

Kiwi Best Practice Manual

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Acknowledgements

This best practice manual, prepared for the Kiwi Recovery Group, is an update of the 2003 version of the Kiwi Best Practice Manual (Robertson & Colbourne 2003), incorporating the new technologies and knowledge that have become available on how best to study and manage kiwi. It has been written with both Department of Conservation staff and community groups in mind. Kiwis for kiwi have greatly assisted with the development of best practice and its promulgation to practitioners.

The entire manual was reviewed by members of the Kiwi Recovery Group in 2014, with a particular focus on developing best practice for new issues, such as the use of birds for advocacy purposes, and the processes and standards for accreditation as handlers and trainers. In addition, Natasha Coad, James Fraser, John McLennan and Troy Makan commented on the entire document.

Individual sections have been reviewed by a number of specialists, including Kate McInnes (veterinary issues), Claire Travers (ONE), Andrew Glaser (kiwi dogs), Stu Cockburn and Andrew Digby (automated call recorders and trail cameras), Paddy Stewart (automated call recorders), and Kevin & Gill Adshead, Robin & Sandy Toy, and Sandy Yong (trail cameras).

The Kiwi Recovery Group is always interested in hearing about new technological developments that may assist with kiwi conservation, and will facilitate trials outside the current 'best practice' on a case-by-case basis so that we may learn and develop better standards to improve the welfare of kiwi and/or save time and money, which can then be put towards 'making more kiwi'.

To all who assisted in the development of this manual, a big thank you.

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Biodiversity Group, DOC

Cover: : Subadult brown kiwi (*Apteryx mantelli*) being processed. *Photo: Hugh Robertson.*

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1. Purpose

The objectives of this best practice manual are to:

- Provide information and resources about the best routinely used techniques that are currently available for managing and studying kiwi
- Help to formalise consistent management practices across kiwi taxa throughout New Zealand
- Provide a mechanism for advocating the continuous improvement of kiwi conservation management and research

In this way, this resource will ensure that the best possible welfare standards are applied during the management and research of kiwi, as required under the Animal Welfare Act, 1999.

This manual should be read in conjunction with the:

- [Kiwi \(*Apteryx* spp.\) recovery plan](#): 2017–2027 (Germano et al. in prep.)
- [Captive management plan for kiwi 2010–2015](#) (Barlow 2011)
- [Brown kiwi \(*Apteryx mantelli*\) husbandry manual](#) (Fraser & Johnson 2015)
- [Operation nest egg incubation and chick rearing best practice protocols](#) (Bassett 2012)

1.1 Background

In the absence of direct management intervention, mainland populations of all kiwi taxa would be declining, with the rate of decline varying according to the presence, absence or cyclical abundance of predators, and the life-history parameters of the different kiwi taxa.

Over the 25 years since the first Kiwi Recovery Plan was published (Butler & McLennan 1991), various management tools have been developed that can halt decline of kiwi populations and actually turn the tide and allow populations of all taxa to recover. Holzapfel et al. (2008) predicted that the planned conservation management would see an increase in the total numbers of rowi (*Apteryx rowi*), Haast tokoeka (*A. australis* 'Haast'), little spotted kiwi (*Apteryx owenii*), and the Northland and Coromandel forms of brown kiwi (*A. mantelli*) between 2008 and 2018, and this goal has been achieved. The most recent Kiwi Recovery Plan (Germano et al. in prep.) aims to grow the national population of kiwi from 70,000 birds in 2017 to 100,000 by 2030, with a minimum of 2% increase per annum for each taxon over this period.

Research and management of kiwi is diverse, as kiwi include five extant species and eleven taxa that are distributed in the wild from near Kaitia in the north to Stewart Island/Rakiura in the south, as well as a small captive population of brown kiwi. Furthermore, there is a need to separately manage different local populations throughout the geographical range of each taxon, not only in recognition of substantial genetic variation that has arisen naturally across the range as a result of the poor dispersal abilities of kiwi, but also to involve local communities throughout the taxon's range.

In many cases, kiwi should be viewed as an indicator of ecosystem health and, wherever possible, their status as an 'iconic' or 'flagship' species should be used to allow their management to benefit other native species in the ecosystems they share. At the very least, the management of kiwi should aim to be neutral for other co-existing native species, avoiding or minimising any harm to them. For example, trapping of stoats can lead to increased peak numbers of rats (Craig Gillies and Ian Flux, pers. comm.) because stoats are no longer suppressing rodent population levels, and so other forms of rodent control may need to be implemented in parallel with stoat trapping to prevent harm to biota vulnerable to rats rather than stoats.

Active management in areas where there is kiwi protection will include a combination of tasks, as recommended in the current Kiwi Recovery Plan (Germano et al. in prep.), in individual kiwi taxon plans, by the Kiwi Recovery Group, or as devised by community groups and permitted by DOC, the local authority and/or landowners.

1.2 Review

The Kiwi Recovery Group is responsible for reviewing and revising this manual to ensure that best current practices are used when working with kiwi.

In some sections, several alternative approaches are currently offered. However, further experience may reveal that one method is superior to the alternatives, and so this may become the sole best practice in the future.

Changes from the stated best practice **must** be approved by the Kiwi Recovery Group and be carefully documented. Such changes should then be promulgated through changes to all versions of this manual, including websites on which it resides, and on the Kiwi Practitioners page of the 'Kiwis for kiwi' website¹.

Separate Animal Ethics approvals would be required if people do not wish to follow the best practices outlined here, even for some trials that the Kiwi Recovery Group might endorse.

1.3 Definitions

Mandatory requirements are those that **must** be followed because of legal requirements or that, after many years of practice, they have been identified as the best and safest methods to use routinely. These procedures are indicated by the words '**must**', '**must not**', '**ensure**', '**are required**', '**shall**', '**use**', '**do not**', '**make sure**', '**only**' or '**never**'. If you think that there is a better method, or that the mandatory method is too restrictive, then, in some circumstances, the Kiwi Recovery Group can allow a trial of the innovative method which must be carefully documented and reported to the Kiwi Recovery Group, whether better or worse than the mandatory method.

Failure to follow the mandatory requirements in the Best Practice Manual may result in a withdrawal of permits, disciplinary action and/or prosecution.

Recommended procedures are those which to our current knowledge are the best methods to use routinely, but that may have good alternatives. These procedures are indicated by the word '**should**' or indicated as being '**preferred**'. If you think that there is a better method, then this must be carefully documented and reported to the Kiwi Recovery Group, whether better or worse than the current recommended method.

¹ www.kiwisforkiwi.org.

1.4 Basic biology of kiwi

Five extant species of kiwi are recognised:

- Brown kiwi (*Apteryx mantelli*).
- Rowi (*Apteryx rowi*)²
- Tokoeka (*Apteryx australis*)²
- Great spotted kiwi or roroa (*Apteryx haastii*)
- Little spotted kiwi (*Apteryx owenii*)²

Within the brown kiwi species, we recognise four geographical forms based on genetic differences that have accumulated with separation (Weir et al. 2016):

- Northland
- Coromandel
- Eastern (from Bay of Plenty to the Ruahine Range)
- Western (from King Country to Wanganui and Tongariro)

Within the tokoeka species, we recognise four geographical forms based on genetic differences that have accumulated with separation (Weir et al. 2016):

- Haast
- Northern Fiordland
- Southern Fiordland
- Stewart Island

All five species and 10 taxa of kiwi share the same general characteristics:

- Mainly nocturnal
- Flightless
- Raft-like sternum, lacking a keel
- Bones filled with marrow, not hollow
- Minute (vestigial) wings
- No external tail
- Feathers with unlinked barbs on a single rachis
- Feathers easily shed – perhaps as a predator defence mechanism
- Short stout legs with three forward-pointing toes and sharp claws
- Long, slightly decurved bill
- Small eyes but moderate vision by night and day
- Large ears and good hearing
- Well-developed sense of smell, with nostrils near the bill tip and enlarged olfactory centres in the brain
- Sensory pits in the bill tip, to detect movement of prey
- Females 20–30% heavier and longer bill than males
- Females have paired functional ovaries
- Large egg in proportion to female weight (typically 15–20% of female weight)
- 1- or 2-egg clutches, very rarely 3-egg clutches in brown kiwi
- Long incubation period (70–90 days)

² Analysis of DNA from subfossil remains and historical records suggest that two taxa of rowi (in NW Nelson and southern North Island), two taxa of tokoeka (both in the eastern South Island), and one or two taxa of little spotted kiwi went extinct sometime between 700 and 1900 AD (Shepherd et al. 2012, Weir et al 2016).

- Chicks hatch as miniature adults, with normal feathers rather than down
- Chicks rely on their yolk sac for nutrients for the first 5 days
- Very slow growth, taking 3–5 years to attain final adult size
- Lower blood temperature than most birds
- Large grey and white pungent droppings – perhaps used for territory marking
- Loud penetrating repeated calls; males give a series of 15–25 shrill ascending whistles, while females give a series of 10–20 lower-pitched and hoarser whistles
- Live from sea-level to alpine tussock grasslands and herbfields at about 1500 m above sea level. Mostly forest inhabitants, they are now present in scrubland, rough farmland, swamps and pine forests, especially where native vegetation remains nearby.
- Eat mainly insect larvae, worms, weta, crickets, centipedes, spiders and fruit.
- Food is taken from the soil, litter layer, rotten logs or on the surface.

The main differences identified to date amongst the five kiwi species are summarised in Table 1.1.

Kiwi are evidently an early offshoot from the evolutionary line of the primitive flightless ratites (moa, emu, cassowary, ostrich and rhea). Initially, it was thought that kiwi were closely related to moa (Cracraft 1974), then taxonomists showed that they were more closely related to the emu and cassowary of Australia (Cooper et al. 1992), and more recent genetic analysis has now placed them closest to the extinct elephant bird of Madagascar (Mitchell et al. 2014). They are certainly one of the oldest members of the New Zealand avifauna and our only endemic order of extant bird.

1.5 History of kiwi conservation

Numbers and distribution of kiwi have declined dramatically since humans arrived in New Zealand about 800 years ago, firstly due to the arrival of dogs and loss of drier habitats to man-made fires. The rate of decline increased following European settlement due to massive habitat loss because most lowland forest and scrub was converted to pasture, and Europeans introduced more mammalian predators, especially mustelids and cats, and more dogs. Two species, rowi and little spotted kiwi, are now increasing as a result of conservation management, but numbers of the other three species continue to decline; however, the rate of decline has slowed in recent decades due to conservation management efforts. Key breeding and behavioural characteristics of the five kiwi species are shown in Table 1.1.

1.6.1 Role of predation in the decline of kiwi

As little as 30 years ago, some ecologists believed – wrongly – that predator impacts in New Zealand forests were over, and that after 100 years of coexistence, kiwi and other prey species had demonstrated both their resilience and ability to go on co-existing with mammalian predators indefinitely.

Accounts from early explorers and museum collectors indicated that kiwi were once far more abundant and widespread than they are now, though there were no actual measurements to allow scientific comparisons. Farmers, trappers, hunters and iwi provided further evidence with accounts of local declines within various individuals' own lifetimes.

The first evidence that predators were seriously involved came from a comparative analysis of kiwi population structure in mainland forests (mammalian predators present) and offshore islands (mammalian predators absent). Despite similar reproductive rates, population on offshore islands contained a greater proportion of young birds than those on the mainland, implying that failure in recruitment was a significant issue for mainland birds (Colbourne 1992; McLennan & Potter 1993).

Table 1.1. Key breeding and behavioural characteristics of the five kiwi species.

BREEDING				VOCALISATIONS
MAIN EGG LAYING	NO. EGGS/ CLUTCHES	INCUBATION	CHICK DISPERSAL	
Brown kiwi				
Mid-June to late Dec	1–2 (usually 2) eggs. Often has 2, sometimes 3 or 4 clutches in a season	Male alone for 75–90 days	First leaves the nest at 5–7 days old, but returns daily for 2–10 weeks. Generally leaves the natal territory soon after leaving the nest	Males give a drawn-out, ascending whistle repeated 15–25 times; female give a hoarse guttural call repeated 10–20 times
Rowi				
Mid-June to Jan	1 egg; often 2, rarely 3 clutches in a season, with some overlap of clutches	Male and female for 65–75 days	First leaves the nest at 5–7 days old. Remains in the nest and/ or natal territory for up to 4 years	As for brown kiwi
Tokoeka				
Mid-June to late Dec	1 egg; 1–2 clutches per season	Male and female for 65–75 days, sometimes with assistance from family members	First leaves the nest at 5–7 days old. Remains in the nest and/ or natal territory for up to 7 years	As for brown kiwi
Great spotted kiwi				
July to late Dec	1 egg; 1–2 clutches per season	Male and female for 65–75 days	First leaves the nest at 5 days old. Remains in the nest and/or natal territory for up to several years	As for brown kiwi, except males usually give 10–20 calls; females 10–15 calls
Little spotted kiwi				
July to Dec; Sep to Dec at Kapiti and Zealandaia	1–2, laid 2–3 weeks apart; often 2 clutches per season away from Kapiti	Male alone for 65–70 days	First leaves the nest at 5–7 days old, but returns daily for 2–4 weeks. Leaves natal territory in 2–6 months.	Males give a crisp whistle repeated 15–25 times; females a hoarse trill repeated 10–20 times

Radio-tracking studies soon revealed that stoats were the primary cause of the recruitment problem. In most localities and years, stoats killed most of the annual crop of young kiwi, usually before the birds were 6 months old (McLennan et al. 1996; Robertson et al. 2011). Population models showed that too few young kiwi were surviving to replace the adults. In some parts of the country, adult survival is remarkably high, with average life expectancies of 40–50 years; however, in other parts of the country, such as Northland, the average life expectancy of adults (13–14 years) is one-third of this (Robertson et al. 2011). Predation of adults by dogs and ferrets is the critical factor driving these kiwi populations towards extinction, even though stoat predation of chicks remained a serious issue that is perhaps easier to tackle than changing human behaviour regarding control of dogs (Robertson et al. 2011).

1.6.2 History of conservation efforts

Kiwi have attracted much interest since specimens were first collected and described scientifically in the mid-1800s. Most of the early work was on the unusual structure and physiology of kiwi, based on museum specimens or captive birds. Because kiwi are nocturnal and secretive, little field research on kiwi was practical until the development of miniature radio-transmitters in the early 1980s. Apart from a few transfers of kiwi to offshore islands in the late 1800s and early 1900s, little conservation management was done, and most species were thought to be holding their own despite local losses due to habitat clearance.

The field research in the 1980s provided important new insights into the biology of wild kiwi, and helped to alert conservation authorities to the difficulties that kiwi faced from predators. The main conservation management actions taken in the 1980s were to successfully transfer little spotted kiwi, the then rarest species, from Kapiti and D'Urville Islands to a number of predator-free offshore islands, to 'rescue' kiwi from habitat clearance operations, and to establish some island populations of brown kiwi.

It was not until 1991, with the launch of the Kiwi Recovery Programme, that significant coordinated conservation management action was taken to prevent kiwi from becoming extinct. The first five-year phase of the programme, from 1991 to 1996, concentrated on gathering baseline information to allow a better understanding of the status, trends and threats of kiwi populations; identifying the key threats to kiwi populations, including assessing the impact on kiwi of toxins used for pest control (McLennan et al. 1996; Robertson et al. 1999a,b); re-examining the genetics of kiwi to better understand their conservation management units (Burbidge et al. 2003) and starting research on some of the poorly known taxa (rowi and tokoeka). Landowners in Northland and Coromandel began trapping and/or poisoning predators of kiwi on their land and public land.

The next five-year phase, from 1996 to 2001, concentrated on experimental management of predators, especially stoats, to see if managed kiwi populations on the mainland could recover; developing and refining Operation Nest Egg as a tool for allowing kiwi chicks to get through the population bottleneck of the first 6 months of life (Colbourne et al. 2005); reassessing status of populations (e.g. Colbourne & Robertson 1997; Robertson et al. 2005), and extending earlier genetic research with larger samples and more collection locations, and more powerful analytical tools. The community efforts increased greatly with the establishment of a number of community groups around New Zealand and landowner groups in Northland where clusters of like-minded landowners coordinated their efforts in order to receive funding and to increase the efficiency of predator control.

The third phase, from 2001 onwards, has moved to experimentally manage five key mainland populations at a landscape scale (10,000 to 20,000 ha) to see if predators could be suppressed to a level which allowed kiwi populations to grow (Robertson & de Monchy 2012). Kiwi populations have been established behind predator-proof fences at a number of mainland sites, and on further islands, often close to where many New Zealanders live. Conservation efforts by community groups have continued to be encouraged, and the area under their active management has steadily grown and has now surpassed the area specifically managed for kiwi by the Department of Conservation. The publication of the first Best Practice Manual (Robertson & Colbourne 2003) meant that all kiwi workers were using the most appropriate tools. Further refinements in electronic technology, such as the development of 'smart' transmitters, Sky Ranger, trail cameras and automated sound recorders, has also led to significant efficiency gains, and has allowed new research on more difficult species (great spotted kiwi and tokoeka). Our understanding of the genetics of small populations has improved and this is guiding conservation management practices.

2. Requirements

2.1 Permits

If you are not working for the Department of Conservation (DOC) on an approved project, you must obtain a permit under the Wildlife Act 1953 for any manipulation of kiwi, which includes the following activities:

- Using dogs to locate kiwi
- Catching and handling kiwi
- Photographing kiwi in nests
- Marking kiwi with bands, wing tags or transponders
- Attaching radio-transmitters to kiwi
- Taking blood or feather samples from kiwi
- Transferring kiwi to a new site
- Uplifting eggs or chicks from a nest as part of Operation Nest Egg™ (ONE)³
- Holding dead kiwi, including for kiwi aversion training
- Holding kiwi in captivity

If the work is for research purposes, you will also need to obtain a Research and Collection Permit from DOC. Since kiwi are regarded as iconic species, the high level of public interest in research on wild kiwi will almost always trigger the need for a High Impact Permit rather than a Standard Permit. Allow 9 weeks to obtain your permit. Further information on permits is available at <http://www.doc.govt.nz/get-involved/apply-for-permits/research-and-collection/>

It should also be noted that adherence to these guidelines does not necessarily remove the need to obtain additional permits under the Animal Welfare Act 1999, particularly when undertaking research manipulations.

2.2 Training accreditation

A formal accreditation system for handling kiwi has been introduced to ensure that current best practice is being followed and the welfare of kiwi is the top priority when they are being manipulated in any way.

The Kiwi Recovery Group maintains a register of accredited handlers. These people are accredited to carry out certain tasks or to train others in those tasks, in much the same way as a driver licence carries endorsements to drive cars, motorcycles and/or light trucks, or the DOC Banding Permit endorses a person to band particular taxa of birds, to use particular capture techniques, or to train others.

To be added to the register of accredited handlers, the applicant **must** declare that they have read the relevant sections of this best practice manual, and also need to supply a letter of recommendation from an accredited trainer for the particular task(s) being registered for, e.g. catching, holding, measuring or blood sampling kiwi. Each year, people on the register **must** advise the Kiwi Recovery Group of the approximate number of kiwi that they have manipulated under each of the tasks they are endorsed to do. Refreshers are also required if the accredited handlers have not carried out the endorsed task(s) for a number of years.

Experienced handlers who have performed various tasks the stipulated minimum number of times can also apply to the Kiwi Recovery Group to become endorsed as an accredited trainer for particular tasks, such as inserting transponders or attaching radio-transmitters.

³ Please note that there is a national ONE translocation permit, and so any activity as part of this programme may fall under that existing permit if certain conditions are met. Please consult the Kiwi Recovery Group leader for further details.

3. Health and safety when working with kiwi

3.1 Disease risk to human health from handling kiwi

3.1.1 Scratches

Perhaps the most common health risk associated with working with kiwi is infected scratches. Kiwi have very strong legs and sharp claws, which they use to dig burrows, fight with conspecifics and defend themselves. The claws are often covered with dirt and harbour all sorts of microorganisms, which can lead to infections. It is not appropriate to wear gloves when handling kiwi because you need good dexterity to handle and measure them.

Action:

- Wash scratches thoroughly with a brush and apply antiseptic. If necessary, cover with a sticking plaster.

3.1.2 Kiwi faeces and blood

The risk to human health from any diseases of kiwi is extremely low, but perhaps the most dangerous and contagious pathogen recorded in kiwi is *Cryptococcus* spp. This pathogen affects the respiratory system and was found in a captive kiwi in Hawke's Bay.

In addition, kiwi, like other birds, may carry *Salmonella* and *Yersinia*. Both bacteria live in the birds' digestive tracts, so you are most likely to come into contact with them if a bird defecates during handling or when you reach into a daytime shelter. These bacteria cause infections of the digestive system (dysentery) of varying severity.

Kiwi also suffer from other diseases that affect their blood system and digestive tract, such as *Coccidia*, avian malaria and *Babesia*. However, these diseases are not known to affect humans.

Kiwi are not known to carry psittacosis, which is caused by *Chlamydia* spp. This disease affects the respiratory system, with very strong flu-like symptoms which may last for months. Although this disease does not kill people, it is serious and debilitating.

Actions:

- You **must** use a mask and gloves when dissecting kiwi.
- After handling kiwi and before eating, wash your hands thoroughly with a disinfectant soap and/or use alcohol-based wipes.

3.1.3 External parasites

Kiwi can carry feather lice, ticks (common in Northland) and fleas (common on Stewart Island/Rakiura and other islands, where kiwi may use penguin burrows infested with fleas). Although feather lice do not bite humans, ticks occasionally do and fleas certainly do, and all three parasites can sometimes cause severe irritation to sensitive skin.

Action:

- Apply topical creams to the affected area.

3.2 Health and safety of kiwi

When working with kiwi, the safety and welfare of the birds should be paramount.

The internal and external parasites and diseases mentioned in section 3.1 could be easily transferred to other kiwi if basic hygiene procedures are not followed. The opportunity for disease transmission is increased when kiwi are held in confined spaces such as weighing bags or transfer boxes.

Actions:

- Use SteriGENE® (formerly called Trigene) or similar antiviral/antibacterial product to disinfect any gear used on birds every time you work with a different kiwi population or species, and wipe calipers down with SteriGENE® or medical wipes between measuring different individuals.
- Generally avoid using bird bags to hold or weigh kiwi. However, if you do use cloth bags, use each clean bag once only before washing and disinfecting it in a solution with SteriGENE® or similar product, and then rinsing it clean before drying.
- If you use cloth bags to hold birds for less than 5 minutes, tape their legs to prevent them from struggling too much. For more than 5 minutes, leave them unrestrained.
- Ensure that the holding bag is strong enough (e.g. canvas with a double layer on the bottom) to prevent an unrestrained kiwi from slashing its way out.
- Ensure that the holding bag is adequately ventilated from time to time (more frequently at higher temperatures) and keep in a cool, dark place.

See Section 6.1 for further information on the correct techniques for handling kiwi.

4. Planning a kiwi project

Most research and management that has been undertaken as part of the Kiwi Recovery Programme has been carried out within a ‘research-by-management’ or ‘adaptive management’ framework. This ensures that the research is closely aligned with management needs, the management actions are recorded and carried out using a suitably robust design, and the effects are quantified.

Before starting, make sure that your project is closely integrated with ongoing projects being carried out in the same area by DOC and other agencies, will not interfere with existing project designs, and ties in with, or optimises, the timing of planned pest control programmes in the study area.

It is also important that you have a clear idea of the expected outcomes of the project (e.g. twice as many kiwi in a given area, technical reports, scientific papers, university thesis, media articles). It is obviously impossible to know in advance precisely what results will occur, but remember that negative results are still results if they are reported accurately. It is always tempting to only report the results of studies with robust sample sizes and which yielded significant results, rather than those where sample sizes were very small or no clear patterns emerged, and these also tend to be the main types of studies published by scientific journals. However, as long as the study was undertaken rigorously, the results will be useful if merged with other similar datasets. Therefore, ensure that you seek advice on project design from the Kiwi Recovery Group, kiwi researchers in DOC or universities, or kiwi research consultants during the project planning stage.

Theoretical studies on wild kiwi should generally be avoided, as they have the potential to seriously disturb or affect the behaviour of the birds (e.g. through very close-order monitoring, or repeated handling or blood sampling). Therefore, be aware that it will be much more difficult to obtain permits for such research.

If any of your research is to be performed on captive kiwi, including ONE eggs or chicks, you will need to answer a questionnaire and provide an outline of your research to the Brown Kiwi Captive Coordinator at the New Zealand office of the Zoo and Aquarium Association of Australasia (admin@zooaquarium.org.nz) before approaching a particular captive institution to ask if you can work there. This proposal will be assessed by a scientific panel, following which the captive coordinator will put you in touch with appropriate captive institutions. Captive institutions have requested this additional step in the process because they desire an independent assessment of the scientific merit of research projects, and it is also useful at a larger scale by allowing the Brown Kiwi Captive Coordinator to oversee the use of captive birds that may be needed for other purposes.

Before you complete your field programme, you should contact the Kiwi Recovery Group, because they may be aware of another project that could usefully build on your project. At the end of your study, allow ample time to restore your study area and study animals back to pre-study conditions (e.g. remove burrow markers and radio-transmitters). You should not remove bands from the birds if they are not otherwise permanently marked with transponders because these individual markers may prove to be extremely valuable at a much later date.

4.1 Consultation with local communities and iwi

During the project planning process, there should be adequate consultation with local communities and tangata whenua, so that affected locals and neighbours know what you hope to do and are given every opportunity to contribute to the planning of your project. When you are ready to begin the consultation process, DOC staff can help to point you in the right direction.

Consultation does not require agreement between parties, but you should aim for this whenever it is possible. To do this, you should allow for an effective lead-in time and provide other parties with plenty of time to consider their position, which may require them to have internal discussions. In some instances this may take a lot of energy. However, if you can reach agreement with your local stakeholders, the effort and time spent will be well worthwhile.

If possible, involve your stakeholders in physical help with the project – the resultant sense of ownership will pay dividends in the long run. Also, ensure that you keep stakeholders informed about the progress of your project through informal and/or formal communication channels, as appropriate.

