE COPY THIS SHEET TO KOKAKO RECOVERY GROUP LEADER FOR NATIONAL MEASUREMENT FILE

LOCATION (+ grid ref.)_____

BIRD NAME _____ STATUS (S, Pr) _____

AGE (Ad,Chk,Sub-A) _____ SEX _____

PARENTS (if chick) _____ _____

DATE __/__/____

METAL BAND NO. _____

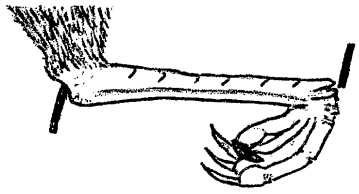
LEFT LEG BANDS _____

RIGHT LEG BANDS _____

TRANSMITTER FQ ._____

MEASUREMENTS

ii)



USE CALIPERS, FROM NOTCH OF UPPER JOINT TO END OF BONE WITH FOOT TURNED DOWN.

Bird + Bag weight (g) _____

Bag weight (g) _____

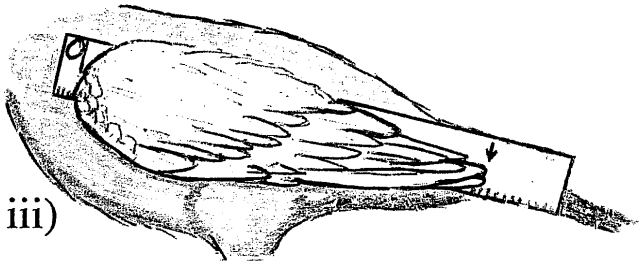
i) Nett weight [-bag](g) _____

ii) Tarsometatarsus (mm) _____

iii) Wing chord (mm) _____

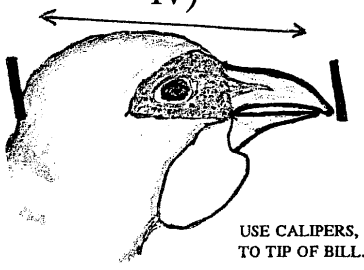
iv) Head and Bill (mm) _____

iii)



USE RULER WITH END PLATE TO BUTT AGAINST LEADING EDGE OF WING. FLATTEN WING ONTO RULER WITH FINGER THEN RELEASE BEFORE READING TO TIP OF PRIMARIES. WING SHOULD LIE NATURALLY, DO NOT STRAIGHTEN.

iv)



USE CALIPERS, LONGEST AXIS OF HEAD FROM BACK OF SKULL TO TIP OF BILL. ENSURE CALIPERS ARE PARALLEL TO AXIS OF SKULL

MEASURED BY: _____

OTHER NOTES:

(MOULT, FAECAL CONTENT, DAMAGED/WORN PLUMAGE, BEHAVIOUR ...)