When planning a translocation, recognise the spiritual significance of such events to tangata whenua at both ends of the transfer process. Often the different iwi involved will want to talk to one another and establish protocols for the transfer, and will almost certainly want to be involved in the first such transfer and be consulted about their wishes to be involved in subsequent identical transfers.

4.2 Data handling

It is very important that information on kiwi is collected systematically.

4.2.1 Field recording

For casual tasks, such as a short visit to a site to catch and band birds, you should enter field data in a pocket notebook made of waterproof paper (e.g. the 'Write-in-Rain' notebooks available from the DOC Banding Office (Biodiversity Group, National Office, Wellington)). Field data should then be transferred to an electronic file as soon as possible or photocopied, with the copy stored in a safe place away from where the field notebook is usually held.

For routine tasks, such as nationwide kiwi call monitoring (see Section 7.2.1) or regular checks on radio-tagged birds, you should enter data onto pre-printed cards (e.g. Kiwi Call Scheme cards; Figs 7.6 and 7.7), or on field data sheets (see Appendix A2.1 for an example devised by the Whangarei Kiwi Sanctuary team). Having a card or form allows consistent data to be recorded each time, with less chance of forgetting to record some variables. Always retain the paper copy after transferring the data to electronic format in case there are subsequent queries or transcription errors.

4.2.2 Electronic databases

A database should be used to store the information collected during each encounter (radio-tracking signal or physical) with an individual, recording measurements, nesting attempts and productivity, and to keep track of transmitter lives and when transmitter harnesses were last replaced.

The following Excel file types have proven useful during a long-term kiwi project in Northland:

- Individual file: This contains basic information on each individual handled, which is useful for keeping track of individuals, filling in banding schedules, and keeping track of when transmitter attachments were last replaced (see Appendix A2.2).
- Data file: This is the master file, which records all of the information from each encounter with each bird, whether radio-tagged or not. This can be sorted on a variety of variables for different purposes (see Appendix A2.3).
- Nest file: This is a more detailed file for each nest, which will help you to predict when the eggs will hatch (see Appendix A2.4).
- Transmitter file: This file contains a separate row for every time the transmitter is used. It can also be useful to have a cell showing the current date and to highlight actively deployed transmitters (see Appendix A2.5).

4.3 Data analysis

The Kiwi Recovery Group and staff from the Biodiversity Group, DOC, can assist with study design, data analysis and population modelling to ensure that a nationally consistent and statistically robust approach is taken. The main contact is Hugh Robertson (Kiwi Recovery Group and Biodiversity Group, Wellington).

Robertson & Westbrooke (2005) produced a practical guide to the management and analysis of survivorship data obtained from radio-tracking studies. This describes the assumptions involved in analysing radio-telemetry data, provides rules for the consistent handling and analysis of data, and gives worked examples in Excel and SPSS of survivorship rate calculations using the Mayfield method (constant survival rate with age) and Kaplan-Meier procedure (variable survival rate with age), and the Mantel Haentzel test for comparing two or more survival rates. These survival data can then be used in matrix population models (Leslie matrices) in combination with productivity data to determine population growth rates (e.g. see Robertson et al. 2011; Robertson & de Monchy 2012; Tansell et al. 2016).

An Excel file is available from Hugh Robertson for the analysis of breeding data, which calculates hatching, fledging and nesting success, as well as daily egg survivorship and nest survivorship rates.

4.4 Reporting

DOC staff and any individual or group who receives funding or in-kind support from DOC must supply an annual report to the Kiwi Recovery Group by 30 September each year. Likewise, any individual or group that receives financial support from 'Kiwis for kiwi' **must** supply a progress report by 31 March each year (or at the time of seeking further sponsorship funding), and must supply an annual report by 15 July each year.

Every study should aim to make the results and interpretation available to the public in the form of a paper in a peer-reviewed scientific journal or DOC science series. Much valuable data languishes in unpublished reports, on temporary websites or, worse still, in notebooks. Contact the Kiwi Recovery Group for assistance if you would like to publish the results of your study but do not have the experience to analyse the data and/or write a scientific report.

5. Capture techniques

The main reasons for catching kiwi are to:

- Establish a marked population of kiwi for designated monitoring or research programmes
- Record band numbers or replace transmitters
- Safely remove eggs or chicks as part of ONE
- Transfer birds in accordance with approved translocation proposals
- Obtain samples as part of management and research projects

You must not capture kiwi without proper training and permits.

Catching kiwi is stressful for the birds, and can cause injury to the bird or handler, or the desertion of nests. Consequently, this **must** only be carried out as part of a project that has been approved by the Kiwi Recovery Group and/or with appropriate permits issued under the Wildlife Act. All captures **must** be made by suitably accredited handlers.

Accreditation

To become accredited to extract or catch kiwi on your own you **must**:

- Have been shown how to correctly extract, catch and handle kiwi by an accredited trainer (see Section 6.1).
- Have extracted/caught and handled at least five different birds on your own in the presence of an accredited trainer, who will supply a letter of recommendation to the Kiwi Recovery Group of your skills.

To become an accredited trainer you **must**:

- Provide evidence that you have captured or extracted >50 kiwi, including those captured/extracted under supervision during your initial training.

5.1 When to capture kiwi

5.1.1 Weather

Catching is best performed in dry to damp conditions (mist, light drizzle or occasional light showers are fine) with a moderate to strong breeze (especially when using certified kiwi dogs; see Section 9).

Do not catch birds in wet weather because handling can cause the kiwi to lose the effectiveness of its waterproofing.

5.1.2 Season

There is some evidence that handling birds shortly before breeding will delay breeding or prevent it altogether for the season, and handling adult birds on nests will almost certainly cause nest desertions. Therefore, the capture of new birds should be performed outside the breeding season, except in rare circumstances, such as for the authorised collection of eggs or chicks as part of ONE, to attach transmitters to chicks, or to change the transmitter or its attachment between clutches. Late summer and autumn are ideal times for catching kiwi, although the precise timing will vary between taxa and, in some cases, localities.

You **must not** attempt to catch new birds during or up to 1 month before the main egg-laying period of the species involved (see Table 5.1 for egg-laying times and exclusion periods) to minimise the risk of handling gravid females, and to reduce the risk of catching and handling nesting birds.

Table 5.1. Breeding season and exclusion periods for catching new birds of the five kiwi taxa.

TAXON	MAIN EGG-LAYING SEASON	EXCLUSION PERIOD
Brown kiwi*		
Northland	Mid-June to December	16 May to 31 December
Elsewhere	July to December	1 June to 31 December
Rowi	Mid-June to January	16 May to 31 January
Tokoeka	Mid-June to December	16 May to 31 December
Great spotted kiwi	July to December	1 June to 31 December
Little spotted kiwi		
Kapiti Island and Zealandia	September to December	1 August to 31 December
Elsewhere	July to December	1 June to 31 December

* Be aware that North Island brown kiwi can nest at any time of the year. Therefore, treat any shelter that looks like a possible nest as an active nest.

Transmitted birds can be caught with care throughout the year, but note that Egg Timer™ and Chick Timer™ transmitters do not accurately record the start of incubation and so should not be relied on to predict a safe time for catching birds mid-breeding season⁴.

5.1.3 Time of day

You can catch kiwi both at night and during the day. However, the optimal method varies between species, as highlighted in the next section.

5.2 How to capture kiwi

Several capture techniques are available for kiwi, as outlined below and summarised in Table 5.2. Ultimately, the decision on which technique to use should be based on the density of kiwi and the resources available, including trained personnel.

Table 5.2. Methods for catching or monitoring kiwi according the time of day of capture.

DAY	NIGHT
<ul style="list-style-type: none"> Initial capture in daytime shelters; very difficult at low densities, but is possible with certified kiwi dogs, especially by searching where first/last calls of the night are given. Recapture of radio-tagged birds. Recapture using knowledge of previously used marked and mapped sites. 	<ul style="list-style-type: none"> Certified specialist night dogs (preferably indicator dogs, such as pointers and setters). Hand catch with nets (open country to light understorey). Hand catch (all terrain). At low densities, locate nests by plotting male calls each night as they leave the nest.

5.2.1 Daytime shelters

Mapping daytime shelters

Burrows or other shelters can be located using certified kiwi dogs (see Section 9) or radio-telemetry (see Section 10). However, since some kiwi use certain burrows regularly, in high-density populations you may also be able to find birds by simply looking into daytime shelters and burrows that you have mapped over a period of time – this sometimes allows you to find these birds, or their partners, 5–10 years later.

⁴ Note: If an adult female needs to be handled during the normal exclusion period, the risk of her being gravid at the time of handling will be very low if you know that her partner (based on the Egg Timer or Chick Timer transmitter signal) has been incubating her clutch for 25–55 days for species with two-egg clutches or 0–50 days for species with one-egg clutches.

YOU WILL NEED:

- Map of the area
- GPS
- Numbered tags (e.g. cattle ear tags or numbers scratched on venetian blind) and/or heavy-duty coloured plastic tape (e.g. duct tape or hazard tape)

METHOD:

1. When you locate a shelter, nail a tag onto a nearby tree trunk where it can be seen, or encircle a branch or trunk with heavy-duty plastic tape so that it sticks to itself rather than mainly to the bark. (Note: Kea can learn to use these markers to find nests, so if they are present in your study area you may have to place markers some distance from the actual shelter).
2. Note the tag number and GPS location, preferably using the average function from a minimum of 100 iterations, or to within 4 m, to accurately describe the location.
3. Mark all kiwi burrows, shelters and nests on a map.
4. Systematically check each burrow in a given territory (see below), or place a palisade of small twigs at the entrance and check daily for signs of disturbance, which may indicate that a bird has entered the shelter.

Extracting kiwi from daytime shelters

YOU WILL NEED:

- Torch
- Hand trowel or spade
- Pruning saw
- Flexible mirror (such as those used on motorcycles) or camera
- Gear for processing the bird (callipers, banding pliers, radio-transmitters, etc.)

YOU MAY ALSO USE:

- Certified kiwi dog (see Section 9)

METHOD:

1. Locate a burrow or other shelter using trained and certified kiwi dogs (see section 9), radio-telemetry (see Section 10), or your own knowledge of previously used daytime shelters (see above).
2. Approach unknown sites with care. Since kiwi can breed at any time of the year, the daytime shelter may be a nest or contain a heavily gravid female. As a general rule, if the entrance is covered with vegetation, treat the shelter as a nest, mark the location and leave the area quietly, preferably by walking further on rather than back-tracking (in case predators such as dogs or ferrets follow your trail to a dead end).
3. Determine whether there are multiple exits and block these off with bags, clothing, or handy rocks or fallen branches.
4. Check the contents of the shelter by shining a torch into one of the entrances; if necessary, use a small mirror on a stick, burrow scope or camera to look further into the shelter. It is usually possible to see how many birds are present and whether they are colour-banded, although the birds may need to be gently moved to make their legs visible.

5. If you cannot see or reach the bird safely and cannot wait for the bird to move to a more accessible shelter at a later date, use a thin branch to try to gently manoeuvre the bird within reach.
6. If you still cannot see or reach the bird, block the main entrance and dig a shaft using a hand trowel or spade, and a pruning saw to remove roots or to cut into a hollow log, as follows:
7. Use a stick to feel the shape of the burrow and to determine its direction. Dig into the shelter further along in the same direction as it is running (it always seems deeper than you imagine), aiming to hit the side of the burrow cavity rather than coming directly down onto it. (Note: Remember that birds may be directly below the shaft, so the holes should be dug carefully, especially when breaking through the last bit of soil.)
8. Once you have gently broken through, check the next length of the burrow with a torch and mirror, and dig further shafts as necessary.
9. Before you capture the bird, make sure that the diameter of the hole is sufficiently wide that the bird can be pulled out easily.
10. Extract the bird with a bare hand (with gloves you lose the necessary feel and dexterity) by taking hold of both feet by the bare skin below the 'knee' joint. **Never hold a kiwi by the bill, body or upper (feathered) leg.** Remember that extracting a kiwi from a shelter is a dangerous operation as you can easily hurt the bird and the bird will often lash out with its feet, which may seriously injure your hands, itself or its partner. Once you have a firm grip of one leg, it should be possible to work the bird around so that you can get hold of both feet. Making sure that a root is not caught between the legs, slowly pull the bird out in steps, with pauses to allow the bird to relax between pulls – this reduces the number of feathers that are shed.
11. If there are other birds in the burrow, block the entranceway with a bag or clothing and concentrate on processing the bird in hand.
12. Once you have finished processing the bird, place it in a sturdy cloth/canvas bag and suspend this from a low branch, if available.
13. Extract any other occupants from the shelter and process these birds.
14. After extracting and processing the bird(s), remove any soil that has fallen into the burrow, and close the shaft(s) using boards, rocks or fallen branches so that it remains closed and watertight for years. Mark the location of shaft(s) so that you can re-use them on later visits if necessary.
15. Return the bird(s) to the shelter head first via their usual entrance; **make sure** that the legs are not still bound with electrical tape. Hold the bare part of the feet until they are well inside and block the entrance temporarily to ensure that they do not back out or otherwise escape.
16. Pack up all of your gear and collect up any feathers that were lost by the bird during handling. Consult your local DOC office for advice on how these can be given to local iwi for weaving.
17. Just before leaving, **make sure** that you remove all the materials blocking the entrances and quietly leave the area. If a bird bolts from the burrow, do not attempt to recapture it, but rather let it go on its way.

5.2.2 Hand capture at night

Kiwi can be fooled into thinking that another bird is in their territory by playing amplified recordings of their calls through loudspeakers⁵ or by mimicking male kiwi calls using a shepherd's whistle. This technique works well for catching territorial kiwi, as they will not

⁵ Calls of different kiwi species can be downloaded from www.nzbirdsonline.org.nz or from www.kiwisforkiwi.org, or you can make your own recordings of local dialects.

only respond to the calls, but many will also approach the site where the call was emitted with uncanny accuracy. Unpaired females generally respond well to male calls; however, juveniles and a certain percentage of adults, particularly females, will not approach within a detection range. The response may vary through the year depending on the stage in the breeding cycle, and kiwi are generally not fooled so easily a second time. Therefore, this technique will result in a sampling bias in favour of new adults, particularly new adult males.

It is important that you get it right the first time because kiwi learn very quickly and will often stop responding to playback if they have had a bad encounter. They seem to retain this wariness for at least 5 years, especially if the same call is played at the same catching site on repeat visits – therefore, vary the calls and the capture sites used between each attempt.

YOU WILL NEED:

- Map of the area
- GPS
- Handnet (fisherman's landing net with c. 2–3-cm knot-to-knot mesh) marked with reflective tape so it can be found if dropped or cast aside
- Playback system or shepherd's whistle
- Torches (each person should have two sources of light on them at all times, e.g. a headlamp and a pocket torch, or a spotlight and a headlamp).
- Suitable clothing that does not rustle

METHOD:

1. In daylight, scout the territories of the birds you wish to catch and select the sites that can be used at night, marking these on your GPS. (Note: A good site in forest is typically a small clearing, free of major obstacles such as fallen logs or dense scrub, and preferably with a clear slope running uphill from the centre of the catching area, or with a fallen log as a 'backstop'.)
2. Identify and mark with reflective tape the approach and departure routes, and significant hazards along access routes.
3. At the chosen capture site, identify hazards, possible escape routes for kiwi (e.g. under a fallen log) and possible non-target effects (e.g. burrowing petrels).
4. Ideally, select a period of moonless nights, or work before the moon has risen or after it has set, because kiwi have reasonable eyesight at night and are less likely to venture into open areas on bright nights. This is not as critical in dense forest because you can hide in the shadows, but the birds are very wary in open situations (e.g. river flats) and stay inside the forest fringes when there is moonlight.
5. On arrival at the designated capture site, extraneous gear such as daypacks should be piled together or hung in nearby trees, using reflector tape to mark their location. In unfamiliar terrain, one person should remain with the gear if a chase ensues, to ensure that everyone can find their way back to their gear afterwards.
6. It is not necessary to work in a large group, but each group must be led by an accredited kiwi catcher, and the minimum team size is two people for health and safety reasons.
7. The experienced kiwi catcher should be located near the centre of the catching area with the playback device.
8. The other catchers should spread out in a circle at a radius of c. 20–30 m (closer in denser vegetation) or around the edge of the clearing. If there are few assistants, ensure that at least one is positioned uphill from the catching area because kiwi tend to run uphill when they are chased.

9. Make sure that you have an unambiguous way of communicating without speaking or turning on torches; for instance, our preferred system is:
 1. A single brief whistle if a bird is heard approaching.
 2. A double whistle (mimicking a morepork call) to request that another call is played
 3. A three-note whistle to cancel a single whistle because the bird has moved away or the noise that was initially heard was not a kiwi.
 4. A four-note whistle to check whether it is time to abandon the site, with a single-whistle response being used to disagree.

It is also worthwhile agreeing on how to describe the area if a chase ensues, e.g. the direction of movement relative to a river, bridge or other landmark.

10. Once you are in a comfortable position (preferably leaning against a tree trunk or sitting on a fallen log in such a position that you can move quickly if a chase ensues) and have a picture in your mind of nearby obstacles, switch off all the lights.
11. Once everyone is set, play or imitate kiwi calls. Most playback sets are back-lit so there should be no need for any lights. Some people like to shine a red light; however, be aware that although some birds appear to ignore red light, others seem to detect it and become wary.
12. Do not play calls too often – about once every 15–20 minutes in low-density areas or once every 10–15 minutes in high-density areas – except when a bird has approached and only moves forwards each time a tape is played. If you have multiple recordings available, play the same male and female tracks rather than a mixture of calls, because you are pretending that an intruder has entered the territory.
13. Play calls in the following manner:
 1. To attract the attention of birds in the vicinity, play a male call because they carry furthest.
 2. If the target bird is a male or unpaired female, use mainly male calls. If the target bird is a paired female, use mainly female calls.
 3. If trying to catch either bird of a pair, play mainly female calls or the male call followed by the female to mimic a duet.
14. Try playing different calls so that birds do not become habituated to a single call played endlessly around an island or up and down a valley, especially if the birds have become wary of being caught from their previous encounters. Preferably record local kiwi calls and use them for playback on the same trip or on a following trip – birds often respond well to their own call being played; however, it is possible to catch kiwi using recordings of other kiwi species.
15. Once the recording has been played, be ready to catch a bird – it is surprising how often a bird responds or appears almost immediately. Remain as still and quiet as possible as, in a chase situation, it is essential that you communicate to others where the bird is and what direction it is heading:
 - Initially, listen for a patter of feet approaching or a twig broken underfoot – remember that at night, kiwi can pass within 5 m of you undetected. Resist the temptation to turn on your torch and rush at an approaching bird. The bird should go to where the call originated from, so let it pass by and into the catching circle, letting the person in the centre initiate the capture or chase.
 - If the bird is wary and skirts around the catching area it is sometimes best not to scare the bird by making a rush for it. Instead, the person in the centre can move away with the sound gear and try to draw the bird through the existing circle.
 - If the bird is just in or near the circle and not moving towards the centre, outlying people should try to catch it if it is close by – although usually the bird is a bit further way than

you think. Sometimes a red light or just a glimmer of white light shone through gaps between fingers on a closed hand can help to determine the exact position of the bird to see if it is catchable, but even this will upset some birds.

- Making slight scratching or 'kiwi footstep' movements in the leaf litter may attract birds to within catching range.
16. Generally, the experienced person in the centre of the circle should initiate the capture attempt. Once the first person has turned their lights fully on (not just scanning the area with red light or occluded white light, or checking playback settings and equipment), turn on all the main lights (spotlight and/or headlamp) and try to catch the bird. Take instructions from the leader or the closest experienced catcher to the bird, and obey calls for silence, because the sound of the kiwi running off is a helpful cue that will be masked by the sounds of people bashing through the bush.
 17. Be aware that most kiwi will attempt to run uphill when being chased and will also head for thick vegetation.
 18. Place a handnet over the bird and hold the net flat to the ground until the legs can be subdued and the bare parts held firmly from the outside; only then can the net be lifted to remove the bird.
 19. In thicker vegetation, or after the net has been abandoned, catch the bird by its legs, preferably by the bare parts below the 'knee'. **Never grab hold of a kiwi by its bill, and do not grab hold of a bird around the body** because kiwi have little muscular protection around the chest area.
 20. Once the bird has been removed from the net, tape its legs together, preferably using a 'spacer' (see Section 6.1 and Fig. 6.2) and return to the catching area.
 21. Be aware that pairs of birds or several family members will sometimes approach, and so it pays to leave one person holding the captured bird some distance away from the loudspeaker, and to repeat the luring and catching process.

5.2.3 Using dogs at night

Dogs have long been used to detect kiwi in their daytime shelters and in the last decade they have also been increasingly used to assist with the capture of kiwi at night. However, although the rewards can be great, there is a huge risk that poorly trained dogs may kill or injure kiwi. Therefore, only dogs that have been specifically certified to detect kiwi at night should be used (see Section 9). It is absolutely critical that the dog responds to commands correctly in any encounter situation. Pointers and setters are very much preferred at night because they indicate the presence of a kiwi nearby, and are much less likely to chase and touch a bird; however, retrievers and herding dogs can be used in some situations or on a lead. Dogs being worked at night **must not** touch or nudge a kiwi, recognising that kiwi will sometimes run into them.

When a team is working with a dog/handler team at night during a kiwi catching operation, the dog handler **must** be in command of the team at all times and all of the party **must** obey commands given by the dog handler. The presence of extra people can be distracting to both the dog and handler alike, and could potentially 'hype-up' the dog, and the noise of people can be a nuisance in a chase situation. A well-trained dog will indicate the presence of kiwi and will follow its scent. Some dogs can also potentially be trained to herd the bird back towards the handler, but they must not attempt to touch the bird at any stage by, for example, nudging it back towards the handler or holding it down.

YOU WILL NEED:

- Certified and muzzled kiwi dog
- Equipment as for hand capture at night (see Section 5.2.2)

METHOD:

1. Visit the site during the daytime to check for and mark hazards, as outlined for hand capture at night (see Section 5.2.2), paying extra attention to possible hazards off the planned route to the catching sites in recognition of the fact that the dogs may well indicate the presence of kiwi while walking to the sites.
2. When walking to or between catching sites, let the dog and handler walk 10–20 m ahead so that they can concentrate on detecting kiwi near the route. When they stop, everyone should stop and become quiet, unless asked to approach quietly.
3. It may be beneficial to have small lights on the dog so that you can track its movements through the vegetation and determine whether it is moving towards or away from you.

5.2.4 Netting

It is impossible to extract kiwi from some daytime shelters, even when they are known to be inside (e.g. from a hollow log, the hollow base of a tree or very deep burrows). In these situations, it is possible to set up a net that surrounds the entrance and then catch the bird by hand when it emerges. Netting **must not** be used to catch adult birds emerging from a nest, however, due to the risk of causing desertion.

YOU WILL NEED:

- 6–10 m of fishing net or mist net with a c. 60-mm knot-to-knot mesh size
- Stakes or tree trunks
- Rope
- Processing gear
- Torches (minimum of two sets plus spare bulbs and batteries per person)

METHOD:

1. Locate the burrow/hollow log/tree stump and mark it on your GPS.
2. Before dark, set up a c. 70-cm-tall net on a set of stakes or tied to nearby trees in a circle approximately 2–3 m from the burrow entrance.
3. Use pegs, branches or rocks to pin the net to the ground, making sure that there are no gaps.
4. If necessary, mark the route to and from the site with temporary reflectors (e.g. reflective clothes pegs attached to branchlets).
5. From around sunset, wait 2–5 m away (preferably behind, downwind and out of sight of the burrow entrance).
6. When the bird has fully emerged, move quickly but quietly to catch it by hand – the bird's instinct is usually to try to run off through the netting, but some do duck back in, so it is a good idea to temporarily block the entrance before trying to catch the bird by the bare part of its legs.
7. Remove the temporary blockage at the burrow entrance because there may be a second bird present.

8. Process the captured bird and release it outside the netting.
9. Catch and process the second bird, if present.
10. Remove the net before you leave the site.

5.2.5 Temporary radio-tracking of another kiwi

The aim of many studies is to radio-tag male kiwi so that nests can be located and their fate determined, chicks can be radio-tagged, or eggs or chicks can be collected for ONE. However, when searching for kiwi, a female (or in species that live in family groups, a subadult) will often be found in a daytime shelter or caught at night. In this situation, a transmitter can be temporarily attached to the bird so that it can be followed until it shares a daytime shelter with the male, or until the male is caught in a shelter that has been used previously or well inside the territory – kiwi territories usually do not overlap, and the boundaries often follow natural features such as streams, spurs or ridges; however, there is occasionally a little overlap along ill-defined edges of territories.

The same principle applies when continuing to radio-track wild-hatched or ONE-released subadult kiwi in the expectation that they will eventually pair up with a wild adult kiwi and start to breed. This method not only provides information on age at first breeding and dispersal, but may also be a more cost-effective way of catching and marking wild birds than carrying out specific catching trips.

YOU WILL NEED:

- Map of the area
- GPS
- Transmitter

METHOD:

1. Catch female or subadult kiwi using one of the capture methods outlined above. (Note: be aware that female kiwi can be gravid at any time of the year.)
2. For adult females, attach a radio-transmitter using baby band (see Section 6.4) without any electrical tape, so the transmitter can fall off naturally after c. 6–8 weeks if the male is not found, so she does not need to be handled during the breeding season.
3. For subadults, attach a radio-transmitter in the usual way (see Section 6.4), and check and replace transmitter/attachments according to the schedule.
4. Check the radio-tagged bird to locate daytime shelters and mark these each day. Non-breeding kiwi, or subadults of species with family groups, will usually spend 10–40% of days together; they are found together more often if they are using burrows and less often if using surface shelters.
5. Check daytime shelters used previously (see Section 5.2.1). It is very unusual for any kiwi apart from a partner (or other territory resident) to use the same daytime shelter within days or weeks of previous use.
6. Once the territorial male has been caught and radio-tagged, remove the temporary transmitter from the female or subadult.

6. Handling, measuring and marking techniques

You must not handle kiwi without proper training and permits.

Kiwi require special care when being handled as they have no sternum, weak pectoral muscles and ribcage, and a long thin and sensitive bill, and so are easily injured. They also have a propensity to shed feathers (presumably as a defence mechanism from avian predators, similar to lizards dropping their tail). Furthermore, kiwi are able to seriously injure handlers with their very sharp claws. Therefore, you must have been properly trained by an accredited trainer before handling them.

6.1 How to hold a kiwi

Special care **must** be exercised when holding kiwi, for the safety of both the bird and the handler. In the field, it will sometimes be necessary for an inexperienced person to hold a bird while the experienced handler is busy. When handling kiwi for the first time, you **must** be shown how to hold the bird properly and be confident of doing so without dropping it if it wriggles. At advocacy visits, media events and public releases of kiwi, birds **must** be held correctly by only accredited handlers (see Section 2.2) or by **only one** other person under the direct supervision of an accredited handling trainer (see Section 13). There are too many photographs on the internet, in newspapers and on television of kiwi being held incorrectly in ways that are dangerous not only to the kiwi, but also to the handler. Fig. 6.1 illustrates the correct way to hold birds.

Accreditation

To become an accredited handler, you **must**:

- Have been shown by an accredited trainer how to correctly hold kiwi and be aware that members of the public are not to touch the head or bill of the bird.
- Have held at least five different birds on your own in the presence of an accredited trainer, who will supply a letter of recommendation to the Kiwi Recovery Group..

To become an accredited handling trainer, you **must**:

- Provide evidence that you have handled >50 kiwi, including those handled under supervision during initial training.

YOU WILL NEED:

- Electrical tape
- Spacer (see below)
- Sturdy cloth bird bag with rope tie

METHOD:

1. You **must** hold a kiwi firmly by the **bare** part of its legs, with the body cradled loosely on top of your forearm (Fig. 6.1A) or, if you are sitting down, on your upper legs (Fig. 6.1B). A firm grip around both legs is needed to prevent a bird from lashing out with one leg and twisting around, which may damage the upper part of the leg being held or inflict serious



Figure 6.1. Kiwi being held correctly while (A) standing up (Photo: David Buckston) and (B) sitting down.

wounds on the handler. If a bird does get one leg free, allow the bird to rotate in your hand to prevent its upper leg from being twisted.

2. **Do not** hold the bird away from your body without support because if the bird struggles, there will be significant pressure placed on the 'knee' joints.
3. **Do not** hold the bird by the feathered portion of its legs because kiwi can easily drop their feathers as a 'shock-moult'.
4. **Never** hold a kiwi solely by the bill or around its body because both the bill and ribcage are delicate and so the bird could easily be injured, and unrestrained legs could inflict severe wounds to the bird or the handler, causing the handler to drop the bird or instinctively grip it even tighter.
2. Once you have both legs in your hands, bind them together with several wraps of electrical tape around the tarsus.



Figure 6.2. A. Closed-cell foam spacer ('Kiwi Kuff') used to keep the legs of the kiwi at a natural angle while being processed; the different sizes (from left to right) are for chicks, subadults and adults. B. Closed-cell foam spacer being used to keep the taped legs of the kiwi at a natural angle while being processed. (Photos: Tongariro Kiwi Team)

3. It is a good idea to place the legs into a spacer ('Kiwi Kuff'), which is a block of high-density closed-cell foam with concave sides, to keep them at a more natural angle and some distance apart (see Fig. 6.2).
4. It is not usually necessary to cover the head of the bird while it is being handled; however, this may reduce stress and struggling. If you are holding a bird for an extended period (e.g. while extracting or processing its partner), it should be placed in a bird bag, with its feet remaining firmly bound to prevent it from struggling and potentially harming itself. Hang the bag from a low branch in the shade and periodically open it on a hot day to allow fresh air in.
5. Bird bags should be used only once before being stored in a sealed plastic bag.
6. To prevent cross-contamination of diseases or parasites, used bird bags **must** be washed in a solution of Virkon or SteriGENE® and then rinsed well.

6.2 How to measure kiwi

Morphological measurements are useful for sexing adult birds (bill length), determining age (weight and condition), deciding which band size to use (tarsus width and depth) and obtaining information on the general condition of the bird (weight and condition). There are very few reliable and useful measurements that can be taken from a kiwi. In decreasing order of importance these are: bill length, weight, condition, tarsus width, tarsus depth and tarsus length. Some people also measure total length and mid-toe length.

As a minimum, you **must** record the bill length and weight of the bird at first capture, and assess its body condition. You should also repeat these three measurements each time the bird is handled. Tarsus measurements should be taken at the time of banding a bird.

When taking measurements, the most important considerations are the accuracy and repeatability of the measurements by different observers or through time. Comparisons both within and between populations (e.g. for taxonomic research or for studies on growth rates) will only be valid if the kiwi are measured in a standardised way. Table 6.1 shows the normal variation found between measurements of kiwi taken by the same person and between different people, demonstrating that tarsus depth and length are much less reliable than tarsus width and bill length.

Table 6.1. Variation in measurements by the same person and between different people when measuring kiwi.

MEASUREMENT	WITHIN OBSERVER	BETWEEN OBSERVERS
Bill length	<1%, often <0.3%	<1.5%, often <0.5%
Tarsus width	<2%	<2%
Tarsus depth	2–5%	2–5%
Tarsus length	2–4%	3–8%

Accreditation

To become accredited to measure kiwi, you **must**:

- Have been shown by an accredited trainer how to take each of the measurements.
- Have measured at least five birds on your own in the presence of an accredited trainer, who will then supply a letter of recommendation to the Kiwi Recovery Group.

To become an accredited kiwi measuring trainer, you **must**:

- Provide evidence that you have measured > 50 kiwi, including those measured under supervision during initial training.

YOU WILL NEED:

- 150/180 mm Vernier callipers
- Pesola spring balances (5 kg, 3 kg, 1 kg and 500 g are the most commonly used sizes)
- Electrical tape
- Medi-wipes (70% Isopropyl alcohol)
- SteriGENE®

Kiwi should be measured only by accredited handlers that have been trained in this area.

METHOD:

1. Make sure that you know how to read Vernier callipers properly before heading into the field because they differ between brands. Electronic callipers (obtainable from engineering or automotive trade shops) are the easiest to read, but are expensive.
2. All measurements described below can be taken by an individual handler; however, it is preferable to get an assistant to hold the bird, as described in section 6.1.
3. Take the measurements one at a time in a strict order to ensure that all measurements are obtained. Pay close attention to always taking the measurements in the same way. If you obtain an unusual measurement (e.g. much shorter or heavier than usual), take the measurement again and note the authenticity of the record in your notes on the bird. Always try to minimise the handling time.

6.2.1 Bill length

1. Measure the chord (straight distance rather than around the curve) of the bill to the nearest 0.1 mm using Vernier callipers (see Fig. 6.3). Be aware that kiwi will often struggle when their bill is first touched, so make sure that you are initially holding it securely near the base to prevent the bill from being damaged by the sharp edges of the callipers.

Place one flat face of the broad end of the callipers (not the sharp pointers) at the tip of the bill and open the callipers smoothly until the other face is at the apex of the curve in the

cere (hard fleshy covering at the base of the upper mandible) on top of the bill. Make sure the callipers are parallel with the bill.



Figure 6.3 Measuring the bill length of a kiwi.

2. If the base of the bill is covered with dried mud, this is best removed so that the bill/cere junction can be seen clearly. At night, shine your torch towards the bird's face to remove any shadow from the raised cere.
3. In rare cases where the bill length exceeds 150 mm, mark the bill with a pencil at the 150 mm mark, measure the rest of the bill, and then add the values together.

6.2.2 Tarsus width and depth

1. Measure the minimum width and depth of the tarsometatarsus to the nearest 0.1 mm using Vernier callipers (Fig. 6.4A & B).
2. Close the flat faces of the callipers vertically against the leg until they are tight.
3. Then close the flat faces of the callipers horizontally against the leg until some resistance is felt.
4. Note that kiwi chicks in the nest initially have swollen fleshy legs, so close the callipers gently until some resistance is felt.

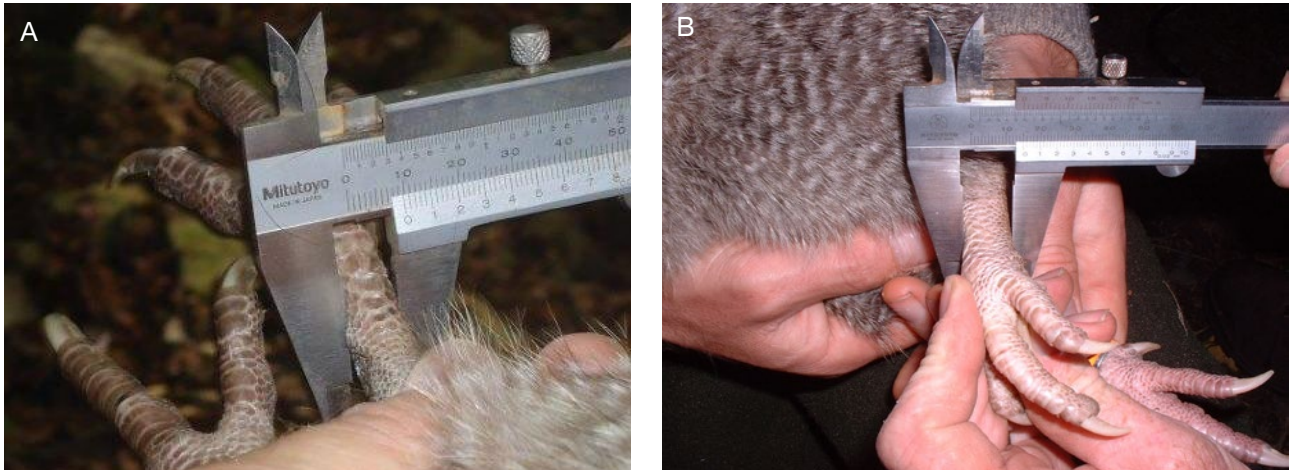


Figure 6.4 Measuring the tarsus width (A) and tarsus depth (B).

6.2.3 Tarsus length

1. Measure the length of the tarsometatarsus to the nearest 0.1 mm using Vernier callipers (Fig. 6.5).
2. Bend the leg at right angles and bend the toes down at right angles.
3. Place one end of the callipers in the notch between the inner toe and the middle toe, and the other end on the end of the bone underneath the 'knee' joint (where the tarsometatarsus joins the tibiotarsus bone). This latter point is not right at the back of the bent 'knee' but at a lump located on the lower outer part of the joint.
4. Note that this measurement is difficult to take on kiwi compared with many species of birds, because the joint is ill-defined, but it allows the best comparisons with measurements of skeletal measurements from subfossil and recent material.



Figure 6.5 Measuring the tarsus length of a kiwi.

6.2.4 Condition

This is a subjective measure that, in combination with weight measurements, can provide useful information on the condition of the bird and can sometimes be used to identify kiwi as being juveniles rather than light males. The condition of kiwi is scored by feeling the amount of fat covering the ribcage and the backbone. It is usually easiest to do this quickly when the bird is being held briefly upside down, because both the ribs and the backbone are then easily accessible. It is generally best to assess condition before you weigh the bird to make it a more independent judgement.

1. Very gently feel the lower abdomen of female kiwi with your fingers evenly from both sides, to see whether an egg can be felt, in which case the bird is described as 'gravid'.
2. If the ribs are like a washerboard and the backbone can be clearly felt, the bird is in 'poor' condition.
3. If the ribs or backbone, but not both, can be felt, the bird is in 'moderate' condition.
4. If neither the ribs nor the backbone can be felt, the bird is in 'good' condition.
5. There are a variety of intermediate conditions between 'poor' and 'good', such as 'moderate-good' where the ribs or backbone can just be felt.
6. Some birds have exceptional fat deposits and can be described as 'very good', 'excellent' or 'obese' to reflect that.

6.2.5 Weight

1. Bind the bare part of the legs together with electrical tape, preferably with a spacer to keep the legs in a more natural position (see Section 6.2).
2. Hang adult and subadult birds briefly upside down from a Pesola balance that is hooked through the tape holding the legs together or through a cord loop around the bare part of the legs, ensuring that the end of the balance hook is facing away from the legs (Fig. 6.6). For small chicks being weighed with a 500-g balance with a crocodile clip, a small tab can be incorporated into the tape around the legs and the clip can be attached to that.
3. Alternatively, weigh the kiwi in a sturdy and clean cloth bird bag
4. Weigh adults and subadults to the nearest 10–20 g, depending on the length of the balance you are using; and weigh chicks and small juveniles (< 1 kg) to the nearest 5–10 g.



Figure 6.6. Measuring the weight of a kiwi.

5. Ensure that the Pesola spring balance is set to zero before you weigh the bird and, if necessary, tare the balance.
6. Ensure that the scale is moving freely and that the balance is held vertically – otherwise the scale can catch on the barrel of the balance and give a false reading. Kiwi will often jiggle when being weighed, so it may take some time before the bird relaxes and the scale settles at a particular point.
7. Lift the balance to eye-level to read the scale.
8. Remember to subtract the weight of the transmitter, harness and band (and, if necessary, the cloth bird bag) from the total weight and ensure that this is made clear in your records, e.g. $2670\text{ g} - 30\text{ g} = 2640\text{ g}$.
9. It is worth checking the accuracy of your balances approximately every 6 months by weighing a variety of water volumes within the typical weight range of the birds you are measuring (1 litre = 1 kg), because the springs can gradually relax – if this happens, replace your balance.

6.3 How to permanently mark kiwi

It is good scientific practice and a requirement of handling kiwi that all individuals that have been handled **must** be marked in some permanent way that allows them to be individually identified on future occasions, maybe several decades later. There are many examples of new studies that have benefitted considerably from the presence of birds that were marked during a previous study, because these birds have a known history of territory occupancy and are of a minimum- or exactly-known age.

6.3.1 Banding

You must not band a kiwi without proper training and permits.

The Banding Office, Biodiversity Group, DOC controls all marking of birds in New Zealand. All banding of kiwi by DOC staff is done under a permit (issued under the Wildlife Act 1953) held by Hugh Robertson of Biodiversity Group in National Office on behalf of the Kiwi Recovery Group. Some non-departmental people also band under this permit, by arrangement. All bands used under this permit must be obtained from the permit holder rather than directly from the Banding Office.

All banding schedules (banding records and recovery sheets), for kiwi banded under the Kiwi Recovery Group permit for the year ending 31 March, **must** be sent to Hugh Robertson by the end of April each year.

People who hold their own banding permit should liaise directly with the Banding Office for bands and banding schedules, and by 30 April each year **must** send in their records for the year ending 31 March.

Individually numbered metal bands provide an excellent way of identifying individuals many years later. Some kiwi have now worn bands for over 30 years, and although the bands have gradually worn from both the inside and outside, the lettering is still clearly legible and no damage to the legs has been noticed, despite the lower edges of the bands becoming sharpened through continual friction with the legs. For short-term studies, the addition of layers of different combinations of coloured reflective tape allows individuals to be identified at night and in deep burrows, without the need to catch and handle the birds. Bands can also be seen clearly on trail cameras; however, individual combinations and colours are not discernible under the infra-red light they use.

A drawback of bands is the potential for them to become entangled in thick vegetation or in rootlets in burrows. Therefore, since the stainless steel that is used in bands has high tensile strength, as much of the natural 'spring' in the metal as possible must be removed when you fit the band to prevent it from gradually opening over time, which will increase the risk that it will become entangled in vegetation or even fall off. Note, however, that up to 2016, from thousands of accumulated years of radio-tracking records, there was only one record of a band becoming entangled (in mangemange, *Lygodium articulatum*) and causing the death of a kiwi, no records of leg injuries from band wear, and only very rare instances of band loss in radio-tagged birds.

An issue arose in the late 1990s and early 2000s with a batch of R and RA bands that were 'springier' (and had a duller lustre) than usual, so that no matter who fitted them, they had a tendency to open up and potentially fall off or get entangled. Once this problem was identified, the Banding Office sourced thicker bands that were less springy, but these have proven to be slightly harder to fit because of the thicker metal and extra strength needed to close them.

Therefore, with the exception of most little spotted kiwi that take O bands, **kiwi must be banded with band numbers above R 62000 or above RA 2800. All bands in the series R 35000 to R 61999, or RA 0600 to RA 1199 must be replaced with a new thicker band from the recommended series** if the opportunity arises.

The other drawback of bands is that they cannot be safely fitted to chicks or unsexed subadult kiwi of species in which the adults wear different band sizes. This is because there is a risk that once the bird has reached adult size, the band will either be too loose and slip down over the hind claw and onto the toes, or too tight and damage the leg.

Accreditation

To obtain accreditation for banding kiwi, you **must**:

- Have been shown by an accredited trainer how to correctly attach bands to kiwi. If you have been trained to attach O bands (used on little spotted kiwi), you will require further training on attaching R and RA bands (used on the other four species); however, if you have been trained to attach R and RA bands, no extra training is required to attach O bands.
- You **must** have correctly attached five bands to at least three different kiwi* in the presence of an accredited trainer, who will then supply a letter of recommendation to the Kiwi Recovery Group.

Note: If you are accredited, but have not banded a kiwi for 5 years, you **will need** to have refresher training under the supervision of an accredited trainer, banding one bird for every 5 years elapsed.

To become an accredited banding trainer you **must**:

- Provide evidence that you have banded over 20 kiwi with R or RA bands, including those banded under supervision during your initial training.

* Because opportunities to band kiwi are limited, it is permissible to band the same bird several times (and then remove the band with circlip pliers and destroy the band, noting this on the banding schedules), though be careful not to hold the bird for so long that it becomes unduly stressed.

YOU WILL NEED:

- Metal bands
- Coloured reflective tape (as used on highway signage)
- Banding pliers for large bands (O, R and RA) or adjustable slip-joint pliers
- Circlip pliers or wire/cord loops
- Banding schedules

METHOD:

1. Although a person can band kiwi alone, it is preferable to have another person hold the bird while it is being banded.
2. Hold the bird as outlined in Section 6.1, with the bare parts of the legs being held in such a way that one tarsometatarsus is clearly accessible.
3. After measuring the tarsus width and depth, choose the appropriate band size for the bird (see Table 6.2).
4. Place the open band evenly in the banding pliers. (Note: RA bands do not quite fit standard large banding pliers, and so need to be partially closed by hand or in a vice beforehand.)
5. Place the open band in the pliers around the unfeathered tarsometatarsus. It is a convention for male kiwi to be banded on the right leg and female kiwi to be banded on the left leg because this doubles the number of colour combinations available and allows

the gender of the birds to be readily determined at night, in burrows and on camera traps without needing to see the entire bird.

6. Once the band is around the bird's leg, close it gently until the opposite ends of the band touch or nearly touch one another, making sure that the ends stay clear of the leg.
7. Turn the band 90° and again squeeze the pliers gently to butt the ends together at one side of the pliers (at 90° to the ends of the pliers), and then squeeze firmly to make the band a more rounded shape and to remove some of the metal tension.
8. The ends of the band will spring apart when pressure is removed. Adjust the position of the banding pliers so that the nose of the pliers is c. 5 mm back from one end of the band and then press gently so that the end underlaps the other. Following this, gently squeeze so that it underlaps by c. 5 mm (O bands) or 5–10 mm (R and RA bands).
9. The ends of the band will once again spring back when pressure is removed. If the ends of the band remain overlapped, open the band with circlip pliers until there is a 5 mm gap and underlap again, adjusting the position of the banding pliers so that the nose of the pliers is about 5 mm back from the opposite end of the band from that in step 8. Keep applying pressure to underlap alternate ends of the band until the band springs back with both ends neatly butted together.
10. When the ends look to be neatly butted together, turn the pliers so that the butt is at the side (90° to the overall line of the pliers) and squeeze firmly.
11. The neat butt end will often spring apart, which indicates that the metal tension has not yet been sufficiently removed, in which case repeat underlapping both ends in turn until the band stays neatly butted with firm pressure from side on (step 10).
12. Check that the band moves freely up and down the tarsometatarsus, and rotates freely.
13. Apply reflective tape as required.
14. At subsequent captures, check whether the band has opened due to relaxation of the remaining metal tension, and close or replace as necessary. With ongoing gradual band-wear, it is probably a good idea to replace bands every 15–25 years, depending on the habitat and rate of wear, so that they remain legible to future workers and do not wear too thin.
15. Record details of the age and sex of the bird, its location, and its bander on the Banding Schedules, and send the schedules for the year ending 31 March to the Kiwi Recovery Group permit holder by 30 April each year.

BAND SIZE

Three sizes of metal band are used on kiwi, depending on the species and sex of the bird (Table 6.2). The choice of size should be such that when the band is completely closed, it will move freely up, down and around the leg, with no danger of it passing over the hind claw and constricting the toes. Although the feet of subadult kiwi reach full adult size ahead of the bill and weight, young birds that have not been sexed may not be able to be banded because the band may be either too loose or eventually become too tight as the bird grows – although in the very rare cases where an assumed adult has grown after being banded, the spring in the steel appears to have allowed the leg to grow because no cases of bands cutting into legs has been reported in radio-tagged birds; partially opened R bands have occasionally been found, however, and replaced with a better-fitting RA band.

If you are in any doubt about whether a bird is fully grown and think that the band size might be too small in the future, use a different marking method (e.g. wing tag or transponder) and band it on a later occasion once it has been determined that the bird has stopped growing. In practice, birds that are breeding or have bred almost invariably have fully-grown legs, even though their bill and weight may still increase for some time.

Table 6.2. Criteria for choosing the appropriate band size for kiwi.

BAND	KIWI TAXON	SEX	TARSUS WIDTH (mm)	TARSUS DEPTH (mm)	EXCEPTIONS
O	Little spotted kiwi	M/F	≤ 11.0	≤ 16.5	A few large females may take R bands
R	Brown kiwi (Northland)	M	11.0–13.5	15.0–17.5	A few birds with larger tarsus measurements take RA bands
	Brown kiwi (elsewhere)	M/F			
	Rowi	M/F			
	Great spotted kiwi	M			
RA	Haast tokoeka	M	≥ 11.5	≥ 17.5	A few adult birds with smaller tarsus measurements take R bands
	Brown kiwi (Northland)	F			
	Great spotted kiwi	F			
	Haast tokoeka	F			
	Fiordland tokoeka	M/F			
	Rakiura tokoeka	M/F			

COLOUR MARKING

Colour marking allows individuals to be recognised at night or when they are in daytime shelters without the need to catch and handle them. This is best done by applying reflective tape to the metal band. Colours can be distinguished even if just a small amount of tape remains, and so if applied to a clean, dry band, two rounds of reflective tape will usually last 5–10 years, depending on the habitat and hence rate of abrasion. If the band is dirty or feels greasy, wipe it with a Medi-wipe and allow it to dry first.

Blue and green reflective tape should be about twice the width of white, yellow, red or orange in colour combinations, because these colours do not show up as well at night. Use a maximum of two colours per band, but the same colour can be used at the top and bottom with a different central colour to increase the number of combinations.

6.3.2 Wing tags

You must not insert a wing tag in a kiwi without proper training and permits.

Fish fingerling tags are tiny alphanumeric tags which have been designed to mark the fins of young fish. They can be used to mark kiwi by clipping them through the carpal patagium on a wing – a bare triangle of elastic skin that carries few blood vessels at the front edge of the wing at the carpal joint (elbow, or the bend in the wing). Each tag bears a unique combination of letters and numbers, which can be read in good light or with help of a magnifying glass (or inverted binoculars).

To reduce the likelihood that the insertion site will become infected or calloused, it is necessary to swab the area before inserting the tag. The long-term usefulness of wing tags in kiwi is not yet well understood, but tags have remained in situ and perfectly legible at least 5 years after insertion.

Accreditation

To become accredited for wing-tagging kiwi, you **must**:

- Have been shown by an accredited trainer how to correctly attach wing tags to kiwi.
- Have correctly attached five wing tags to kiwi* in the presence of an accredited trainer, who will then supply a letter of recommendation to the Kiwi Recovery Group.

Note: If you are accredited but have not wing-tagged a kiwi for 5 years, you **must** have refresher training under the supervision of an accredited trainer, wing-tagging one bird.

To become an accredited wing-tagging trainer you **must**:

- Provide evidence that you have wing-tagged over 5 kiwi, including those wing-tagged under supervision during your initial training.

* Since opportunities to wing-tag kiwi are limited, it is permissible to wing-tag a bird in both wings and record both of the numbers in the Banding Scheme.

YOU WILL NEED:

- Fish fingerling tags
- Special banding pliers for attaching fish fingerling tags
- Medi-wipes (70% isopropyl alcohol)
- Banding schedules

METHOD:

1. Although a person can wing-tag a kiwi on their own, it is preferable to have another person hold the bird while it is being tagged.
2. Hold the bird as outlined in section 6.1 and pull one of the wings out from the body.
3. Swab the wing and your fingers with a Medi-wipe.
4. Place the wing tag in the special pliers, with the small hole in one end of the wing tag placed over the notch cut into the pliers.
5. Position the wing tag around the bare carpal patagium (not the propatagium, which runs between the carpal joint and the body on the leading edge of the wing) so that there is a 2-3-mm gap between the edge of the skin and the bend of the wing tag.
6. Close the pliers slowly but firmly until the tag is closed.
7. Record details of the age and sex of the bird, its location, and who inserted the tag on the Banding Schedules, and send the schedules for the year ending 31 March to permit holder for the Kiwi Recovery Group by 30 April each year.

6.3.3 Transponders

You must not insert a transponder into a kiwi without proper training and permits.

A transponder is a tiny microchip embedded in sterile and inert glass that is implanted under the skin on the flank of a kiwi with a special syringe. The transponder theoretically remains in place and is responsive for life. Each transponder is programmed with a unique alphanumerical code that can be read by passing a special pocket calculator-sized radio frequency reader within 3 cm of it.

Although the technology is generally very reliable and represents an excellent method for permanently marking juvenile kiwi from shortly after hatching, there are several potential problems with transponders. Infection can occur at the point of insertion, although this can be minimised by sterilising the area before the transponder is inserted. In addition, some

transponders have been known to have either fallen out (presumably through the syringe hole where they were inserted), migrated beyond the range of the reader or somehow failed. Furthermore, at least two kiwi have died during the insertion process despite no major blood vessels being punctured, presumably as a result of shock or stress; and one bird died after forming a callus around the transponder, which blocked a major blood vessel that subsequently burst.

Several brands of transponders and readers are available in New Zealand, with the two most widely used being Trovan and Allflex. When purchasing a reader, ensure that it can be programmed to read both main types of transponder rather than just the one you have chosen to use in your study.

Accreditation

To become accredited for inserting transponders, you **must**:

- Have been shown by an accredited trainer how to correctly insert transponders into kiwi.
- Have correctly injected five transponders into kiwi in the presence of an accredited trainer, who will then supply a letter of recommendation to the Kiwi Recovery Group.

Note: If you are accredited but have not inserted transponders into a kiwi for over 5 years, you **must** have refresher training under the supervision of an accredited trainer, inserting a transponder into one bird for every 5 years elapsed.

To become an accredited wing-tagging trainer you **must**:

- Provide evidence that you have inserted transponders into >10 kiwi, including those inserted under supervision during your initial training.

YOU WILL NEED:

- Transponders (Trovan or Allflex)
- Transponder reader
- Transponder injector
- Medi-wipes (70% isopropyl alcohol)
- Surgical gloves
- Banding schedules

METHOD:

1. Although a person can insert transponders into kiwi on their own, it is preferable to have another person hold the bird while it is being marked.
2. When working in or near a population in which birds have already had transponders inserted, you should first check that the bird does not already have a transponder – it is surprising how many birds have had two transponders inserted, although in radio-tagged birds, one transponder may have failed or fallen out.
3. Make sure that the transponder scanner is reading the code inside the transponder needle before you open the sterile envelope.
4. Note the complete code in your notebook or onto your datasheet.
5. Hold the bird as outlined in section 6.1, and pull one of the wings out from the body.
6. Swab the skin over the ribcage behind and below the base of the wing with a Medi-wipe – this will both sterilise the surface and wet the feathers, which will make it easier to see where the transponder needle is going.

7. Pinch the skin about 1.5 cm behind the wing and insert the needle into the raised flap of skin (Fig. 6.7) with its bevelled side upwards, **aiming downwards** (from the horizontal of the upright bird), **away from the axillary blood vessels and nerves near the base of the wing**, and parallel with the outer surface of the ribcage, not into it.
8. Be careful that the needle does not come out through the skin on the opposite side of the pinched skin.
9. Push the trigger or plunger of the syringe gently but steadily to the end and then remove the needle while pushing on the skin around it.
10. Dispose of the needle into a safe container and ultimately into a sharps container.
11. Wearing a surgical glove, place a finger over the insertion hole and massage the skin gently to close off the passage caused by the needle so that the transponder does not pop back out the way it went in.
12. Check that the transponder can be read in the bird before you release it by running the reader slowly down the feather surface on the sides of the bird.

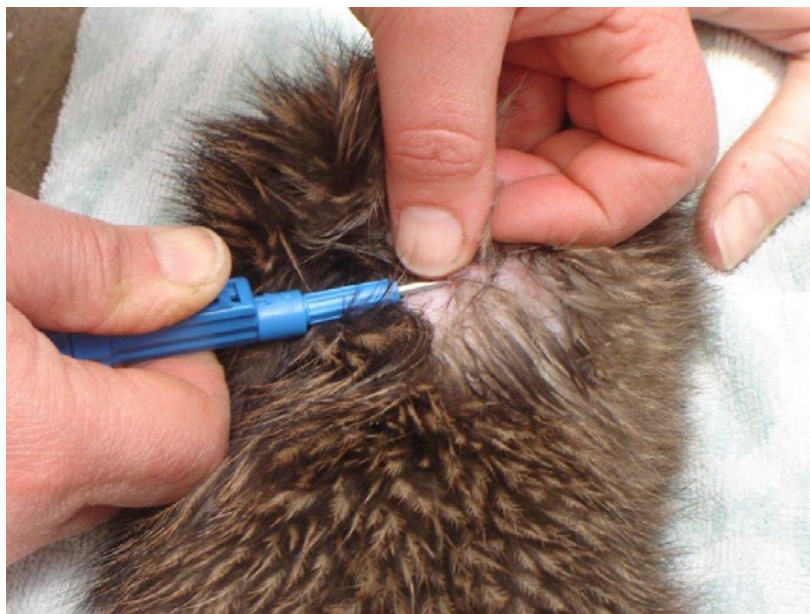


Figure 6.7. Correct insertion of a transponder. Photo: Claire Travers.

6.4 How to attach transmitters

Transmitters are electronic devices that emit radio waves at particular intervals (pulses) within a given frequency. Their use has revolutionised the study and monitoring of kiwi, providing us with information about the whereabouts, survival/mortality and breeding status of these secretive birds. However, like any other device we use on wild animals, transmitters need to be used with care to prevent changes in behaviour, energetic costs and the accidental injury or death of the study animal⁶. Also, since transmitters occasionally fail or fall off, they **must not** be used as a surrogate for permanently marking kiwi – rather, always use in combination with one of the three permanent methods (bands, wing tags or transponders; see Section 6.3).

⁶ Be aware that transmitters can become entangled in thick vegetation, particularly mangemange (*Lygodium articulatum*) and *Muehlenbeckia* spp., however, several kiwi carrying transmitters having been rescued from holes, and treated for injuries and illnesses that would probably have proven fatal without timely discovery. Although you cannot completely prevent entanglement accidents, you can greatly reduce the odds by carefully following carefully these guidelines.

In New Zealand, wildlife transmitters (which are designated as ‘restricted radiation devices’) **must** operate in a 0.47 MHz frequency range between 160.12 and 160.59 MHz for general use. Transmitters that are specially designed to be used on kiwi have been developed in New Zealand by Sirtrack Ltd and Kiwitrack Ltd. You can also buy transmitters from international companies, but **must ensure** that these comply with New Zealand radio frequency regulations. Legal transmitters are picked up on the standard tuning of a Telonics TR4 receiver labelled as channels 0 through 47, which correspond to wavelengths of 160.12 MHz through 160.59 MHz. (Note: Channels 48 to 99 can be used in exceptional circumstance under a special license). Other receivers, such as the Communications Specialist R1000 and the Biotrack Sika, can be programmed to show both the frequency and standard transmitter channel.

Avoid using the lowest ten channels (160.12 to 160.22 MHz) in study sites near urban centres due to significant electrical interference. It is acceptable to use transmitters operating on adjacent channels if the birds are distant from one another, but if less than 20 study birds are present at the site, you should aim for even or odd numbered channels to prevent the frequencies from being too close together.

Transmitters come with either an external whip aerial or an internal aerial built into the loop that the harness passes through. External aerials have the disadvantage that with movement, they sometimes break at the joint with the transmitter housing, resulting in their broadcast range suddenly dropping markedly. Internal aerials are available only in the larger transmitter packages (11+ g) and so are not suitable for chicks <400 g. **Ensure** that the internal height of the ‘gate’ between the transmitter body and the loop containing the aerial is no more than 5 mm deep for all but adult transmitters, where up to 8 mm is acceptable. This will mean that the transmitter will sit close to the leg and be less likely to become entangled, and it will also reduce the wear and tear on the transmitter harness.

6.4.1 Choosing a transmitter

Transmitters add weight to the bird, which may increase their predation risk and interfere with breeding, and may also become entangled in vegetation. Therefore, the transmitter and attachment **must** weigh <3% of the body weight for short-term use (e.g. chicks) and <2% for long-term use (e.g. subadults or adults), and preferably be placed on the opposite leg from any band that has been fitted.

Transmitters have been developed for kiwi that take into account the weight of the bird (Table 6.3).

In addition to determining the optimal weight of the transmitter, you will also need to decide whether you will use a single-stage or double-stage transmitter. Single-stage transmitters do not have the same range as double-stage transmitters), but they are smaller and lighter than double-stage transmitters, and so are used on kiwi chicks. In addition, they can come with temperature sensors that are sensitive to 0.1°C, which can be used to detect various things including mortality. However, they cannot be programmed with normal time-since-death, egg-timer, chick-timer or duty-cycle functions.

Table 6.3. Guide to the selection of kiwi transmitters.

TRANSMITTER TYPE	WEIGHT OF BIRD	TRANSMITTER SPECIFICATIONS*				
		WEIGHT (g) [†]	AERIAL	PULSES/MIN	RANGE (m) [‡]	LIFE (months)
Chick	<600 g	5.5	8 cm	30	50–1000	12.0
Juvenile	600–1200 g	10.0	10 cm	30	100–3000	3.0
Juvenile/ little spotted kiwi	600–1200 g	11.0	Internal	30	100–3000	6.5
Adult	>1200 g	22.0	internal	30	100–3000	20.0

* The maximum gate height is 5 mm for all but adult transmitters, where up to 8 mm is acceptable.

[†] Add 0.5 g for chick transmitter attachment, 2 g for juvenile/little spotted kiwi attachments and 3 g for adult attachment.

[‡] Minimum (non-line of sight) and maximum (across valley) expected range.

6.4.2 Turning transmitters on

Single-stage transmitters come with a magnet attached, which, when removed, switches the unit on, and a magnet is used to turn the unit off. It is important to ensure that magnets on different transmitters do not come into contact with one another, and especially that magnets on single-stage transmitters do not come into contact with double-stage transmitters and accidentally turn them on.

Double stage transmitters are switched on and off by briefly touching a magnet against the silver spot in the transmitter casing. The magnet is held over the silver spot until the signal starts or stops, as required. Double-stage transmitters can be stored together, but they should be kept well away from magnets until they are ready to be deployed.

6.4.3 Mortality transmitters and time-since-death function

Mortality and time-since-death functions can be added to two-stage transmitters at the time of construction at no extra cost. The mortality function works by changing the pulse rate of the transmitter (usually to double the normal rate so that the change in pulse rate is easily noticed) if a motion sensor (a mercury switch) inside the transmitter has not been activated for 24 hours, meaning that the bird has died, or the transmitter has fallen off and is lying on the ground.

The time-since-death function records the time that the transmitter has been in mortality mode. This information is given as a stream of pulse data every 10 minutes, with one protocol that 2 pulses are added to every number to make zeros clearly identifiable as 2 pulses rather than as no sound at all. Hours since mortality mode was triggered is always given as three digits, separated by short double beeps. For example, 139 hours since mortality mode was activated (= 163 hours, or 6 days and 19 hours since the transmitter last moved) would be heard as a double beep (“) followed by three normal pulses (2+1), then another double beep followed by five normal pulses (2+3), then a double beep followed by eleven normal pulses (2+9), ending with a double beep, before reverting to normal pulses for the next 10 minutes; 5 hours (= 29 hours since last movement) would appear as “2”2”7”, i.e. 2+0, 2+0 and 2+5). Theoretically, you could listen to each 10 minute stream of data until the hour shifts up one, which would provide accuracy regarding time of death to within 10 minutes. This time-since-death data is useful for calculations of survivorship, but especially useful in pinpointing time of death and hence possible causes of deaths – e.g. in Northland, a fencing contractor’s dog was known to have been in the area in the hour when a radio-tagged kiwi was calculated to have been killed.

6.4.4 Egg Timer™ and Chick Timer™ functions, and diagnostic transmitters

Wildtech NZ Ltd has adapted the motion sensor technology used in mortality transmitters to estimate when incubation has started (Egg Timer™) and optionally also when the egg(s) have hatched (Chick Timer™), and ‘diagnostic transmitters’ for use in species where both genders incubate. This technology relies on changes in the behaviour and daily schedule of a bird when it starts to incubate and once the chick has hatched (Taylor et al. 2014). The technology has been ‘truthed’ and refined for different species by comparing read-outs with known behaviour in the field.

The transmitter records the number of times the motion sensor is triggered in each 10-minute period throughout each day and designates each 10-minute block as being active or inactive. Every 10 minutes, the transmitter broadcasts a stream of data, which includes up to eight sets of 2 digit numbers noting:

- Days since incubation started (there is a lag of 5 days before switching to ‘incubation’ mode, to reduce the chances of false-alarms caused by temporary inactivity caused by bad weather or disturbance. Normally, a transmitter is programmed to transmit at 30 pulses/min when not incubating, but at 48 pulses/minute during incubation to make it clearer to the listener that breeding is under way).
- Days since a hatching event

- Days since nest abandonment (return to normal non-breeding activity)
- Hours since last emergence from the burrow (this can be used to predict when to collect eggs or chicks, or to catch the adult for a transmitter change).
- Number of weeks of battery life remaining
- Number of active 10-minute blocks the previous night
- Number of active 10-minute blocks two nights ago
- Average number of active 10-minute blocks in the past 4 nights

The 'diagnostic transmitters' for species with shared (dual) incubation record the number of minutes the bird was active for each of the previous 14 days as a means to develop specific 'Egg Timer' and/or 'Chick Timer' transmitters for that species, but in reality field operators can make assessments of incubation progress from the stream of data obtained.

Of these data collected, the start of incubation is possibly the hardest to detect because kiwi, especially those with 2-egg clutches, generally do not start proper incubation for 10–14 days after the first egg is laid. Also, hatching is sometimes difficult to detect in a 2-egg clutch because the adult continues to incubate the second egg after the first has hatched. Nevertheless, this Egg Timer™ and Chick Timer™ software has proven valuable in hugely reducing field time spent checking nests, and also reduces nest disturbance to just those times when crucial activities are required (egg or chick collection for ONE, or radio-tagging chicks).

6.4.5 Duty cycles

As a method of improving battery life, and hence saving replacement costs, 2-stage transmitters can be programmed to switch on and off at different times of the day. If all your work is done in daylight hours, there is no need for the transmitter to be transmitting pulses during the night. Depending on the type of transmitter, be aware of the need to tell the transmitter what time of day it is when it is first turned on or to switch it on at dawn, and wrap it in tinfoil until needed, otherwise the signal will interfere with other telemetry work.

6.4.6 Ensuring the best performance from transmitters

Two of the most difficult things to accept when working on kiwi in any environment are transmitter failures and transmitters falling off prematurely.

When you receive the transmitters, check that there are no bubbles in the epoxy resin coating them, which occurs when the drying process is too fast. If bubbles are present, they will become exposed when the epoxy coating wears, which may let water into the internal parts of the transmitter. Also, listen to each transmitter to ensure that the signal is clear and sharp – and then make sure that you turn it off. Any transmitter that does not turn on or has a fuzzy signal should be returned to the manufacturer. Finally, keep track of the age of the transmitters, as the older they are, the less battery life they will have because batteries have a fixed shelf life – if in doubt, consult with the transmitter manufacturer to obtain a new estimate of the transmitter's life.

Transmitters should be stored separately so that they cannot be turned on accidentally by a neighbouring magnet this is best done by cutting out appropriately shaped holes in foam rubber within a plastic lunchbox. You should periodically check all stored transmitters to ensure that none are switched on.

At 30 pulses per minute, an adult transmitter should last 20 months; however, its life will shorten if it is programmed to speed up during incubation or in mortality mode. Therefore, aim to change each adult transmitter at 12–14-month intervals outside the breeding season. Try to check the transmitter attachment after c. 6 months, e.g. while handling chicks in a nest, and replace the harness if necessary.

6.4.7 Attaching and monitoring transmitters

You must not attach a transmitter to a kiwi without proper training and permits.

The method for attaching transmitters to kiwi that was described by Miles & McLennan (1998) is current best practice. Research has been undertaken to attempt to devise new attachment methods that reduce the handling time and allow the transmitter to fall off if it becomes entangled in vegetation. However, until field trials have been completed and are deemed successful, this method of transmitter attachment **must** be used.

Accreditation

To become accredited for radio-tagging kiwi, you **must**:

- Have been shown by an accredited trainer how to correctly attach radio transmitters to kiwi.
- Have correctly attached five radio-transmitters to a minimum of three different kiwi* in the presence of an accredited trainer, who will then supply a letter of recommendation to the Kiwi Recovery Group

Note: If you are accredited but have not attached transmitters to a kiwi for over 5 years, you **must** have refresher training under the supervision of an accredited trainer, attaching one transmitter per 5 years elapsed.

To become an accredited trainer for attaching transmitters, you **must**:

- Provide evidence that you have attached over 30 transmitters to kiwi, including those attached under supervision during your initial training.

* Since opportunities to attach radio-transmitters are limited, it is permissible to attach, remove and re-attach transmitters to a single bird, although care should be taken not to unduly prolong the handling time.

YOU WILL NEED:

- Radio-transmitters
- Inert plastic hospital identification bands (baby bands)
- Insulation tape
- Scissors
- Radio receiver with spare batteries

METHOD:

1. Choose the transmitter you are going to use based on the weight of the bird you plan to put it on (Table 6.3. Make sure that any transmitter bought from overseas conforms to New Zealand regulations and the specifications for kiwi (weight, gate height, etc.).
2. Check the weight of a typical transmitter package (transmitter, baby band and electrical tape). **Make sure you do not** attach a transmitter package that weighs > 3% of body weight for short-term use (e.g. chicks), or > 2% for long-term use (subadults or adults).
3. Check on your records that no bird in the vicinity is on the same frequency as the transmitter you plan to use – at some sites, other animals may be radio-tagged and this may cause confusion.
4. Once you have caught your bird, turn the transmitter on and use a radio receiver to check the frequency and power of the signal.
5. Hold the bird as outlined in Section 6.1, and extend one of the legs.

6. Some people like to wrap Gladwrap or veterinary tape (e.g. Vetrap from 3M or Co-Flex from Andover Healthcare) around the leg to prevent the feathers from adhering to the electrical tape when the transmitter is being attached.
7. For kiwi chick and juvenile / little spotted kiwi transmitters, cut off the broadened section of the baby band and remove the two white locking domes and place the male end in the hole nearest the rounded end of the baby band. For subadults and adults, leave the whole baby band intact.
8. Pass the baby band through the loop (gate) in the transmitter, with the projecting part of the male dome facing outwards and the flat surface against the leg.
9. Place the transmitter on the bird's leg immediately **above** the 'knee' joint, with any aerial pointing upwards.
10. Close the baby band to the appropriate hole so that there is sufficient room to allow it to turn freely around the bird's leg, but not so freely that the package could be pulled down over the 'knee' joint.
11. Audibly click the domes together and test that they are connected.
12. Cut the baby band at the hole beyond the one you have used to close the band, and retain for helping to pass the insulation tape through the gate on the transmitter.
13. For kiwi chicks, add up to one and a half rounds of dark (black, blue, green) insulation tape (preferably the 'Nitto' brand, which has been proven to last well and not tighten on itself) on top of the baby band; do not pull tightly as you attach it because the whole package may become too tight. This insulation tape provides extra strength, but do not put any more tape on because if the transmitter fails, the transmitter package needs to be able to fall off before the leg becomes constricted. In open habitats, electrical tape is probably not even needed, but in dense vegetation the one and a half rounds may be needed to keep the transmitter on. When putting the insulation tape on, the most important things to remember are:
 - Make sure that the surfaces are dry and there are no feathers or grit between the layers.
 - To help pass the insulation tape through the gate in the transmitter, stick it to a cut off end of a baby band and ensure that the tape does not stick to itself by maintaining gentle pressure. Avoid using excessive pressure, however, because the whole package will become too tight on the leg.
14. For subadults (> 800 g) and adults, use the full-sized baby band and add rounds of insulation tape around the bracelet according to the age of the bird (Table 6.4). **Do not use any more rounds of electrical tape than is shown.**
15. **Make sure** that the transmitter attachment is not too tight, especially for subadult birds and adults in poor condition (e.g. males soon after they have finished nesting) because their legs will grow and the package may become tight.
 - Before releasing the bird, you must check that the transmitter moves freely but will not drop over the 'knee', and should check that the transmitter is actually working. Also, make sure that you have recorded the frequency of the new transmitter and that this gets updated in your databases.

Table 6.4. Instructions on transmitter attachment and monitoring.

	SIZE OF BIRD			
	<800 g	800–1200 g	Subadult >1200 g	Adult
Rounds of tape	1.5	2–3	4–6	6–8
Check attachment	Monthly	6-weekly	Quarterly	6–12-monthly*

* It is best to catch and check transmitter attachments on adult birds 6-monthly; however, breeding males may need to be checked annually so that nesting attempts are not disturbed.

- Check the attachments periodically (see Table 6.4), and replace the harness if it is worn or should be moved to the next hole to prevent the harness constricting the leg.

The same transmitter can be used on several birds in succession, e.g. if it is a growing chick or if you only wish to carry out short-term monitoring; however, you will need to wash the transmitter in SteriGENE® between birds and maintain a file to keep track of the elapsed time each transmitter has been deployed for.

6.5 How to determine the age of kiwi

Knowing the age of birds in a population is very important for long-term management because the age structure is an indicator of the population's health – there will be a good spread of ages in a stable population, an excess of young birds in a growing population and an excess of old birds in a declining population. Many factors affect the size and growth rate of kiwi, including the species, age, gender, location, climatic conditions, food availability, size of the egg they hatched from and health status.

Age estimates become increasingly inaccurate the older a bird becomes, mainly because the individual histories of wild birds are generally unknown. Although kiwi chicks hatch as miniature adults, they develop very slowly. In brown kiwi, bill and weight grow for up to 3.5 years in males and 5 years in females (Heather & Robertson 2015). Four categories should be used to report the age of kiwi: chick, juvenile, subadult and adult. However, the definitions of these categories vary slightly according to the life history of the taxon (see Table 6.5). For some taxa we still have little data on their growth rates and age at first breeding.

Table 6.5. Definitions of age categories in kiwi.

CHICK	JUVENILE	SUBADULT	ADULT
Brown kiwi, great spotted kiwi and Haast tokoeka			
0 to 10–50 days	10–50 days to 6 months	6 months to 4 years, or age at which they first breed	Over 4 years or whenever they start breeding
In nest continuously or returning each day	Independent from nest		
Rowi, Fiordland tokoeka and Rakiura tokoeka			
< 50 days	50 days to 6 months	6 months to 4 years, or age at which they first breed	Over 4 years or whenever they start breeding
In nest continuously or returning each day	In nest continuously or with parents most days		
Little spotted kiwi			
In nest continuously or returning each day	Independent from nest and <500 g	> 500 g, but < 1 kg when in 'moderate' or better condition	> 1000 g (male) or > 1100 g (female)*

* Some adult little spotted kiwi in 'poor' or 'moderate' condition (see Section 6.2.4) can weigh as little as 790 g.

6.5.1 How to determine the age of chicks

You can estimate the age of a chick by looking at it, weighing it, measuring it, or using Chick Timer transmitter records.

BY SIGHT

If the chick:

- Is still wet, it is < 1 day old.
- Retains an obvious internal yolk sac or pot belly, it is < 5 days old.
- Has been feeding (dried mud on the bill), it is > 5 days old.
- Is coming and going from the nest, it is > 5–7 days old.

BY WEIGHT

- The weight of a kiwi chick declines for the first 10–20 days, before increasing. Therefore, if the weight is declining, assume that the chick is < 15 days old.

BY BILL MEASUREMENTS

- Bill length is the most useful measure, because it increases almost linearly for the first 100 days (McLennan et al. 2004) regardless of the sex and weight of the bird, allowing you to calibrate the bill length of a chick/juvenile of unknown age against known-aged chicks in your study area. It is preferable to sex the chick/juvenile from its DNA before attempting to estimate its age because females hatch with significantly longer bills than males, but with considerable overlap between the sexes (Prier et al. 2013; Hugh Robertson, unpublished data).

6.5.2 Classifying subadults and adults

A bird of unknown history is considered to be an adult if:

- Its bill length does not increase by more than 1.5 mm between measurements taken 6 months apart. Since different people usually measure bill length to within ± 1 mm, an increase of 1.5 mm is likely to reflect real growth rather than observer error. Final male bill length (within a measuring error of ± 1 mm) is usually achieved by 3 to 3.5 years old, while the bills of females continue to grow until 4 to 5 years old.
- It is nesting, has a brood patch or is gravid. In low-density sites with good food resources, kiwi as young as 11 months old can breed while they are still growing; however, kiwi generally do not breed until about 4 years old, by which time male bills have stopped growing and females have almost reached their final adult bill length.
- It shares a burrow with another unrelated adult kiwi. Again, there can be exceptions, particularly among 3-year-olds, but most birds found together are fully-grown adults. Note: In rowi, great spotted kiwi, and tokoeka in Fiordland and on Stewart Island/Rakiura, subadult birds can be found with one or both of their parent.

6.6 How to determine the sex of kiwi

Kiwi can be sexed based on morphological measurements, breeding characteristics and molecular techniques. Measurements and breeding characteristics should be used to sex adult birds, while molecular techniques should mainly be used to sex chicks, juveniles and subadults.

6.6.1 Sexing based on bill length

In all taxa of kiwi, females are larger than males, with little or no overlap in bill lengths between adult females and adult males from the same locality. Leg measurements and weights can also provide additional evidence for birds that are close to the cut-off between male and female sizes, and can be useful for identifying subadult females that are passing through the range of adult male bill lengths; however, there is more overlap between the sexes in these measurements.

There is considerable variation in bill length within species, often following a North–South cline of increasing or decreasing bill length. There can also be considerable variation within a region due to either genetic drift, or variation in habitats or abiotic factors affecting bill growth. For example, brown kiwi at Trounson Kauri Park in western Northland have on average 9% longer bills than those at Waitangi Forest 65 km away on the east coast and, on Stewart Island/Rakiura, birds at Port Adventure on the east coast have on average 7–8% longer bills than birds only 33 km away at Mason Bay on the west coast. Therefore, it is important to compare measurements within a population, or with nearby populations, if at all possible. Table 6.6 provides information on the bill length of a number of kiwi populations that can be used as a guide to sexing adult kiwi. These data have been collected from birds handled during a number of research and management projects, and often represent the measurements made by a large number of observers using the standard measurements described in Section 6.2.

YOU WILL NEED:

- Vernier callipers
- Pesola spring balances

Table 6.6. Sexing kiwi based on bill length.

LOCATION	BILL LENGTH (mm)		CUT OFF (mm)
	SHORTEST – MEAN – LONGEST (n)		
	MALE	FEMALE	
Little spotted kiwi			
Kapiti	61.0 – 68.1 – 76.3 (190)	76.6 – 83.7 – 90.1 (140)	76
Great spotted kiwi			
NW Nelson	84.9 – 95.8 – 105.1 (52)	103.0 – 123.2 – 140.3 (49)	104
Paparoa	88.1 – 95.5 – 107.4 (24)	110.1 – 121.4 – 130.7 (16)	108
Canterbury	84.8 – 93.0 – 102.8 (36)	105.3 – 117.7 – 127.0 (38)	104
Brown kiwi			
Central Northland	86.1 – 101.2 – 119.1 (212)	113.7* – 135.8 – 155.8 (199)	120
Moehau	83.2 – 92.9 – 98.7 (27)	107.1 – 121.6 – 131.8 (29)	103
Urewera National Park	80.0 – 94.9 – 106.7 (36)	108.0 – 120.1 – 137.0 (25)	107
Tongariro	86.5 – 94.3 – 102.1 (37)	109.2 – 124.2 – 132.4 (25)	105
Rowi			
Okarito	83.5 – 94.8 – 104.2 (48)	109.9 – 125.5 – 140.3 (51)	107
Tokoeka			
Haast	84.9 – 92.2 – 103.0 (89)	109.3 – 122.0 – 136.1 (72)	106
Northern Fiordland, (north of Wilmot Pass)	89.6 – 98.3 – 110.4 (89)	109.8 – 127.8 – 148.0 (42)	110
Southern Fiordland (south of Wilmot Pass)	92.2 – 100.8 – 112.2 (13)	131.0 – 136.5 – 139.5 (5)	120
Stewart Island/Rakiura	94.4 – 106.3 – 118.0 (57)	133.4 – 145.9 – 167.6 (54)	125

* This female had an exceptionally short bill; the next shortest bill was 119.6 mm.

METHOD:

1. Measure the bill length of as many birds as possible in your study area using Vernier callipers (see Section 6.2.1) and identify known males and females based on their breeding characteristics (see Section 6.6.2), molecular methods (see Section 6.6.3) or the fact that adult birds are found together – which in brown kiwi and little spotted kiwi can be assumed to be a male and a female.
2. Plot the measurements to see if there are two separate bell-shaped curves. Where data are sparse, plot bill length against weight or bill length against tarsus width (the least variable tarsus measurement) to see if there are two separate clusters.
3. Determine whether there is any overlap between the two curves or clusters. If not, you can sex the birds on the basis of bill length, or a combination of bill length and weight or tarsus width.
4. If there is some overlap, try adding more measurements (variables), e.g. tarsus width and weight, and plot a 3D graph to see if the clusters separate. Alternatively, you could arbitrarily assign gender either side of a middle point in the area of overlap and accept that some birds may not be assigned correctly; you can then focus your effort on trying to obtain other independent sexing data for those birds near the point of overlap.
5. As further measurements are collected from birds in the population and known sexes are identified based on breeding observations or DNA analysis, reassess your assignments and cut-off points.

6.6.2 Sexing based on breeding characteristics

Kiwi can be reliably sexed based on a number of breeding characteristics, assuming that your study runs long enough to span one or more breeding seasons. Gravid females are easily identified, as are males that are found on a nest or with a brood patch / re-feathering brood patch in those taxa where incubation is carried out by the male alone. In species where incubation is shared, males are usually off the nest in the middle of the night, and females are off the nest in the early part of the night and/or pre-dawn period.

6.6.3 Sexing based on DNA

Huynen et al. (2003) described a DNA test for gender assignment in kiwi that can be run on a few feathers—preferably growing (pin) feathers, which have good quantities of DNA in their growing bases. For most taxa, this method correctly sexes over 90%, and often over 95%, of known-sex wild birds of all taxa except Haast tokoeka, which has proven more difficult to sex using this method. Failure to sex birds correctly has been mainly attributed to the contamination of samples in the field or laboratory, or a lack of amplification of the smaller female loci at small concentrations of DNA due to allelic dropout. This method has even allowed feathers collected from birds as young as 1 day old and feathers stored in plastic bags for up to 7 years to be correctly identified.

YOU WILL NEED:

- Small zip-lock bags or philatelists' envelopes
- Labels or Sharpie marker pens

METHOD:

1. Carefully search through the feathering for any pin feathers with enlarged dark bases.
2. With your fingers holding the feather tip, gently pull the growing feather out and place it in a labelled bag or envelope, being careful not to touch the feather base (where it attaches to the bird's body) on anything but the inside of the collection bag or envelope. Collect 6–8 pin feathers from a variety of parts of the surface of the bird rather than all from one small area.
3. If no pin feathers are present (they are absent from young chicks), collect 10–12 ordinary feathers and place in the collection bag, again without touching their bases. **Make sure** that the feathers have all come from the bird in question—it is easy for feathers from a bird handled earlier to adhere to catching nets, bags or clothing.
4. Seal the zip-lock bag or envelope, and label it clearly with the band, wing tag and/or transponder number, location and date.
5. Use a new zip-lock bag or envelope for each bird.
6. Store at room temperature; zip-lock bags have proven to be a satisfactory storage medium for up to 7 years at room temperature.
7. Given that each DNA test costs c. \$35, only get samples analysed where you cannot determine the gender of the bird based on measurements or breeding characteristics, or where you need an immediate answer (e.g. when trying to ensure even sex ratios during a transfer).
8. Send **half**⁷ of your sample (i.e. 3–4 pin feathers or 5–6 ordinary feathers) in a courier bag, with a covering letter providing your contact details and stating that you want the sexing service, to the Equine Parentage & Animal Genetics Services Centre, Massey University.
9. Be aware that some errors are likely as a result of low quality or quantity of DNA in the sample (e.g. from very young kiwi chicks that do not have pin feathers).

⁷ By sending only half of the sample, your complete sample will not be lost if the courier package goes astray. Note: If you do not request that the unused portions of the samples are returned to you, they will eventually be destroyed, preventing them from being used for other genetic research at a later date.

6.7 How to take blood samples

You must not take blood samples from a kiwi without proper training and permits.

Blood sampling is an invasive technique, so great care should be taken. Most important of all is for you to know what kind of information you can obtain from blood sampling and the limitations of the techniques that use blood samples. Blood samples are mainly taken to determine the presence of parasites and pathogens (particularly when transferring birds to new areas outside their local population), and for research purposes to provide baseline health data on kiwi to aid with the diagnosis and subsequent treatment of sick birds. Blood sampling of kiwi is usually not required for genetic research now that tests have been developed using earlier blood samples and from the DNA in pin (growing) feathers (see Section 6.6.3).

Accreditation

To obtain accreditation to take blood samples from a kiwi, you **must**:

- Be a qualified veterinarian, experienced with taking blood samples from birds; or
- Have taken blood samples from five kiwi in the presence of an accredited trainer or experienced veterinarian, who will then supply a letter of recommendation to the Kiwi Recovery Group.

Note: If you are accredited but have not taken blood samples from a kiwi for 10 years, you must have refresher training under the supervision of an accredited trainer or experienced veterinarian, taking samples from two birds per 5 years elapsed.

To become an accredited trainer for taking blood samples, you must:

- Provide evidence that you have taken blood samples from over ten kiwi, including those taken under supervision during your initial training.

YOU WILL NEED:

- Medi-wipes (70% isopropyl alcohol)
- 1-mL insulin syringes and 23-26-gauge needles
- Specific equipment for the particular purpose of the blood sample
- Cotton wool/gauze
- Sharps container for used needles
- Plastic container or large zip-lock bag for trash
- Anticoagulant (e.g. heparin/EDTA)
- Silver nitrate stick

METHOD:

1. Set up all of the equipment before extracting the kiwi from its burrow or daytime shelter so that the bird is held for as short a time as possible.
2. Hold the bird on its side with its legs pointing towards you (usually held by another person) so that you have clear access to the metatarsal vein on the inside of the leg – this is the only site you may use to take blood from a kiwi in the field. This vein runs along the inside of the lower (unfeathered) part of the leg and can be seen running from the 4th toe (spur) diagonally upwards to the front of the ‘knee’ joint. Have the handler grasp the leg above the blood collection site to put pressure on the vein so that it fills with blood.
3. Clean dirt and faeces from the area of the leg with a Medi-wipe.
4. Insert the needle at a 30° angle between the scales above the vein towards the body to puncture the vein, then flatten the angle of the needle and advance it to enter the vein.

5. Apply a small amount of traction on the plunger until you see blood entering the syringe. If there is no blood flow, carefully rotate the needle or insert slightly further or pull slightly back, always keeping the suction on the plunger. If there is still no blood flow, remove the needle, get a new needle and try another site or the opposite leg after cleaning it (step 3).
6. Collect the smallest amount of blood necessary for your purposes. It is unusual to need more than 0.6 mL of blood for all of your analyses.
7. Draw the plunger out slowly but evenly. If you take longer than c. 15 seconds to draw the blood, it will start to clot. If you apply too much suction, the vein may constrict and block the flow. (Note: Gently bending the toes back and forth can stimulate blood flow through the vein.)
8. When you have collected the blood you need or when the blood has stopped flowing, withdraw the needle and suck up any blood that immediately wells up from the site.
9. Sometimes you may wish to fill blood haematocrits from the blood that wells up or from the syringe once the needle has been removed.
10. Carefully place the used needle into a sharps container, or back into the plastic sleeve it came in and later dispose of it into a sharps container. **Never use the same needle or syringe on different birds.**
11. Place a fresh gauze or bud of cotton wool over the site and maintain firm pressure on it for at least a minute to stop the blood flow. If blood is still flowing, hold firmly for another minute and re-check. If it is still flowing after this, apply a silver nitrate stick to the site and re-apply the gauze/cotton bud and pressure, OR apply a temporary **bandage** with gauze/cotton bud, held with electrical tape until the bleeding has stopped. Remove the temporary bandage and check that the bleeding has stopped before releasing the bird.

Note: Blood clotting ability seems to vary between the different species of kiwi. The blood of brown kiwi clots very quickly, and you can use 22-23-gauge needles on adult birds, or 25-26-gauge on chicks. The needle may have to be lined beforehand with an anti-clotting agent such as heparin or EDTA by inserting the sterile needle into the anticoagulant, pulling the plunger up, and then pushing back to eject the liquid (but not back into the anticoagulant bottle) – check beforehand that the tests you are using the blood for will allow the use of these anticoagulants. By contrast, little spotted kiwi, great spotted kiwi and tokoeka are easier to obtain blood from and so an anticoagulant is not usually needed, and rowi tend to be ‘free-bleeders’ and so **do not** use anticoagulants and use a smaller (25-26-gauge) needle on adults, and 28-gauge on chicks.

6.8 How to take cloacal swabs

You must not take cloacal swabs from a kiwi without proper training and permits.

Cloacal swabs are mainly taken to determine the presence of parasites and pathogens (particularly when transferring birds to new areas outside their local population), and for research purposes to provide baseline health data on kiwi to aid with the diagnosis and subsequent treatment of sick birds.

Accreditation

To obtain accreditation for taking cloacal swabs from a kiwi, you **must**:

- Be a qualified veterinarian, experienced with taking cloacal swabs from birds; or
- Have taken cloacal swabs from two kiwi in the field in the presence of an accredited trainer, who will supply a letter of recommendation to the Kiwi Recovery Group.

To become an accredited trainer for taking cloacal swabs, you **must**:

- Provide evidence that you have taken cloacal swabs from over ten kiwi, including those taken under supervision during your initial training.

YOU WILL NEED:

- Cloacal swabs
- Medi-wipes (70% isopropyl alcohol)

METHOD:

1. Have the cloacal swabs ready before extracting the kiwi from its burrow or daytime shelter so that the bird is held for as short a time as possible.
2. Hold the bird on its back with its legs pointing towards you (usually held by another person) so that you have clear access to the cloaca.
3. Wet the feathers surrounding the cloacal area with a Medi-wipe to make it easier to locate the cloaca.
4. Remove the local swab probe from the tube it is in and ensure that the tip of the swab is covered with the transport medium gel.
5. Slowly insert the probe into the cloaca so that the cotton bud at the tip is fully inserted – **do not force it in** as you could cause damage. Rotate gently and withdraw the probe.
6. Without touching anything, return the probe to the tube and transport medium it came from and seal.
7. Label the tube and store it in a sealed Bio-hazard plastic bag. Try to get the sample to a laboratory within 24 hours, but if that is not possible, store it in a refrigerator or a cool chilly bin, but **do not freeze**.
8. Indicate to the laboratory what tests are required – the usual tests are for *Salmonella* and *Yersinia*, but *Campylobacter* may also be tested for.

7. Survey and monitoring techniques

7.1 How to determine kiwi presence, abundance and distribution

The fact that kiwi are secretive and almost exclusively nocturnal makes it very difficult to count all birds in a known area. Therefore, we use surveys to indicate kiwi presence and activity in an area. Six methods are used in the Kiwi Recovery Programme to survey for kiwi, and record their presence and/or abundance:

1. Casual observations – the Kiwi Reporting Card Scheme
2. Kiwi Call Scheme and distribution surveys by listening for calls
3. Surveys using acoustic recorders
4. Walk-through surveys
5. Dog surveys
6. Trail cameras

These techniques can be used to find kiwi in areas where there is no previous information or there is believed to be a small kiwi population, and can also provide information on the relative abundance and distribution of kiwi over wide areas.

Three of these methods make use of kiwi calls because we know that most territorial kiwi call occasionally but very loudly – indeed, birds can be heard calling up to 2 km away in ideal listening conditions. Furthermore, male and female calls are distinctly different, and pairs often duet, with one bird responding to its partner's call either by calling shortly afterwards or by overlapping with alternating bursts of notes.

Unlike many songbirds, kiwi call all year around, but there is still significant seasonal variation in call rate. The peak in calling usually coincides with mating and the start of each incubation period; species that lay two clutches normally have two peaks of calling, but those with normally just one clutch have a single peak (Table 7.1). Survey work can be done at any time of year, but if this is, or could turn into, a long-term monitoring project, then limit your survey times to the period 1 February to 30 June in order to reduce the variables between recording sessions.

Table 7.1. Times of peak calling activity for various kiwi taxa.

TAXON	PEAK CALLING
Brown kiwi	April–June, September–November
Rowi	May–June
Haast tokoeka	February–June
Fiordland tokoeka	November–February
Rakiura tokoeka	November–February
Great spotted kiwi	November–March
Little spotted kiwi	February–August

Survey techniques based on calls currently only allow estimation of relative abundance, because not all kiwi call as frequently or loudly as each other. For example, males are heard approximately 3 times more often than females, likely due to a combination of them calling more often and their whistle-like calls carrying further than the lower pitched calls of females. In addition, juveniles are usually silent in their first year and some non-territorial adult or subadult birds rarely call and, during the breeding season, many birds are on nests and so not calling. However, since kiwi are territorial, you may be able to determine the minimum number of individuals and their distribution in a specific area if you can locate different calling birds.

7.1.1 Casual observations – Kiwi Reporting Card Scheme

The Kiwi Reporting Card Scheme is important for drawing attention to the possible presence of kiwi in an area. This scheme is primarily aimed at the general public, particularly hunters, trampers and climbers, but DOC field staff can also help by recording the same observations when they are in the bush. This scheme solicits records on standard cards (Fig. 7.1) of:

- Kiwi sightings
- Kiwi calls heard, feathers found (often caught up in hook grass *Uncinia* spp. or bidi-bidi *Acaena* spp; Fig. 7.2)
- Kiwi probe holes (Fig. 7.3; but beware of potential confusion with holes made by walking poles and those made when cicadas emerge from underground)
- Kiwi footprints (Fig. 7.4)
- Kiwi faeces (Fig. 7.5).

Although there is sometimes confusion between sign made by kiwi and other animals (e.g. calls or footprints), follow up surveys by experienced observers, or with acoustic recorders, can be undertaken to verify or dismiss these reports.

If possible, take photos of sign and send them along with the completed card to the Kiwi Call Scheme Coordinator (presently Rogan Colbourne), Biodiversity Group, Department of Conservation, PO Box 10-420, Wellington.

DATE:		OBSERVER DETAILS		<p>Please complete this form as fully as possible and return to a Department of Conservation office.</p> <p>NOTES:</p> <ol style="list-style-type: none"> 1 The call of the male kiwi is a repetitive (8-25 notes) high-pitched ascending whistle. 2 The call of the female kiwi is a repetitive (8-25 note) coarser raspy call 3 Calls of weka, moreporks and possums are often confused with kiwi calls 4 Footprints are about the size of those of domestic chickens, with three toes, and are often seen in mud, snow or sand. 5 Probe holes usually occur in groups in soft substrate, and look like a screwdriver has been pushed into the ground and worked around. They are usually about 10 cm deep. <p>This form can be used to report other species of wildlife such as kaka, whio or bats. Please ensure that you clearly identify what you are reporting.</p> <p>Thank you for your cooperation. Your assistance will help stop the decline of New Zealand's native fauna.</p>
LOCALITY:		NAME(S):		
LOCATION:		ADDRESS:		
Grid Ref: _____ E _____ S				
Map grid used: NZMG (old) NZTM (new)				
Lat: _____ Long: _____		EMAIL:		
NUMBER OF KIWI SEEN:		PHONE:		
NUMBER OF KIWI HEARD:		COMMENTS (Observations, habitat, predators seen, ...)		
Male calls: _____ Female calls: _____				
SIGNS OF KIWI PRESENT: (e.g. footprints, feathers, droppings, probe holes)				
Are you 100% sure that what you saw or heard was a kiwi YES/ NO				

Figure 7.1. Kiwi Reporting Card.



Figure 7.2. Kiwi feather caught in hook grass.



Figure 7.3. Kiwi probe holes in sand.



Figure 7.4. Kiwi footprints in sand.



Figure 7.5. Kiwi faeces.

7.1.2 Kiwi Call Scheme and distribution surveys using calls

Since 1985, the Kiwi Call Scheme has collected over 4000 casual observations, one-off surveys or short-term studies, and has three main aims:

1. To determine the national distribution of kiwi
2. To relate kiwi call rates to locations and habitats
3. To assign a kiwi call index during a particular season to each listening site to monitor the dynamics of the population over time

The record card (Figs 7.6 and 7.7) is intended for use by interested field workers whenever they are spending one or several nights in likely kiwi habitat.

The Kiwi Call Scheme will allow only the relative, rather than absolute, abundance of kiwi to be determined for a number of reasons. First, although there is a good correlation between call rates and kiwi density in high-density populations, the relationship is weaker at low densities. It is also possible that a stable population with established pair bonds will have lower call rates than a population of the same size that has been subject to predation and/or recent new pairings of birds. This is partly due to birds who recently lost their partner calling more often to attract and retain new partners, and proclaim their territory, and partly through territory holders calling more frequently to chase wandering kiwi out of their territories.

For rapid surveys, it is probably best to cover more listening sites rather than to make repeat counts at each site (especially if kiwi distribution is patchy and/or numbers are very low). However, for more detailed surveys (particularly for resource consent purposes) where you plan to repeat the listening at these sites in the future, you should visit each station on at least 3 (not necessarily consecutive) nights. At least 6 hours of listening at each site should reveal the presence of most (c. 90%) resident males and many (c. 70%) resident females within c. 500 m of the listening site, though the detection range will vary depending on the topography. Where a record of the presence or absence of kiwi is critical (e.g. for some resource consents or for determining if possum traps can be set on the ground), a minimum of 10 nights listening for 2 hours (i.e. a total of 20 hours) should be carried out. Even then, it is possible that some kiwi may go undetected, especially where the listening site is at the edge of the home range of a local bird – obviously, though, counts do not need to continue night after night once you have detected that kiwi are present.

It is difficult to concentrate on listening for kiwi calls for more than 2 hours continuously. However, if the terrain is suitable (e.g. on a track system), each listener may be able to walk to another listening station and listen for a further 2 hours at another station on the same night.

CARD No.		KIWI CALL SCHEME			
OBSERVER		Date:		Locality Name:	
Initials _____ Surname _____					
Address					
Affiliation					
NOTES		<div> <div> GRID REFERENCE Grid (map series) used NZTM (Topo50) NZMG (NZMS260) </div> <div> Easting <div></div> </div> <div> Northing <div></div> </div> </div>			
<div> NUMBER OF KIWI CALLS NUMBER OF INDIVIDUALS MINUTES LISTENED </div>		<div> <div> WIND DIRECTION N NW W E SW S </div> <div> WIND 1 Calm 2 Light 3 Moderate 4 Strong RAIN 1 Nil 2 Light/ showers 3 Moderate TEMPERATURE 1 Cold 2 Mild 3 Warm CLOUD COVER 1 Clear 2 Partly cloudy 3 Overcast </div> <div> GROUND CONDITION 1 Dry 2 Damp 3 Wet MOONLIGHT 1 Bright 2 Dark 3 Black LISTENING SURVEILLANCE 1 Narrow 2 Medium 3 Wide </div> <div> Major Habitat Types 1 Beech forest 2 Podocarp forest 3 Broadleaf forest 4 Exotic forest 5 Scrub 6 Logged 7 Burnt 8 Undeveloped farmland 9 Developed farmland 10 Grassland 11 Tussock 12 Swamp 13 Coastal 14 Beach 15 River terrace 16 Alpine 17 Other </div> </div>			

Figure 7.6. Front of Kiwi Call Scheme card.

Start time:		Finish time:			
	Species	Sex	Time	Bearing	Distance
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

OTHER ANIMALS HEARD				
	1	2	3	4
Morepork	none	few	mod	many
Weka	none	few	mod	many
Possum	none	few	mod	many
		few	mod	many
		few	mod	many

Figure 7.7. Back of Kiwi Call Scheme card.

YOU WILL NEED:

- Torches, spare bulbs and batteries
- Compass
- Watch
- Kiwi Call Scheme card
- Pens/pencils
- GPS
- Maps
- Warm clothing

The main point to note with this scheme is to try to select a period for listening that takes advantage of the optimum conditions for kiwi calling. This means you should start listening no earlier than 30 minutes after sunset and should preferably listen within the first 2 hours of darkness. Counts in areas with few or no known kiwi are particularly important – remember, negative results are just as valuable as positive results.

SURVEY METHOD:

1. Go through the Kiwi Call Scheme card methods and fields before you go out. You may also wish to practice or refresh your skills by listening to the calls of kiwi at: <http://nzbirdsonline.org.nz/>
2. Choose listening sites that cover a wide listening area, preferably on a prominent knob, spur, hilltop, ridgeline or riverflat, away from loud river, stream, sea, traffic or hut noise. However, do not be put off listening from a campsite in thick bush if that is the most practical way of conducting a count.
3. Neighbouring listening sites should preferably be at least 1 km apart to increase the overall coverage.
4. On a topographical map, or GIS map system, estimate the listening range from each listening site – at many places, a ridge or spur will cut out distant calls from certain directions or the habitat in some directions may be unsuitable for kiwi, and so the listening range may be far from circular.
5. Before departing to the listening sites, remember to synchronise your watch with others who are listening in the same general area, so that you can better determine if a bird was heard at multiple sites.
6. Arrive at the listening site with enough time to get ready for recording. Remember that if your listening site is on a hill, you will require some time to cool off and to then pile some clothing on and prepare your forms before you will be ready to listen. Have all of your clothing and gear handy, so that you do not make unnecessary noise during the survey.
7. Start your listening period no earlier than 30 minutes after local sunset. Sunset times are available from <http://www.linz.govt.nz/hydro/nautical-info/astronomical-info> and on many GPS units.
8. Preferably do your listening in the first 2 hours of darkness (from 30 minutes after local sunset). Listening conditions are often best on a dark night, with little or no wind, rain or other noise, but counts in any conditions will still be valuable. Try to listen for a 2-hour period, because call rates will tend to average out, but listening periods of different durations are acceptable. Avoid doing a short listen simply to include a call that you heard when you were not otherwise intending to do a survey – in this situation, you are better off filling out a Kiwi Reporting Scheme card. Record any birds that called outside your planned listening period in the 'Notes' section, rather than, for example, adding onto the count the pair that called when you were packing up your gear!
9. At the end of each hour of listening, total up the number of calls heard and estimate the number of individual males and females you heard calling (allowing for movement of birds during your listening period) in the 'Notes' section.
10. **Do not solicit calls** from kiwi by using tapes or shepherd's whistles **in the first hour** of listening, and only do so later in the night if it is important to determine if kiwi are present at the site. In this case, make sure that this is clear in your notes, along with the times that the calls were broadcast.
11. If you hear other teams broadcasting calls from another site, record this information on your card, along with the time, estimated distance and direction—it may be that you have heard a bird responding to their broadcast rather than the broadcast itself.
12. At the end of the second hour, summarise your data in the field (while information is fresh in your mind):
 - Total up the number of calls heard in the second hour and estimate the number of individual kiwi you heard calling.
 - Add the two counts together and estimate the total number of birds heard during the 2-hour period, again allowing for movement of birds over the whole 2-hour period. Note that one male calling four times is a quite different biological result from four males which each called once.

13. Describe the listening site well (e.g. at cairn on terrace 5m south of where the track drops down the true right (eastern) bank of the large stony creek, 1200 m west of Cameron's Hut, North Hurunui Valley) so that the exact same listening spot can be used in future surveys.
14. Photocopy or scan the card for your own records, and then send the original card or the scanned copy to the Kiwi Call Scheme Coordinator.

How to complete the Kiwi Call Scheme card:

CARD NUMBER

Leave the top right-hand space blank. If you wish to link the card to the number of a listening station in the area surveyed, use the 'Notes' section on the card.

OBSERVER

If more than one person listened from a listening station, give the name of the most experienced observer first. For each new observer, provide the address and affiliation on the first card only. This information is not required on subsequent cards unless addresses or affiliations change.

LOCALITY NAME

Provide, in order, the province, the offshore island name (if applicable), the forest or reserve name and the nearest named locality or feature (such as river, stream, trig, etc.), followed by a brief description of the exact location of the listening station (use the 'Notes' section if you run out of space). For example, Southland, Stewart Island/Rakiura, Rakiura National Park, Mason Bay, sand hill 100 m east of Island Hill Homestead. This location will be further verified by the grid reference. This enables all records from Southland or Stewart Island/Rakiura to be sorted. If possible, include a photocopy of a map of the area with the listening stations marked on it, and the estimated listening extent over suitable habitat, even if you did not hear any birds calling throughout the marked area.

GRID REFERENCE

Wherever possible, use the Topo50 map series, which is the official topographical map series used by the New Zealand emergency services. These maps cover the entire country. If you are using a GPS system, you should change the settings on your GPS receiver to 'NZGD2000', the datum used by Topo50, or to the 'New Zealand TM' (Transverse Mercator) position format and 'WGS 84' map datum, which is coincident with NZGD2000. If you do not have access to these maps or have a lot of data in the older grid reference, you can still use the metric NZMS 260 series maps and keep your GPS unit set to the 'New Zealand' position and the map datum set as 'NZGD49' or 'NZGD1949'. However, the grid references will need to be converted later from the NZ Map Grid to the NZ Transverse Mercator projection (NZGD2000) using a conversion programme such as that available at <http://apps.linz.govt.nz/coordinate-conversion>.

For the section labelled 'Series', either put T50 to indicate Topo50, or 260 to indicate that you have used the NZMS260 map series. Ignore the N S X on old versions of the card, and enter the Sheet Name for NZMS 260 maps. You should use grid references rather than the alternative decimal latitude/longitude system. Grid references are easy to interpret on maps and it is straightforward to work out how far each point is from adjacent points – something that cannot be done with latitudes/longitudes. The grid reference should be given to 7 places for the easting (horizontal) and 7 places for the northing (vertical), i.e. to the nearest metre, even though old versions of the Kiwi Call Scheme card have only 5 spaces available.

You can download maps as image files (TIFF and GeoTIFF formats) and data files (Shape and IFF formats), or you can purchase paper maps from local retailers.

NOTES

If kiwi are heard in the area but do not call during the listening period, please note this fact. This information is important for distribution analyses. If more space is required for notes, continue writing under the entry of the last call heard on the back of the card (upon completion of the listening period).

WIND

This is a subjective score of the average influence of wind on your count. In general, calm and light winds will not reduce the ability to hear birds calling, moderate winds may result in the loss of distant calls, and strong winds will make distant calls very difficult to detect, especially if there is a lot of noise from the wind in trees nearby. **If the weather or noise conditions change markedly during a count, fill in separate cards for the different parts of the count.**

RAIN

This is a subjective score of the average influence of rain during your count. Noise from rainfall can reduce the listening range, and so moderate rain should be scored when you feel that the results have been affected by the noise of rainfall.

TEMPERATURE

This is a subjective score of the average temperature during your count. Note accurate readings if you have them available

CLOUD COVER

This is a subjective score of the average cloud cover during your count.

GROUND CONDITIONS

This is a subjective score of the average ground conditions during your count.

NOISE

This is a subjective score of interference to listening caused by other types of noise, such as river, waterfall, traffic or sea noise, talking by non-listening members of the party, or noise from other animals, e.g. petrels calling, cows mooing or frogs croaking. Avoid noisy conditions wherever possible.

MOONLIGHT

This is a subjective score of how bright the moonlight was, averaged over the listening period. Some early studies on brown kiwi, in particular, showed that they called noticeably less often on bright, moonlit nights. Interim results of more recent work indicate that this may not always be the case; however, until these data are fully analysed, it is best to continue to plan surveys on dark nights wherever possible.

LISTENING COVERAGE

When listening from a ridge on a calm night, choose 'wide' as the descriptive term. When listening from a campsite in a gully, underline 'narrow'. When listening in a gully with a noisy creek and pouring rain ... head back to your tent!

MAJOR HABITAT TYPES

Mark a maximum of three categories of vegetation types found within the listening zone. If the types of vegetation present are not listed, circle 17 and explain in the notes. Developed farmland is typical New Zealand pasture, and is well fenced, intensively grazed and has few trees. Undeveloped farmland has rank grasses interspersed with mānuka, gorse and other scrub throughout, and may include extensively grazed river flats or frost flats.

MINUTES LISTENED

Give the total time that calls were listened for, in minutes. The number of calls will eventually be expressed as a number of calls per hour. As a general rule of thumb, 1 hour per station is a good continuous period for listening for kiwi calls. Do not listen for more than 3 consecutive hours in a single night, as your concentration will rapidly diminish beyond this. Do not be tempted to 'start' listening as soon as you hear a kiwi calling or to 'finish' a count as soon as a bird has called.

CALLS

Record calls according to the species calling, sex (M/F), time, compass bearing that the kiwi called from and the estimated distance (metres). If you are not confident of estimating distance,

then write 'near', 'moderate' or 'distant'. A call is made up of a series of notes, ranging from just 1-2 to about 25. Because it is the call rate that is important, if two calls from the same individual are more than a minute apart, record these calls on separate lines. If a pair duet (male or female responds during or shortly after the call of its partner), indicate that these calls are linked. In some species, a duet will comprise alternating calls, with a number of notes from one bird followed by a number of notes from its partner, and then a number from the original bird, and so on; regard this series of calls as being just one call from each member of the pair, unless one of the calls is obviously from a third bird. At the completion of listening, estimate the number of individuals you heard during the listening period, taking into account the possibility that birds may have moved around during this time.

OTHER ANIMALS HEARD

Record other animal species that you heard calling during the listening period, and make an estimate of their abundance using the following criteria:

Few	1-2 individuals
Moderate	3-6 individuals
Many	6+ individuals

USE OF TAPED CALLS

You **should not** broadcast recorded kiwi calls or blow shepherd's whistles to stimulate kiwi to call before or during the first hour of listening. This means that repeatable data will be collected for that listening period. Technological advances in recording and broadcast equipment, and improved knowledge of the function of calls will likely result in a different response rates to broadcast calls in the future, which may mask any real changes in call rates. Also, populations that have had calls played to them may become less responsive over time and this could be misinterpreted as a decline in the populations.

If you are especially interested in determining if kiwi are present at a site (e.g. if the population was known to be very sparsely distributed and determining presence is more important than measuring call rates) you can play tapes or whistles after the first hour of listening has been completed. Make sure that you indicate on the card the type and times of calls played. This will allow these solicited call rates to be separated from natural call rates.

When broadcasting taped calls, we usually alternate male and female calls at about 15 minute intervals, or mimic calls on a shepherd's whistles at about 15 minute intervals.

How to access the Kiwi Call Scheme data

The information that you send to the Kiwi Call Scheme Coordinator on the cards will be checked and vetted, and then stored in a computer file (presently in Microsoft Access). Printouts from given areas, together with a map of the national distribution, are available on request. While information on the presence of kiwi in 10-km grid squares can be made available to the general public, the precise locations may be of a more sensitive nature, particularly regarding the most endangered taxa.

For further information contact:

Rogan Colbourne
Kiwi Call Scheme Coordinator
Biodiversity Group, Department of Conservation
PO Box 10-420, Wellington
rcolbourne@doc.govt.nz

7.1.3 Surveys using acoustic recorders

Acoustic recorders are devices that record sound in a digital format onto removable SD memory cards. These recordings are then downloaded onto a computer and with appropriate software

the sounds can be displayed as pictures or spectrograms (Fig. 7.8) showing the intensity of sounds at different frequencies over the duration of the recording. The calls of each species, and background noises such as rain, wind, rivers and aircraft, have distinctive patterns that can be recognised by a person, and then scored and catalogued. Work is currently underway to develop automatic computer recognition of the particular patterns of kiwi calls, but this is still in the development phase.

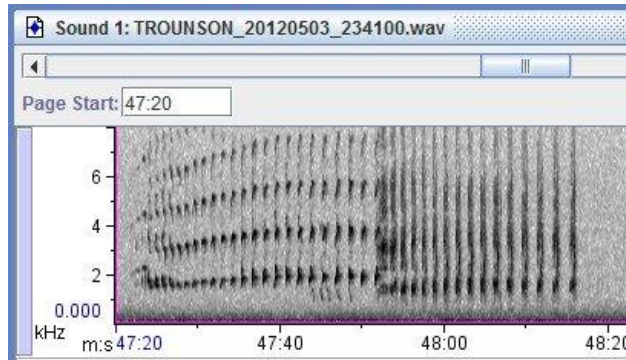


Figure 7.8. Spectrogram of the calls of a pair of brown kiwi. The more sharply defined male call is followed by the female call; each call has several harmonics showing above the lowest frequency in the 1–2-kHz range.

The key advantage of modern acoustic recorders is that data can be collected over large numbers of hours without someone needing to sit up all night, and camp in remote and hostile locations, and with almost the same level of detection – although the range of detection varies with terrain and vegetation density. The recorders usually detect c. 80% of kiwi calls compared with a person listening from the same site, but at some sites the filtering of background noise from sea or rivers can bring the rate of detection much closer to or even better than human hearing. Recordings can also be stored permanently and checked or re-analysed (e.g. for the presence of other species, or to check the original identification) years later. However, a disadvantage is that, in the absence of an array of synchronised recorders, the distance and direction of calls cannot be determined, making it difficult to assess the actual number of individuals in an area.

Another drawback is that different models of recorders (including upgrades to microphone technology over time) are not necessarily comparable, which will need to be accounted for in any long-term monitoring programmes. In addition, a non-technical, but nevertheless important, drawback is that acoustic recorders do not engender the same sense of ‘ownership’ of kiwi in an area as listening for their calls in person.

Because acoustic recorders do not have the same listening coverage as people, it is probably best to plan to have more listening sites than if you were doing the same survey using people. The recorders should be deployed at least 1 km apart, because they seem to record most calls within about 300 m, many calls people hear at 300–500 m distance, but few very distant calls compared with what people record.

In 2016, two main models of acoustic recorders were being used in New Zealand. DOC’s Electronic Laboratory produces a cheap (NZ\$400 including two sets of four rechargeable AA batteries and two 8-Gb SD cards), light (400 g including batteries and SD card), waterproof, sensitive and robust model that can record for 120 hours on one set of four rechargeable NiMH AA batteries at the frequencies needed to record kiwi calls. Wildlife Acoustics, USA (www.wildlifeacoustics.com) produces the ‘SongMeter 3’, which is good for research purposes because it can record for 270 hours with a set of four alkaline D batteries or 180 hours with rechargeable NiMH D batteries, and very much longer with an external 12-V battery such as a car or motorcycle battery, but has a much higher cost of NZ\$1700 (including shipping, import duty, two sets of four rechargeable D batteries and two 32-Gb SD cards) and weight (3.2 kg including

batteries and SD cards); these units are also waterproof, but the external microphones can be chewed by possums, kea, kākā and rats, and so some extra protection may be required if these species are present (e.g. a wire cage around the entire unit).

The ease of using acoustic recorders makes it tempting to collect a large amount of data. However, this can significantly increase both the field costs, and the costs of interpreting and storing the data.

Software is available to scroll through large audio files (up to 2 Gb), usually broken down into more manageable 15 minute blocks at the time the recorder is set up. These programmes show the spectrograms and the viewer manually picks out kiwi calls and records the number and gender of each one. Vocalisations and other noises made by different animal species have different patterns and frequencies, and the distinctive patterns of kiwi calls can be learned very quickly. The viewer draws a 'selection' box around each call and labels it as male or female kiwi (or other species) on a drop-down menu, and can optionally also indicate call strength/quality; these data are then exported and collated in an Excel file for analysis. Each normal computer screen can usefully show 2-10 minutes of recordings and can be scanned for the distinctive call patterns in a few seconds. Viewing these electronic files as spectrograms and recording the data on the time and gender of the kiwi is usually 10-20 times more time efficient than listening to the same recordings by ear. If in doubt with faint recordings, the use of earphones will help to confirm or reject the faint 'visual' recordings.

Currently, the audio files need to be analysed visually, but software is being developed to 'teach' computers how to recognise a kiwi call using powerful algorithms and to automatically load each encounter into an Excel spreadsheet. Other software is being developed to skip sections of recordings where no sound pattern similar to that of a kiwi call is detected, or skip sections where background noise from wind and/or rain is too great to accurately detect kiwi calls if they were present.

For distribution surveys, acoustic recorders should be set up on a small tree at about head height, or in open country on a stake 1-1.5 m above the ground. Record the position with a GPS, and photograph the recorder in situ so that the exact same site can be used in future if the survey sites turn into a longer-term monitoring site some years later.

Local logistics and practicalities should be considered when determining how many nights automated recorders will be deployed for, striking a balance between the likelihood of recording birds if they are present and the total area covered by the survey. In particular, this will depend on the purpose of the survey, how easy it is to shift recorders between sites and the likely weather pattern during the survey – strong wind and rain can make it impossible to separate kiwi call patterns from the background noise.

Where it is **critical** that the presence or absence of kiwi is determined (e.g. to define areas where leg-hold traps need to be raised 70 cm off the ground or to determine whether kiwi are present in an isolated exotic forest that is about to be logged), a minimum of 10 nights (100-120 hours) recording should be made at each site. The survey may be truncated as soon as you have detected the presence of kiwi at a site. In many situations, if birds are present their calls will be recorded in the first few nights. However, the longer period allows much greater certainty, giving birds that have a very large home range (sometimes > 100 ha) time to randomly walk into and call within range of the recorder at a time when the noise from wind and rain is sufficiently low to allow calls to be detected.

By contrast, in areas where kiwi are suspected to be present based on other information (e.g. old reports of birds being seen or heard, or in suitable habitat between other known populations) and only presence/absence data are required, the recorder can be deployed for just 1-2 full nights (12-24 hours recording) and then shifted to another site 1 km or more away. However, if more than presence/absence is required, a minimum of 4 nights (c. 40-50 hours) of recordings should be made to give a reasonably accurate hourly call rate or detection rate for that site.

The unit should be programmed to start at dusk (30 minutes after sunset) and run all night until dawn (30 minutes before sunrise).

YOU WILL NEED:

- Automated recorder (e.g. DOC, SongMeter, or similar commercial unit) with a unique identifier label
- Batteries
- SD card
- Duct tape, bungy cords or cable-ties for attaching the recorder
- Stake if in open country (warratah or fibreglass electric fence post)
- Computer and software (e.g. Freebird or Raven Pro)
- Camera
- GPS

METHOD:

1. Choose listening sites that are at least 1 km apart, preferably overlooking a reasonable amount of terrain, and away from river, stream, sea and nearby vegetation noise. Recorders placed on high ground will have a wider listening range, but are more likely to be adversely affected by wind noise, and so areas that are in the lee of a ridge or in a hollow on high ground often make good sites. It is also best to set the recorders at least 10 m away from walking tracks or other places that are likely to attract attention from people. Be aware that it is not legal to record conversations without the subject's permission, so do not set a recorder up near a camping site, picnic table or seat.
2. Programme the acoustic recorder to turn on at around dusk (30 minutes after local sunset) and to finish recording at dawn (30 minutes before local sunrise), or for shorter periods if necessary but including at least the first 3 hours of darkness from dusk.
3. Set the acoustic recorder to record at a 8-kHz sample rate ('low' mode on DOC recorders), as this is suitable for kiwi recording and will make the batteries and SD card last longer.
4. Attach the recorder to a sapling or low branch at about head height, making sure that there is no vegetation nearby that will brush against it if it gets windy. In open sites, attach to the top of a stake, 1–1.5 m above the ground. Position the recorder with the microphone facing downwards (DOC recorders) or horizontal (SongMeter).
5. Clearly label the SD card so that it relates to the sampling site and/or labelled recorder unit. Some models allow an electronic prefix to be added to the filenames. Ensure that the batteries and SD card are fitted properly.
6. Get an accurate grid reference for the site.
7. Preferably take a photograph of the acoustic recorder as it was set up, so that the exact same site can be replicated if required in a future survey.
8. After the sampling period, collect each SD card (or recorder), place it in a separately labelled zip-lock bag, and download the recordings from the SD card to a computer hard drive and/or a portable storage device as soon as possible.
9. Maintain two copies of the recordings until they are analysed, and then curate a copy of the recordings and summarised data on a safe medium.
10. Using a software programme such as Freebird or Raven Pro, search through the spectrograms for kiwi calls, with a screen resolution that gives 3–10 minutes of recordings per normal screen (up to 15 minutes on a super wide screen). For each kiwi call, record the time, gender and strength of the call (loud, moderate, faint), and note if it is part of a duet. With some duets, the male and female alternate calls with a few bars from each—treat these

as a single call from each bird, unless there is evidence that a third bird is involved or if a new call starts from the typically low frequency early notes rather than resuming at the frequency of its most recent notes). Present data as calls per hour, preferably separated by gender.

11. An alternative, and possibly preferable, method is to simply record the presence or absence of any kiwi call in a set time interval. A 15-minute sampling period is generally appropriate unless call rates are > 20 calls per hour, in which case 5-minute intervals are preferable. This will allow different call rates to be distinguished because the longer 15-minute period may have close to 100% presence making real differences hard to detect. The advantage of this method is that once a kiwi call has been detected, you can move on to the next 15- (or 5-) minute interval, and there is no confusion about the number of calls to record when calls stop and start again, and less statistical bias caused by duets or by neighbours responding to calls.

Note: During the current exploratory phase of analysing automated recorder data for kiwi calls, it is probably best to analyse recordings and present data using the two different techniques in Paragraphs 11 and 12, and with more time and experience a preferred method will be chosen.

12. Exclude from your analysis any periods when there is excessive noise from wind, rain, vegetation, river, stream or other animals that obscures the kiwi calls—your computer screen will appear dark grey to black and most calls will be impossible to see.
13. Send the survey information and a map of the surveyed area to the Kiwi Call Scheme (currently Rogan Colbourne), Biodiversity Group, Department of Conservation, PO Box 10-420, Wellington.

7.1.4 Walk-through surveys

In areas where there is a low kiwi density or their presence is unknown and there is a good track system or river flats that can be followed, walk-through surveys can provide valuable site records whilst covering a large area relatively quickly. These surveys can be undertaken at any time of the night in any month of the year, but it may be worth coordinating these with the time at which the target species has a peak calling activity (Table 7.1).

If you can, plan a route out and back and on the return journey play tapes at the same sites used on the outward journey. Kiwi have an uncanny ability to home in on where a call was played, and on your return they may still be lurking in the vicinity and respond immediately to a new broadcast call.

YOU WILL NEED:

- Torches, spare bulbs and batteries
- Compass
- Watch
- Kiwi Call Scheme cards
- Pens/pencils
- GPS
- Maps
- Playback system with amplified speaker / shepherd's whistle
- Warm clothing

METHOD:

1. Record the start time, the prevailing weather, moonlight conditions and habitats.
2. Turn your GPS unit on before you start and ensure that it can detect suitable satellites to provide a fix, and then reset your trip computer to zero so that you can work out how far you have travelled during the survey.
3. Listen for kiwi as you walk. When you hear a call, record your GPS position, the time, distance and compass bearing to each bird, and its sex.
4. Stop every 400 m and play a set of male calls from an amplified audio unit or mimic these on a shepherd's whistle. If there is no response after 1 minute, play a female call or again imitate a male call on a shepherd's whistle (female calls cannot be mimicked on a whistle). Listen for a full 5 minutes at each site before moving on.
5. Record the GPS position of each site at which calls were played and the number of responses. It is critical to also note the position of sites where no response was heard.
6. As accurately as you can, plot the location of all calling birds on a copy of a Topo 50 or NZMS 260 map.
7. Record your finish time and any change in weather conditions along your route.
8. Summarise the number of times you stopped to play calls, their locations, and the number of individual kiwi seen and heard during your survey, and send the survey information and a copy of the map to the Kiwi Call Scheme (currently Rogan Colbourne), Biodiversity Group, Department of Conservation, PO Box 10-420, Wellington.

7.1.5 Dog surveys

In high-density kiwi populations (where over 30 independent encounters of kiwi could be expected within a sampling period (up to a month)) information on the age and sex structure of the populations can be derived from dog surveys, as dogs appear to find male and female kiwi equally well and find adults and juveniles in direct proportion to their abundance (Robertson & Fraser 2009). This method can be used to assess the efficacy of management programmes because the snap-shot of the age structure it provides will allow determination of whether recruitment is adequate, and any changes in encounter rate (birds per hour) can be used to assess changes in population density.

In some cases, it is possible to see that a bird is a juvenile, an adult female, or an individually colour-banded or radio-tagged bird without needing to capture it; however, measurements and DNA sexing of feathers of unknown birds allows more detailed analysis of the data.

Because kiwi are not found randomly in different vegetation types (e.g. young birds generally favour rank grass, dense scrub, dry swamps, river margins or ridgelines), the survey should ideally be conducted along transect lines that randomly sample the range of vegetation types roughly in proportion to their abundance. This can be achieved by following randomly chosen compass bearings from randomly selected points or, more practically, by designing a route in advance that samples vegetation types evenly (stratified sample) or randomly (e.g. parallel transect lines across a forest block). If vegetation is roughly uniform, blocks can be searched thoroughly or you can follow established walking tracks rather than needing to follow long transects.

If the aim is to record changes in population structure or density over time, you should ideally follow the same route or search the same block thoroughly each time the survey is carried out. Also, try to repeat the search at the same time of year and preferably in similar weather conditions, e.g. by avoiding conducting surveys in extreme conditions such as on hot, calm days.

YOU WILL NEED:

- Certified kiwi dog (see Section 9)
- GPS
- Transponder reader
- Callipers
- Pesola spring balance
- Information on the size range of adults of both sexes in the general area
- Access to a DNA sexing service

METHOD:

1. Without prior knowledge of the location of resident birds (e.g. do not radio-track birds), plan a safe route to search that systematically covers the entire area, with sweeps generally no more than c. 100 m apart.
2. Record the starting time of the search each day.
3. Plot the route covered and the location of all birds found on your GPS.
4. Walk the planned route slowly with your dog, allowing it to search for scent in its usual manner. Follow it when it picks up scent, but once it is 50 m from the line pull it back to the transect and resume progress along it to resume searching.
5. Record the time spent handling each bird (including extraction and physical handling), and any rest breaks. Although some GPS units have a moving and stationary time feature, this is not reliable when working under canopy cover and so these times should be recorded with a stopwatch.
6. Record the identity, age and sex of each bird.
7. Mark each bird found with a permanent marker (leg band, wing tag or transponder) in case it is found elsewhere on a subsequent day or on a subsequent search years later.
8. Collect a sample of pin feathers from any bird whose sex is indeterminate (remember that subadult females pass through a stage where they are hard to distinguish from adult males).
9. Aim to capture a minimum of 30 birds, preferably >50. A pair of adult birds sheltering together should be considered a single encounter when comparing encounter rates and age ratios, but both birds should be included in an analysis of sex ratios. If a bird moves away and is then found again the same day, ignore the second record, but if a bird is re-sighted on a different transect on a different day, include it in your sample on the basis that there was an equal chance of a bird moving in the opposite direction and being undetected on the two independent transects.
10. Record weather conditions during each search, the finish time each day, the total time spent searching (excluding handling and stoppage time), the route length and the number of encounters, broken down by age and gender.

7.1.6 Trail cameras

Video cameras have been used in kiwi research projects for over 30 years, but up until recently their use was confined to specific research work because they and/or their batteries were heavy and required frequent maintenance. The introduction of commercially-available light-weight trail cameras that take infra-red still images or videos has opened the door to many more applications. Be aware that it is illegal to secretly film people, and so if the cameras are being used at a site where people may be filmed, then you need to erect signs warning them that surveillance cameras may be operating in the area.

These cameras are strong, relatively cheap, and weatherproof. There are at least 20 different models designed for extended use outdoors, and some can record still images for over a year onto an SD card using just eight AA batteries. Most cameras come with a strap that allows it to be attached to a tree. The camera will automatically take a picture when it senses motion (using passive infrared light sensors (PIR sensors)), so beware not to have shrubs and tussocks in view that will trigger the camera in strong winds. Cameras usually have an LED, giving a red glow or no glow, and although the red glow gives some assurance that the camera is functioning, it appears that this light disturbs some kiwi, and so no glow LEDs are probably best used near nests. Each image is stamped with the date and time it was recorded. Videos often run for a fixed time even if the bird is still within view and, depending on the recovery time, may or may not resume filming this bird. The recovery time also affects the number of still images the camera can take when a bird remains within the field of view for a prolonged time

The camera will function day and night and detect and record kiwi-sized birds within about 5 metres of the camera. Those cameras with a detection (trigger) time of less than 1 second are most useful, otherwise the bird triggering the camera will often be missed - there are many studies which show multiple birds entering a nest, but none emerging, because the camera consistently failed to pick up the departing bird. The wider the angle of view, the greater the chance of detecting a bird within shot, but image quality will decrease. You will need to consider how close to a nest it is safe to go, and what angle the birds are likely to take when approaching or leaving a nest, so you don't disrupt their nesting but you have a good chance of capturing all of their images.

All images are recorded onto a memory card, such as a commonly available SD card. This also allows users to conveniently transfer the images to a computer or they can be viewed, copied and deleted by a Viewer in the field. More expensive units have the ability to wirelessly upload captured images to a computer or website without the user risking disturbing birds when servicing the camera.

Trail cameras have generally been used to monitor kiwi activity at nests by recording the arrival and departure times of the adults during incubation and of the chicks once they start to become mobile. These same cameras can also provide an insight into the presence and behaviour of predators visiting nests.

Cameras can also be used to determine the presence of kiwi in an area (especially if set up near an automated call broadcast system that can attract kiwi to a site, or if placed on favoured pathways, such as small footbridges or gaps in a fence line). They can be set up at likely looking or used burrows or hollow logs/trees that are impossible to see into but where certified kiwi dogs may have shown an interest. Bands and transmitters show up on the images (though not the colour of reflective tape or transmitter), and the age and gender of some birds can be determined from their size.

YOU WILL NEED:

- Trail camera
- SD card
- Batteries
- Computer to download and store images

METHOD:

1. Attach the camera securely to a small tree or on a tripod, about 1-1.5 m above the ground, and about 3-4 m away from the centre of the image that you want to take (e.g. burrow entrance, playback device), preferably not at right angles to the direction of travel the kiwi is likely to take, otherwise it may have moved out of view before the camera starts taking images.

2. With the viewfinder on the camera, make sure that the field of view is what you want.
3. Hide the camera as much as possible if there are kea, weka or people in the area.
4. Make sure that there are no shrubs, flax or tussock close by that will trigger the camera on windy days.
5. Decide whether you want to take still images or video footage, and how long the video should run for each time.
6. Make sure the SD card and batteries are correctly fitted and set the camera going.

7.2 How to monitor population trends

Once you have an idea of the status of your kiwi population, you can develop a monitoring programme to track long-term changes resulting from natural events (increase or decrease in predator numbers, changes in age and sex ratios) or management.

The best monitoring programme for your population will depend on the time and resources available, and should consider the estimated density and distribution of birds, as well as factors such as other research being carried out at the same time.

7.2.1 The Nationwide Call Count Monitoring Scheme

In the early phase of the Kiwi Recovery Programme, a standardised national scheme was established to monitor changes in kiwi call rates as a surrogate measure of the changes in their populations. This involved use of a practical sampling procedure that was capable of detecting a 25% difference between two sets of call counts conducted several years or even decades apart (McLennan 1992).

In 1993, 20 sites were selected throughout New Zealand that covered most populations of kiwi that were known or suspected to be genetically distinct, a variety of habitat types, and areas with positive or negative population pressures (e.g. predator-free islands, and areas in which kiwi management was underway). Call rates continue to be systematically monitored at 17 of these sites (Table 7.2), each of which has 3–6 permanently marked listening stations with a wide listening coverage across multiple kiwi territories. Two hours of listening is conducted at each

Table 7.2. The 17 sites where Nationwide Call Count Monitoring is conducted.

TAXON	SITE	# STATIONS
Brown kiwi	Northern Northland	5
	Western Northland	5
	Eastern Northland	6
	Southern Northland	6
	Te Hauturu-o-Toi / Little Barrier Island	6
	Moehau, Coromandel	5
	Whitecliffs, Taranaki	5
	Tongariro Forest Park	5
Haast tokoeka	Haast Range	5
Rakiura tokoeka	Freshwater River to Mason Bay	5
Great spotted kiwi	Goulard Downs	5
	Heaphy River	3
	Westport Coal Measures	4
	Taramakau River	3
	North Hurunui Valley	3
	South Hurunui Valley	3
Little spotted kiwi	Kapiti Island	4

station for 4–8 nights, (i.e. 3 stations × 8 nights, 4 stations × 6 nights, 5 stations × 5 nights, or 6 stations × 4 nights). This giving a total of 48–50 hours of listening per site per session.

This procedure was initially repeated for 3 consecutive years at the same time of year to establish a firm baseline of call counts to allow the measurement of changes over time. Since then, the sites have been revisited approximately every 5 years, but annually in some places (e.g. Northland), during which time counts have been made at the same stations at the same time of night and year. The data have been used to determine if there is a significant trend in call rates at each listening station over time, and to assess patterns of change in the call rates for a particular species, which can be related to any management that has been carried out near each listening station (e.g. Pierce & Westbrooke 2003).

YOU WILL NEED:

- GPS and coordinates and description of previously-used listening station
- Compass
- Watch
- Kiwi Call Scheme cards
- Pencil/pen
- Torches, spare bulbs and batteries
- Warm and waterproof clothing
- Map

METHOD:

1. Before heading into the field, get all listeners to synchronise their watches, review the survey methods, familiarise themselves with reading compass bearings and listen to the playback of kiwi calls so that everyone is confident about correctly identifying kiwi.
2. If practical, rotate observers between listening stations each night, especially if call counts are being carried out as part of an expedition, as there is always the risk that a change in call rates detected at a station may be due to a difference in the listening acuity of observers rather than real changes in the call rate.
3. Mark or re-mark the listening site so that future counts can be made at the same place and check the GPS position of the listening station. Preferably take a photograph of the marked listening station and store this with the count data.
4. Aim to arrive at the listening station with enough time to get ready for recording. Have all your clothing and gear handy that you will need during the listening period.
5. **Do not solicit calls from kiwi** during Nationwide Call Count Monitoring, because broadcast calls will not be repeatable over time due to changes in technology, which may bias the results.
6. Start to listen at the standard time used for that particular listening station (usually c. 30 minutes after sunset).
7. Record the gender, time, compass bearing and estimated distance to each kiwi heard calling. Where a call is interrupted mid-sequence (as often occurs during great spotted kiwi duets), record as one call if one of the birds resumes calling mid-sequence after their partner has finished, but as two calls if they (very rarely) restart their call sequence from the beginning. Bracket calls that you think are duets with the initiator's call shown first and the response second.
8. Listen for 2 hours. Also record the details of any birds heard calling before or after the official counting period, but do not include these in the main count.

9. Fill in a separate card for each 1-hour period because weather conditions can change whilst listening. It is best to record weather conditions at the end of each hour by recording the average or modal conditions during the whole hour.
10. After each hour, estimate the number of individuals heard during the hour, and at the end of the second hour, estimate the total number of individuals heard during the 2-hour period.
11. Only record complete hours of listening. If a count is halted part-way through an hour (e.g. if heavy rain starts), that complete hour should be re-counted on another night to bring the sample up to the appropriate number of hours.
12. Nationwide call count data should be sent to Hugh Robertson, Biodiversity Group, DOC National Office, PO Box 10-420, Wellington. These data are stored separately from the usual Kiwi Call Scheme data because inclusion of data from these sites would give a bias in mean call rates towards these especially productive calling sites.
13. If the call rates are found to have decreased significantly at any listening station during the repeat surveys, consider repeating the counts the following year rather than waiting 5 years to determine whether the result was an anomaly or the result of real population changes.

7.2.2 Monitoring with acoustic recorders

At remote sites, or those with a low population density, automated acoustic recorders provide an excellent method of monitoring long-term changes in the call rates of kiwi. Similar principles apply as with normal call count monitoring (Section 7.1.2), i.e. listening stations should be chosen that have a wide coverage so that multiple territories are included in the listening range. Although the detection range of acoustic recorders is less than that of human ears (see Section 7.1.3), this can be rectified by having more listening stations to cover an equivalent or greater number of territories, and night-to-night and hourly variation in call rates can be reduced by collecting and analysing far more hours of data.

For long-term monitoring, the recorders must be deployed at exactly the same location (site and position on a tree or post) in the same month of the year, and at the same start and finish time each time. In addition, monitoring should be carried out in the period a week either side of the new moon because the relationship between calling rate and phase of the moon is complex and varies between species, and possibly between habitats and situations. This standardisation reduces the number of variables, making it easier to detect any real differences in call rate. Also, deployment of the units for longer than absolutely necessary will allow the windiest and wettest nights to be removed from the dataset, further reducing night-to-night variation in the detection rate.

YOU WILL NEED:

- Acoustic recorders with fresh batteries and SD cards
- GPS

METHOD:

1. Before heading into the field, check that all acoustic recorders have fresh batteries and SD cards fitted, and that the time is set correctly on all units. Also, note the brand and model of the recorder used in each monitoring session and, if possible, use the same equipment between sessions, or at least calibrate the differences in detection ability between the different models.
2. Note the GPS position of each listening site and mark or re-mark it so that the recorders can be placed in exactly the same place with microphone(s) facing in the same direction on future occasions. Preferably take a photograph of the recorders in situ and store these with the analysed count data or report.

3. Set the recorders to all start at the same time (30 minutes after sunset) and to record for 4 hours. In some cases, this may not coincide with the greatest rate of calling (e.g. great spotted kiwi tend to call most just before dawn), but this early evening period is traditionally used for human listening and so will facilitate any future comparisons between the two methods.
4. Set the recorders to operate for 15 consecutive nights, from the last quarter through the new moon phase to the first quarter, during the period from 1 February to 30 June.
5. **Do not solicit calls from kiwi** during acoustic monitoring, as broadcast calls will not be repeatable due to changes in technology, which may bias the results.
6. Collect the recorders after 15 nights and, if necessary, re-deploy them with fresh SD cards and batteries.
7. Back up all audio files on two separate hard drives as soon as possible, and store each in a separate location.
8. Before you begin to analyse the data, quickly scan the 15 nights (60 hours) of recordings and set aside the 5 nights with the greatest noise interference from wind, rain, flowing water or animals chewing on the microphone!). Do not base your decision on the presence or absence of calls, just the colour of the background noise (the computer screen has lots of dark tones when it is noisy).
9. For each 15-minute recording, count the number of male and female calls (but see 13 below), and their strength on a 1–3 scale (1 being strong with a very clear outline, 3 being very faint), and also note the number of duets (where a bird responds within 10 seconds (but usually much less) after the end of a call sequence by a bird of the opposite sex).
10. In cases where a call is interrupted mid-sequence (as often occurs during great spotted kiwi duets), record it as one call if the bird resumes calling mid-sequence and two calls if the birds restart their call from the beginning.
11. Record background noises on a 0–3 scale (wind = calm to strong; rain = none to heavy; and other (e.g. sea, rivers, insects, other animals, aircraft) = no interference to very noisy). Note that although some of these other noises would ordinarily affect human listening, the kiwi calls will likely still be clearly visible on the spectrogram because their frequency ranges are often very different.
12. Only record complete 15-minute recording periods. If a count is halted part-way through a 15-minute block (e.g. if heavy rain starts and obliterates any chance of seeing kiwi calls), that complete block should be set aside.
13. An alternative approach, and one that may be implemented once automated call recognition software is available, is to simply record the presence or absence of kiwi calls in each 15-minute block, i.e. once a call has been detected move on to the next block. This method will greatly reduce the rather tedious task of reviewing the records, and the pattern of presence/absence of calls should also change over time if the underlying population is increasing or decreasing. This method has yet to be fully tested at a range of call rates, but since the recordings are kept, the standard method can always be applied retrospectively, or with very little effort, the standard method can be reanalysed and additionally reported in this format.
14. Aim to repeat the monitoring at yearly intervals for the first 3 years to establish a good baseline, and then repeat the monitoring at 5-year intervals thereafter. If call rates decrease significantly at any listening station during the repeat surveys, consider repeating the counts the following year rather than waiting 5 years to determine whether the result was an anomaly or the result of real population changes.

7.2.3 Radio-telemetry studies

Many kiwi populations are being intensively managed through predator control programmes and/or ONE. To model the response of a kiwi population to such management, it is important to obtain good data on the survival of all age classes of kiwi, the productivity of birds, and the rates of immigration and emigration.

Radio-telemetry is the best available tool for monitoring the effectiveness of conservation management programmes, because it provides good data on the survival and movements of kiwi. It also provides an excellent and unbiased approach for following the fate of each nesting attempt and thus estimating the productivity of each individual each year. These data can then be used in population models (e.g. Leslie matrices) to estimate the overall rate of population growth. The drawbacks of radio-telemetry include the high costs and the risk that transmitters will become entangled in thick vegetation at some sites, e.g. areas with mangemange and muehlenbeckia should be avoided.

Since the productivity and survival of kiwi vary between sites, it is not necessarily reliable to use data from other study areas where the predators or energetic costs may be quite different. Furthermore, there is considerable variation between individuals in productivity, and so good sample sizes (20+ pairs) are required to obtain reliable data on what the population is doing as a whole. There can also be considerable year to year variation in both productivity (breeding effort) and survival (predator densities and effects), and so you should aim to follow a sample of radio-tagged birds for a minimum of 5 years to stabilise this variation.

When modelling the population dynamics of kiwi, it is important to consider human-induced stresses that may cause birds to desert their nests or accidents that cause birds to die prematurely (e.g. transmitters becoming entangled in thick vegetation) and take this into account when modelling their population dynamics. Robertson & Westbrooke (2005) provide a practical guide to the management and analysis of survivorship data from radio-tracking studies, with examples that use real kiwi data. In addition, Robertson et al. (2011) and Robertson & de Monchy (2012) provide information on the methods and results for analysing the life history parameters of kiwi based on radio-telemetry data, calculating population growth rates from Leslie matrices and making population projections for a number of populations under different forms of management. For further help with population modelling, consult Hugh Robertson (Biodiversity Group, National Office, DOC, PO Box 10-420, Wellington).

7.2.4 Monitoring designated banded populations

A cost-effective method for estimating trends in kiwi populations is through the periodic mapping of territories and undertaking a 'roll-call' of banded territorial birds (e.g. Robertson et al. 2005). The geographical scale of monitoring by this method is very much smaller than that covered by the Nationwide Call Count Monitoring Scheme (see Section 7.2.1), but it provides important independent information on changes in the number of occupied territories in a designated area, and on the survival and replacement of individual birds within them, both of which can be used to make population projections. Furthermore, at some sites, Nationwide Call Counts are carried out within the banded population, allowing the effectiveness of monitoring by call counts alone to be assessed.

Banded populations of kiwi have been established at many sites around the country as a result of research or management projects. Some of these populations are part of long-term management projects (e.g. Rowi and Haast Tokoeka Sanctuaries, Project Kiwi, Friends of Flora), and so do not require specific banding and territory mapping visits as long as there is a continuing programme of banding all birds encountered, and collecting data on the survival of individual radio-tagged birds and the turnover of mates; however, if continuous monitoring ceases, this short-term monitoring technique could be used to assess population changes in the future.

The Kiwi Recovery Group has identified seven sites across New Zealand where sufficient territorial birds have been banded to effectively map the number of territories, monitor the survival of individuals, and record population turnover and population change at c.5-yearly intervals (Table 7.3). These seven sites cover three taxa, and include sites with and without protective management.

Table 7.3. Sites where banded populations of kiwi are monitored at 5-yearly intervals.

TAXON	SITE	MANAGED?	NEXT CHECKS
Rakiura tokoeka	Mason Bay	No	2018, 2023
	Port Adventure	No	2017, 2022
Great spotted kiwi	Saxon Hut, Goulard Downs	Yes	2019, 2024
	North Branch, Hurunui River	No	2020, 2025
Little spotted kiwi	Tiritiri Matangi Island	Yes	2017, 2022
	Red Mercury Island (Whakau)	Yes	2021, 2026
	Kapiti Island (Okupe, Te Kahuoterangi, Trig/McKenzie)	Yes	2018, 2023

It is intended that each site is visited every c.5 years, and as many birds as possible are caught and marked or re-marked over a 2–3 week period. A 5-year interval was chosen to give a reasonable chance of recapturing a large proportion of the birds banded during the previous check, and to minimise the likelihood of death of both members of a pair between visits – if annual survival is 90–95%, then 59–77% should be alive after 5 years and 34–60% should be alive after 10 years if individuals are missed during the previous check.

During each site visit, the aim should be to catch at least one member of each pair and >60% of residents. Territory mapping is usually coarse due to time restrictions, giving few specific locations from capture, telemetry and listening data; however, long-term trends in the number of occupied territories are usually very clear.

Visits should be made in autumn (no later than the end of May), outside the main breeding season. During most site visits, the locations of birds calling at night, and sightings of banded and unbanded birds (including those caught on trail cameras) are plotted on maps of the study area, and linked to data from the capture and short-term radio-telemetry of some birds to determine the number of pairs present. However, at a few sites where the population density is very high (e.g. Kapiti Island), the site visit will be limited to checking for specific territorial kiwi in well-established territories, whilst also carrying out wider searches to find previously banded birds that may have left the study territories, identify new pairs to monitor and mark neighbouring birds that may fill vacancies in the key territories at a later date.

It is important that these particular banded populations are not disturbed between the 5-yearly visits and that the visits are made outside the main breeding period to reduce any potential adverse effects on the natural survival and productivity rates of the birds. Permits must not be issued to conduct new scientific research on kiwi at these particular sites, or to transfer eggs or birds from near these study areas without agreement from the Kiwi Recovery Group. Those wishing to conduct management or other non-kiwi scientific research at these seven sites should consult with the Kiwi Recovery Group, who will consider the effect that any disturbance may have on the banded kiwi populations there.

7.2.5 Dog surveys to determine changes in population structure

Repeated surveys with certified kiwi dogs (see Section 9) can be used to detect changes in the structure of kiwi populations (Robertson & Fraser 2009; see Section 7.1.5 for methodology). To be effective, a minimum of 30 independent encounters is required during each survey, and it is preferable to follow a similar route or thoroughly search the same block each time the survey is carried out. If all birds encountered are permanently marked, standard capture-recapture

statistics can be applied to estimate population size, in addition to gaining information on changes in age structure and sex ratio in the population. The analysis of changes in encounter rate may also be of value, although it is important to note that this can be affected by the age, experience and type of dog, the age and fitness of the dog handler, and the weather, season and time of day.

8. Kiwi translocations

This section provides information on how to translocate **subadult and adult kiwi** and the equipment you will need, as well as specific information about ONE.

8.1 How to translocate wild kiwi

Translocations have five distinct steps:

1. Permissions and planning
2. Capture of kiwi to be translocated
3. Transportation
4. Release
5. Post-release monitoring

Before planning a translocation, ensure that you have read the Translocation SOP and carefully worked through each step.

8.1.1 Permissions and planning

Obtaining permission

A translocation proposal will need to be submitted to DOC, providing detailed information about the reasons for the translocation, the possible effects it may have, the proposed plan of action and any consultation that has been carried out. However, before preparing this formal proposal, you will first need to prepare an outline of your idea to translocate kiwi⁸ to determine whether it has general support. This can be submitted to your local DOC office, who will discuss the translocation idea with key stakeholders and other relevant DOC offices to gauge the level of support, and seek the opinion of the Kiwi Recovery Group on whether they support the concept and whether particular issues need to be addressed when developing a formal proposal.

If your outline is supported, you will next need to prepare a formal translocation proposal, which will be assessed by DOC in consultation with the Kiwi Recovery Group. To simplify the application process, the Translocation Proposal Form acts as an application form for the translocation and for most of the permits required from DOC. Note: Permits for banding/ marking animals and entry to non-DOC land, and approvals from the Animal Ethics Committee for activities that do not comply with the operative Best Practice Manual need to be applied for separately.

Your proposal should include a detailed plan of how the operation will be run, including capture, transportation, release event, and monitoring methods and equipment, and mention of all trained personnel who will be involved (e.g. approved dog handlers, accredited handlers). Contingency plans and checkpoints at which the operation may stop if intermediate goals are not achieved should also be included.

Note: It is important that you fill all required fields on the Translocation Proposal Form, if necessary stating 'Not applicable'. When in doubt about what to write, please consult with your local DOC office or the Kiwi Recovery Group. Once completed, the proposal should be sent to the Permissions Team in the Department of Conservation who will assess the proposal in consultation with local departmental staff and the Kiwi Recovery Group.

⁸ See 'A guide to establishing a new kiwi population' (<http://www.kiwisforkiwi.org/wp-content/uploads/2013/12/Establishing-a-new-kiwi-population.pdf>).

The Kiwi Recovery Group will assess the translocation proposal at the concept stage and again at the formal proposal stage to:

- Ensure that it supports one or more objectives of the operative Kiwi Recovery Plan or will provide an additional benefit to kiwi conservation that is not covered in that plan.
- Ensure that it does not conflict with higher priority translocations that are being planned.
- Provide scientific and technical advice to improve the chances of success and learning from the translocation.
- Ensure that Best Practice is being followed.

Should your translocation proposal be approved, DOC will issue you with permits that allow you to carry out the translocation activities you require (such as the capture of wildlife) using the methods described in your approved proposal.

Planning a translocation

Several steps need to be taken to prepare for a translocation prior to capturing the birds. This includes, consulting with key stakeholders, preparing release burrows and organising any release events.

YOU WILL NEED:

- Trained personnel
- Transfer boxes

METHOD:

1. Follow the procedures in the Translocation SOP, including consultation with iwi and other key stakeholders at both the capture site and the release site.
2. Iwi should be consulted about how they wish to be involved in the initial transfer and in subsequent identical transfers.
3. Translocations of adult kiwi must be carried out between **1 February and 31 May** (with the exception of little spotted kiwi from Kapiti Island, which can be moved up until mid-July, because breeding starts in September) to minimise the risk of catching and handling gravid females, and to reduce the risk of transferring nesting birds.
4. Subadult birds can be transferred from wild sites or kohanga kiwi at any time of the year, but it is best to plan your releases for autumn, when feeding conditions are improving and the nights are getting longer. It is often difficult to distinguish a subadult kiwi from an adult kiwi without handling it, and so avoid transferring subadults from wild populations between 1 June and 31 January unless they are already radio-tagged, or the resident adults are radio-tagged and so can be avoided.
5. Decide when and where to release birds. Prepare or find suitable release burrows well in advance of the transfer. When preparing a new burrow, dig a sloping hole 50 cm deep x 20 cm x 20 cm and cover the entrance with plywood or a log. Mark it clearly so that it can be found on the day of release.
6. In some circumstances, birds can be released directly into unused 'penguin boxes' with the exit temporarily blocked, or into thick vegetation similar to that used by birds during the day, e.g. under dense bracken, pampas or buffalo grass.
7. Organise public and iwi involvement in the release. This can be particularly important when the behaviour of people, such as dog-owners or the local community, will play a key role in the success of the translocation.
8. Organise all transportation for the birds, with contingency plans in case bad weather prevents travel. If the birds are travelling by air, make sure that the airline knows well in

advance that the birds are going to be travelling that day, and that DOC staff are able to meet the plane at any stop-over sites to ensure that the birds are appropriately transferred from flight to flight and stored in suitable quiet conditions and that no-one opens the boxes to have a peek inside. See Section 8.1.3 for further information on transportation.

9. Ensure that transfer boxes are appropriately labelled with 'This Way Up' and 'Live Animals' stickers, and with Kiwis for kiwi logos on at least the front, top and back.
10. If the release will be attended by a large number of people, make sure that you have enough accredited kiwi handlers attending the release event so that people will have an opportunity to see kiwi up close.

8.1.2 Capture of kiwi to be translocated

Health screening

For further information, consult the DOC Wildlife Health SOP (docCM-442078) and the Translocation Health Management Workbook (docCM-54393).

Each kiwi that is moved is a potential carrier of a wide range of viruses, bacteria, fungi and parasites, which could threaten the health of the wild population to which they are introduced or even the health of other bird species. Furthermore, kiwi displaying ill-health may worsen due to the added stress of translocation, and so should not be moved for their own welfare.

The standard health screen tests that are required before kiwi are transferred are:

- A physical examination and measurement of body weight and condition
- Cloacal swabs for *Yersinia* and *Salmonella*
- A faecal egg count for worms and *Coccidia*
- Preferably blood smears to identify blood parasites such as avian malaria and Babesia, and to check whether white blood cell counts and percentage composition are outside the normal range, indicating the presence of infection

Note:

1. Since kiwi are difficult to quarantine, there is no history or suspicion of major disease outbreaks in kiwi, and most transfers are to sites that are not already occupied by kiwi, quarantine procedures are not usually followed for wild-to-wild transfers. However, quarantine is necessary in captive-to-wild transfers due to the higher disease risk from living at high densities in captivity, and exposure to a wider range of different species and disease risks.
2. Health screening is not required where the transfers are local (i.e. within an ecological district, or between adjacent ecological districts that are not separated by a significant water barrier) because kiwi could naturally disperse across these distances.

YOU WILL NEED:

- Trained personnel
- Cloacal swabs

METHOD:

1. If kiwi are being transferred to a high-risk location where important wildlife (e.g. kakapo) could be put at risk of new zoonoses, all birds to be transferred **must** be disease-screened and given the all-clear before translocation.

2. Because it is often not practical to sample from every individual that will be transferred, and if the risk to other wildlife is deemed low, disease-screening often involves a sample of birds at the source site that includes most, but not all, birds being transferred. If this population sampling shows no major disease threats (based on an assessment of cloacal swabs, and possibly blood parasite DNA surveys), then the transferred birds are sampled at the time of transfer so that an *a posteriori* assessment can be made should any individuals subsequently die or should the transfer fail.
3. In some situations, where birds are being collected from a remote site, and where risk to other wildlife at destination is deemed low, disease-screening can be done at the time of translocation so that an *a posteriori* assessment can be made should any individuals subsequently die or should the transfer fail.
4. If any kiwi in the population show signs of any major disease, such as *Salmonella*, the transfer **must not** proceed until the strain and/or risk has been determined and the DOC veterinarian gives the all clear to proceed. Often this will involve postponing the transfer until the disease prevalence in the population has been more fully assessed and all sampled birds are clear of the disease.
5. Kiwi **must not** be transferred if the pre-transfer physical examination shows that they are in poor condition, have a very heavy parasite load, or display any ill-health, significant injuries or genetic deformities.

Capture of birds

YOU WILL NEED:

- Trained personnel
- Handling gear (for measuring, weighing, sexing)
- Bands/transponders and/or wing tags (see Section 6.3)
- Transmitters, if applicable (see Section 6.4)

METHOD:

1. Where practical, try to catch pairs of birds at the source site and attach a transmitter to help find them at the time of transfer. Transferring pairs of birds will reduce social disruption at the source site, but generally pairs do not remain bonded after release.
2. Avoid transferring any kiwi that has injuries or deformities (e.g. blind). Birds in poor condition should generally not be transferred; however, their poor condition may be caused by overcrowding at the source site or by having only recently finished breeding, and so some experienced judgement is needed.
3. Birds should be caught as close to the time of transfer as possible, though it could be more sensible to hold birds in their transfer boxes overnight in a quiet, dark place rather than rushing to catch them on the day of transfer, as no problems have been encountered using this approach. If you need to hold birds for more than 1 night (e.g. from remote sites where transport is difficult or expensive), delay catching the birds until 3–4 hours after dark on the first night so that they have an opportunity to feed before capture, and hold the birds in transfer boxes in a cool, dark place through the next day and night, avoiding disturbing them. The maximum time a bird should be held between capture and when it is first able to feed in its new environment should be no more than 45 hours.
4. If you need to walk long distances with captured birds (or birds that are about to be released) in forest or difficult terrain, you can use canvas bags to carry them rather than the large and heavy transfer boxes. Open the bag carefully to allow fresh air in every 15–20 minutes.

5. Permanently mark each bird with a band, wing tag or transponder at the capture site, take any health screening samples and, if applicable, fit transmitters. This will reduce handling time and stress on the kiwi at the release site.

8.1.3 Transportation

Transfer boxes

Ideally, transfer boxes should be built specifically for the transportation of kiwi, and no other species, to avoid the risk of spreading disease between species. Transfer boxes must not be used for the transfer of poultry or other domesticated animals. If transfer boxes are used to transport other native birds, including other kiwi, they must be thoroughly cleaned with SteriGENE® before being used again.

A transfer box needs to be strong enough to hold a kiwi and must have good ventilation. Although the box should not be too small, there should not be so much space around the bird that it could be injured if the box is jolted. Both single boxes (one compartment) and double boxes (two compartments separated by a solid barrier) have been used successfully in the past. Double boxes are easier to stack, allow members of a pair to stay together, are more stable and are cheaper to build, but single boxes are easier to carry and fit into limited spaces in helicopters.

YOU WILL NEED:

- Wooden box
- Air vents
- Fine-mesh insect screen
- Perspex
- Closed cell foam (optional)
- Newspaper/paper towels/towels

METHOD:

1. Build or select a suitably designed transfer box (see Fig. 8.1 for an example).
2. Position commercially available air vents with a series of parallel blades close to the bottom of the box with the internal part of the blades pointing upwards, and near the top of the box with the internal part of the blades pointing downwards, so that the bill cannot extend out of the box. Each vent must have a fine-mesh insect screen stapled securely across the inside to further prevent a bird from trying to poke its bill out of the vents.



Figure 8.1. Wooden transfer box (external dimensions: 610 mm long x 360 mm deep x 360 mm high, including lid) made with 100 mm thick (7ply) marine plywood).

3. Place a separate sheet of Perspex on top of each compartment so that the kiwi can be viewed when the lid is opened and to prevent the bird's bill from becoming jammed under the lid when the box is shut. The Perspex sheet should preferably be slid into place in slots; however, designs where the Perspex lid is lowered onto a batten frame, with a small finger-sized hole to allow it to be lifted up from the outside, are also acceptable – but be aware that the bird could dislodge the lid when the box is opened.
4. Sheets of closed cell foam can be stapled to the outside of the box to reduce noise and heat, but ensure that the air vents remain uncovered.
5. **Make sure** that no nails or screws protrude into the compartment or are loose within the compartment.
6. Line the bottom of the box with folded newspaper, paper towels, clean towels or vegetation. Kiwi can be very messy, and so have a supply of extra paper or towels available so that the lining can be changed completely, particularly if a bird is held overnight.
7. When placing a kiwi in a transfer box, **make sure** that its bill is well clear of the top of the box or Perspex lid before closing it.
8. **Never** place two birds in the same compartment, even a pair, as the heat build-up may become an issue and the birds may fight or injure one another accidentally in such a stressful situation.
9. Place the boxes far enough apart to allow air to circulate through ventilation holes.
10. When extracting a kiwi from a transfer box, the accredited handler should gently reach under the bird to take hold of both legs before fully opening the box or withdrawing the Perspex lid.
11. If a bird is removed from a compartment for cleaning or processing, always return it to the same compartment to reduce the risk of the transfer of disease or parasites.
12. It is not necessary to provide water if the kiwi are to be kept in the box for only 1 night. If practical, or if birds are to be kept for more than 1 night, provide earthworms (75–90% water content), mealworms (61% water content) or huhu grubs so that they can obtain water by that means at 50 mL water per kg body weight per day. Do not discard uneaten worms or mealworms at the new site.
13. If held overnight, keep the birds in a quiet, safe place, preferably in a locked and darkened room. This avoids the temptation for people to take a look, open the lid and risk the kiwi escaping, each causing more stress for the bird.
14. After use, discard the soiled papers, towels or vegetation in a safe manner. The boxes must then be scrubbed clean with a solution of SteriGENE® and rinsed with water. They should be left to dry in a well-ventilated area before being stored in a dry area. While cleaning the boxes, check for any damage and carry out repairs, rather than waiting until the next transfer.

Transport

It is preferable to travel during the day, particularly if the bird can be released before dusk, as the birds will tend to be sleepy and more relaxed.

ROAD

Vehicles that are used for transporting kiwi should be kept as cool as possible to avoid heat stress. Full ventilation or air conditioning is essential on sunny or warm days. Do not transport kiwi in the boot of a car, as not only is there less ventilation, but it is noisier and there is a risk of carbon monoxide poisoning. If kiwi are transported in the back of a ute, have the side windows (but not the back window) open and preferably use a ute with an air dam in the canopy, which ducts fresh air into the canopy space.

If the vehicle is parked, for example for a meal break, it is preferable that someone stays with the car and that the windows are left fully open. Alternatively, park the vehicle in the shade and open the windows sufficiently to allow airflow whilst keeping the car secure.

The transfer boxes should be secured at all times with seatbelts or straps so that they do not tip over or slide around. Place an old carpet or closed cell foam on the tray of a ute to reduce the movement of boxes and the noise levels. Periodically check that there is good air space between the boxes, but resist the temptation to open them to see how the kiwi are doing.

Drive at close to normal speed on sealed roads to minimise the travel time, but take corners more slowly than usual to prevent the birds from being thrown around. Also drive more slowly than usual on unformed and gravel roads to minimise bumps. Keep noise levels in the car to a minimum if the birds are inside.

BOAT

Boats are often used to transport kiwi to or from islands. Bad weather and big swells should be considered as part of the risk assessment, and the exact timing of the transfer and contingency plans should be devised accordingly. Always have a helicopter back-up or be prepared to abandon the transfer and release birds back at the source site if conditions deteriorate so much that transportation is impossible.

Stow the transfer boxes in a dry area or place a tarpaulin over them to prevent spray from entering the vents, but maintain ventilation. It is sometimes better to transport the birds on the deck rather than deep in the cabin or hold where there is little air flow.

AIR

Radio-transmitters on birds must be turned off during flights in case they interfere with the navigation or communication systems of the aircraft. Ensure that transmitters are then turned on again and are working at the destination site before release.

In 2012, Air New Zealand announced a sponsorship programme for carrying threatened and endangered species for Department of Conservation, though this does not extend to community group projects. A guide to this programme is available on docCM-999105. Contact the airline well in advance of any planned transfer to clarify their requirements and yours. Generally, kiwi are not accompanied on commercial flights, but photographic ID (e.g. drivers' licence) of the accredited kiwi handlers will be required at the departure point and arrival destination, as well as at any transit stops. For this reason, it is often preferable to get a direct flight rather than one that has a transit stop.

Transfer boxes should be labelled clearly with the destination, flight number, 'Live animal' stickers, and 'This way up' stickers. In practice, transfer boxes should be taken to the cargo section at least 60 minutes before the flight, and will be taken separately to the aircraft once suitable security clearances have been given. **Make sure** that the kiwi are transported in pressurised and heated holds in aircraft flying above 3000 m. It is particularly important to ask airline staff to ensure that there is some space around the boxes so that the ventilation holes are not butting up against other boxes or the side of the hold. At the destination, the accredited handlers, carrying Government-issued photographic ID, should make themselves known to airline ground staff well in advance of the flight's arrival and explain the nature of the consignment that they are receiving.

On non-commercial charter flights, the boxes are best carried on seats in the passenger compartment rather than in holds, unless the holds are pressurised and heated.

8.1.4 Release

YOU WILL NEED:

- Trained personnel

METHOD:

1. When the kiwi arrive at the site of the release ceremony, keep them in the shade and well ventilated, in as quiet a place as possible.
2. Allow one transfer box containing birds to be used as part of the welcoming ceremony, but try to keep it in the shade as much as possible.
3. Allowing the public to see kiwi at close quarters is a powerful stimulus that invokes empathy for kiwi and their conservation. However, this **must** be done in a controlled way that is safe for the kiwi and the public. There are usually ample opportunities for people to have their photograph taken with a kiwi and to touch kiwi at a kiwi release. The birds **must** be held correctly by the unfeathered part of the legs, with the body lying on top of the arm, as described in section 6.1.
4. Only accredited handlers should remove kiwi from transfer boxes, and generally hold the kiwi during any media and public-viewing opportunities arising during a translocation; however, if the approved handler considers it safe and desirable, one other non-accredited person may release each kiwi, after tuition from, and under the direct supervision of, the accredited trainer at all times – see Section 13 for further guidance.
5. Accredited trainers **must** assess the condition of all birds being held, and return them to their transfer box if they show any signs of stress (panting, opening the bill and head lolling).
6. When showing birds to the public, appoint a ‘minder’ to make sure that the handler has a clear passage through the crowd so that the bill of the bird is not accidentally damaged.
7. People may take photographs of kiwi, though flash photography should be kept to a minimum, particularly in the daytime when it is often unnecessary.
8. People may gently touch or stroke the body of a kiwi that is being held correctly without causing undue stress to the bird. **Never** let people touch the bird’s bill or head.
9. Try to keep the viewing time to a maximum of 20 minutes per bird and the total viewing time (sometimes viewings occur at several locations *en route* to and at the release site) to a maximum of 45 minutes per bird. Periodically change the birds being shown to the public, and only use those that appear relaxed and are not showing any signs of stress during the process.
10. At the actual release site, release the bird into its prepared burrow, box or thick vegetation head first, release your grip on its legs only after it is well inside, and quickly replace the plywood cover on the burrow or box.
11. Release known pairs, or birds that were found in a daytime shelter together, near to one another or into the same prepared burrow or box. (Note: In practice, it seems that many existing pair-bonds are broken during translocations, implying that it is the territory rather than the individual that was the original attraction.)
12. At least 20 minutes after release, and preferably towards dusk, quietly return to the burrow or box and shift the cover aside to allow the bird to exit in its own time – resist the temptation to look in to see how the bird is doing because this will only stress them again and may make them stay in the burrow all night. Quietly leave the area without waiting to watch them emerge.

8.1.5 Post-release monitoring

There is no standard prescription regarding the level and type of monitoring that should be carried out after release because individual circumstances vary so much. Some form of post-release monitoring is essential when birds have been introduced to a site without an existing kiwi population so that we can learn from our management; however, subsequent releases do not need the same level of monitoring if the original release was deemed successful. Likewise, if birds are released into habitats with resident kiwi, there is less need for intensive monitoring unless there are concerns that resident birds will exclude the transferred birds.

As a minimum, all transferred kiwi **must** be banded, wing-tagged or have a transponder implanted, so that they can be identified at a later date.

The decision around whether to attach a transmitter to released birds will depend on the particular circumstances surrounding the release. In some environments, there is a danger of transmitter entanglement, and some release sites are very remote and expensive to monitor by radio-telemetry, and so monitoring should be carried out by other means, such as by using acoustic recorders or periodic timed call counts (see Section 7.2).

In most instances, post-release monitoring will involve checking the fate of radio-tagged individuals with mortality transmitters (see Section 6.4.3). Transmitter signals should be checked at least weekly for the first month, fortnightly for the next 2 months, and three-monthly thereafter for a minimum of 1 year or until the birds have bred. Subadults and adults wearing transmitters should be caught, weighed and measured no more frequently than at monthly intervals for the first 3 months, and at 3-monthly or greater intervals thereafter.

If the release was into a new site without resident kiwi, it is useful to catch a sample of birds about 10 years later and compare the ratio of transferred birds to those that were hatched at the release site. This 10-year interval allows the released birds to have become established and breed, and for there to have been enough turnover of adults to estimate the status of the new population.

Monitoring must meet the requirements stated in the translocation proposal and in the Department of Conservation's *Standard Operating Procedure for the Translocation of New Zealand's Indigenous Terrestrial Flora and Fauna*.

8.2 Operation Nest Egg (ONE)

Note: Specific information on ONE, the collection of eggs or chicks from the wild, and the transfer of eggs and chicks to captivity or chicks to a crèche or kohanga kiwi site are covered in the Operation Nest Egg incubation and chick rearing best practice protocols (Bassett 2012).

Release of ONE birds (and the release of their offspring from crèche islands or kohanga kiwi sites) back to the original source area, will normally be included in the approved national translocation proposal for ONE. Translocations to sites not already occupied by kiwi, or to sites more than 50 km from original sources areas, will need a separate translocation proposal.

Research has shown that at unmanaged sites, approximately 85–90% of kiwi chicks fail to reach 6 months of age and 95% die before reaching adulthood, mainly due to predation by stoats and cats (McLennan et al. 1996, Robertson et al. 2011; Tansell et al. 2016). In 1994, ONE was developed as a means to avoid this predator-induced bottleneck in the life history of kiwi populations (Colbourne et al. 2005). Although the name implies that only eggs are involved, the removal of nestlings to captivity is also included as part of this programme. The technique involves collecting eggs or young chicks from the wild, hatching the eggs in captive facilities, rearing the chicks in captivity and/or at predator-free crèches (islands or predator-proof sanctuaries), and then releasing subadults to the mainland once they are big enough to defend themselves from cats and stoats.

By 2016, over 2000 subadult kiwi had been released to the wild as part of this programme, to bolster existing populations or to create new populations. Because most kiwi species provide little parental care, the chicks are naturally wired to behave like kiwi, and so many released birds have bred successfully with wild kiwi and some third-generation ONE birds are now known. Aside from having a slightly higher post-release mortality compared with equivalent-aged wild subadults, the life history and behaviour of these kiwi appears normal – and rather than only 5% of chicks reaching adulthood, ONE chicks typically have survival rates to adulthood in excess of 50%.

In a few cases, eggs or chicks will be rescued from a deserted or disturbed nest, in which case the same protocols will apply as with ONE.

It is a good idea to attend an egg candling course before embarking on a ONE project, or at least to receive in-field training during an egg-lift from those familiar with the technique. Currently, egg-candling courses are run approximately biennially at Kiwi Encounter, Rotorua.

8.2.1 When ONE should be used

ONE is only one of a number of management options and **must not** be embarked upon without full consultation with the Kiwi Recovery Group. It is a very labour-intensive and expensive programme, and consideration **must** be given to the genetic consequences of using this.

While ONE clearly benefits kiwi, it does not benefit other species or the ecosystem that the kiwi live in. Therefore, an intensive, long-term, fully integrated pest control programme that consists of trapping and/or poisoning pests may benefit not only kiwi, but also the rest of the kiwi's environment and a range of other threatened species. By contrast, a pest control programme that focuses on only one pest, such as a stoat trapping programme, may upset the ecological balance and prove counter-productive in the long-run (Craig Gillies, DOC, pers. comm.).

ONE releases should preferably be used in conjunction with the control of ferrets and dogs, because these are the two main predators of adult and subadult kiwi – there is little point in raising subadult kiwi if they are going to be killed shortly after release.

ONE should be used:

- Where new populations are to be established, particularly for the establishment of kohanga kiwi sites, because it allows the genetic structure of the population to be controlled, e.g. by avoiding having too many closely-related birds among the founders.
- Where it is desirable to quickly build a population so that other forms of kiwi conservation (e.g. trapping or aerial poisoning) become more cost-effective.
- Where very depleted populations are to be enhanced and re-juvenated.
- To rapidly recover the populations of the most endangered kiwi taxa (rowi and Haast tokoeka)
- Where other threatened species may be adversely affected by predator responses, or directly affected by trapping or poisoning pests to protect kiwi.
- During years of high stoat numbers when conventional pest control methods may fail to adequately protect young kiwi.
- Where populations are unlikely to receive adequate protection but the offspring can be released into neighbouring populations that have a successful long-term pest control programme.
- Where the transfer of disease or parasites would be an issue if adult birds were to be moved, and
- As an advocacy tool to engage local stakeholders in a much larger *in situ* kiwi protection programme.

ONE has proven to be excellent for building critical conservation linkages with tangata whenua, local communities, local schools and captive-breeding institutions, as well as for highlighting the

threats to kiwi in the popular media. However, although its usefulness as an advocacy tool should not be underestimated, this should not be the driving force behind the use of ONE.

A recent review of ONE has shown that it remains an expensive tool (Gillies et al 2013), and it benefits only kiwi, not their environment. Furthermore, if the causes of decline (usually mammalian predators) are not addressed in a population, ONE will not offer a long-term solution because the offspring of the released ONE birds need to survive and breed to ensure that the population is self-sustaining. Therefore, in many situations, the opportunities for kiwi advocacy have to be weighed up against the benefits of protecting more kiwi and their environment through the use of other management tools.

8.2.2 Transfer of eggs and chicks for ONE

It is preferable to collect eggs rather than chicks for a ONE programme because this significantly increases total productivity and does not compromise the health of the adult birds in any way. The collection of eggs at mid-term incubation also allows more time for the pair to re-nest during the same season, than by waiting to intercept chicks when they emerge from the nest. However, in some cases (e.g. where a nest is very deep and it is impossible to reach the eggs), chicks have to be collected.

8.2.3 Optimum timing of egg or chick collection

The optimum time to collect eggs from a nest is a balance between the increasing likelihood of hatching success in captivity as eggs get older, and the chances that nests will fail as a result of predation, abandonment, flooding or cows standing on them before the eggs are collected.

It appears to be almost impossible to successfully hatch eggs in captivity that are less than 10 days old at the time of collection. The reason for this is unknown, but is likely related to the incubation temperature or incorrect egg turning resulting in poor chick development. The hatching rate of eggs improves rapidly from 10 days old to reach an asymptote of c. 90% hatching success at approximately 30 days old – which is much higher than the 45–60% hatching rate normally observed in the wild.

The situation for brown kiwi is complicated because c. 60% of pairs have a two-egg clutch, with the eggs laid 18–25 days apart. Robertson et al. (2006) calculated that to maximise hatching success, the eggs from one-egg clutches should be collected at 22–57 days old, whereas those from two-egg clutches should be collected when the older egg is 41–68 days old. Since the number of eggs in a clutch is generally not known until the eggs are collected, the optimum time to collect eggs was calculated to be at 41–57 days after the first egg is laid. Egg Timer and Chick Timer transmitters (see Section 6.4.4) help to calculate when the first egg is laid, although in Northland these usually have a lag of c. 10 days, presumably because incubation regimes are not sufficiently established after the first egg is laid to trigger the ‘incubation mode’ – this delay in starting incubation fits with the observed hatching asynchrony of c. 12 days between chicks.

Research in the Whangarei Kiwi Sanctuary (Hugh Robertson, unpubl. data) showed that the number of eggs laid each year was >30% higher in pairs whose first clutch was collected before they were 57 days old, largely due to the increased probability of re-nesting within the same breeding season. There also appeared to be no significant costs to the females in re-nesting, as there was no significant decline in egg size through successive clutches, and the likelihood of a pair remaining together, which is dictated by a combination of survival and mate retention (which often decreases when pairs fail to breed successfully), was similar between pairs whose eggs were collected for ONE and those not involved in the programme. Furthermore, male kiwi whose clutches were collected at <57 days old may have had an advantage over those that went full-term, because they did not enter the phase of near-continuous incubation (Colbourne 2002) and so did not experience the associated severe weight loss in the latter stages of the incubation period (Hugh Robertson, unpubl. data).

Therefore, in brown kiwi, the optimal time to collect eggs for ONE is 41–57 days after incubation commences. By contrast, in taxa with one-egg clutches, the optimal time for egg collection is 22–57 days after incubation commences, with collection between 22 and 35 days associated with an increased probability of re-nesting.

The collection of chicks will always be a suboptimal approach, not only because some nests will fail during incubation and the early stages of chick growth before the kiwi can be collected, but also because this allows less time for pairs to re-nest in the same season and because incubating birds put their energy into incubation rather than re-nesting.

8.2.4 Collection of eggs

Eggs are generally collected during the day, regardless of whether incubation is shared (continuous) or not. Our experience in Northland over many years has shown that only a very small number of eggs (<3%) are found to be cracked on collection, and the majority of these were cracked well before egg collection rather than damaged by the incubating male during egg removal. Elsewhere, people prefer to stake-out nests at night and wait for the incubating bird to leave before collecting the eggs, eliminating the need to touch or otherwise disturb the incubating male. Night collection of eggs is recommended as best practice for East Coast / Bay of Plenty kiwi, which appear to be less tolerant of disturbance than their Northland counterparts.

YOU WILL NEED:

- Chilly bin full of shredded paper or containing foam rubber with kiwi-egg-shaped holes
- Torch
- Measuring gear
- Soft-leaded pencil

METHOD:

1. Before you go out to collect eggs, make sure that the captive facility you will use knows to expect their arrival and that transport has been organised to get the egg(s) there. If you know that you may not be able to get the eggs to the captive facility that day, have a temporary incubator set up and ready to receive the egg(s).
2. In the field, you have two options for removing eggs: remove the incubating bird from the nest and then remove the egg(s), or take the egg(s) from beneath the incubating bird. The former method is generally safer and necessary if you also plan to change or check the bird's transmitter or attachment.
3. Brown kiwi nests are often (but not always) shallow burrows, making it is easy to reach the bird and egg(s) without needing to dig access shafts (see Section 5.2.1). Set up your chilly bin ready to receive eggs, and other gear such as Pesola balances, vernier callipers and a pencil.
4. Make sure that the bird is awake and aware of your presence. To maintain dexterity and sensitivity, use a bare hand or wear fingerless gloves rather than full gloves to reach into the nest.
5. If you are removing the incubating bird, slowly move your hand to shield the egg(s) as it backs away and then, once it is clear of the egg(s), take hold of its legs and lift it away from the egg(s). If you are removing the egg(s) from under the bird, gently grasp an egg with your hand above and over it, so that if the male does strike out, it is your hand rather than the egg that receives the kick. If there are two eggs, place the first egg immediately into the chilly bin and remove the second egg in the same manner.
6. When all eggs have been collected from the nest, weigh and measure them, and determine the position of the air sac by candling them. With a soft-leaded pencil, draw the outline of

the air sac on the egg shell, mark the top of the egg (where the air sac lies uppermost), and label each egg with information on date, location, nest number and parents' identification.

7. If an egg is clearly rotten, either break it open in the field to determine if it was developing or place it in a plastic bag and let experts determine this. Do not put it in the chilly bin as it will contaminate it. Be aware that a perfectly viable egg can smell rotten if it has been sitting next to a rotten egg for several days, so do not assume that both eggs from a smelly nest are addled.
8. In the unlikely event that an egg is cracked or pierced during removal, or more likely found with an existing crack or concave dent in it (rather than convex cracking, which is caused by the egg starting to hatch), temporarily seal the crack with electrical tape or medical tape. The captive facility will later clean the site and apply nail varnish or superglue, or superglue a small patch over the puncture hole.
9. Place the egg(s) into the middle layer of the chilly bin in a natural (horizontal) position with the marked top of the egg uppermost. Cover the egg(s) with more shredded paper, or with the other half of the foam rubber mould.
10. Carry the chilly bin carefully and transport it as smoothly as possible to a captive facility as soon as possible.
11. Where the egg(s) cannot be delivered to the captive facility that day, they should be placed in a temporary incubator.
12. If a freshly hatched chick is to be transferred, treat it in the same way as an egg, but limit the amount of shredded paper in the chilly bin to a 1-cm layer on the bottom of the bin. Be careful handling it, particularly if it has an obvious internal yolk sac or pot belly (i.e. is < 5 days old), because it will be easy to perforate.

8.2.5 Egg/chick handling at captive facilities

Detailed information on the procedures used in captive facilities, from the time that eggs are quarantined on arrival, through to egg and chick husbandry, to chick quarantine procedures before release are outlined in the Operation Nest Egg incubation and chick rearing best practice protocols (Bassett 2012).

8.2.6 Release to predator-free crèches and kohanga kiwi

Although wild brown kiwi chicks have been successfully released onto predator-free islands as young as 8 days old, ONE chicks should be released into predator-free island crèches, predator-free fenced sanctuaries or kohanga kiwi once they have regained their hatching weight. In captivity, the weight of healthy brown kiwi chicks usually drops by 20–30% over the first 10–13 days, as yolk sac reserves are used up, but once they begin to feed on an artificial diet the weight soon increases rapidly to return to the hatching weight at c. 20 days old.

All chicks released onto predator-free islands or into predator-free crèches **must** be marked either with a wing tag or with a transponder so that their identity can be determined when they are caught at a later date.

For the first release into a new crèche site or kohanga kiwi, the birds should preferably be radio-tagged, and captured, weighed and measured weekly for the first month, fortnightly for the next 2 months, and then monthly thereafter. At each capture, the radio-transmitter harness should be inspected closely and, if necessary, replaced. However, be aware that transmitters can become entangled in mangemange fern and pōhuehue (*Muehlenbeckia complexa*), so birds should be monitored using other methods (e.g. with kiwi dogs) if mangemange or pōhuehue is common at the release site.

For more routine operations, where birds are being released to crèches or kohanga kiwi with a known history of being suitable for kiwi, no post-release monitoring is required, except for the periodic round-up of birds being returned to the mainland. To determine whether the carrying capacity of the site is being reached the weights and condition of birds should be noted each time they are caught, even those that are deemed too small to be transferred to the mainland. If growth

rates have slowed markedly or the birds are in poor condition, reduce the translocations to the site and put more effort into removing birds of suitable size for release to the mainland.

Keep translocations of subadult kiwi to an absolute minimum, and so avoid shifting birds from crèche to crèche, in order to reduce the stress incurred on the bird by each transfer, and to reduce the social disruption that each translocation causes.

8.2.7 Release of subadults to the mainland

When young kiwi reach 800–1000 g (at about 6 months old for all but little spotted kiwi, which take several years to reach 1 kg), they become much less vulnerable to predation by stoats and cats, and so can be returned to the wild on the mainland. This ‘safe’ weight is a guide rather than a ‘magical’ weight at which there is no chance of these two predators killing a kiwi (in rare instances, birds up to 1700 g have been killed by stoats and cats). Birds should be returned from crèches or kohanga kiwi to mainland sites as soon as possible after they reach 1000 g (and certainly by the time they reach 1200g) so they can start to seek territories and form pair bonds at about the size and age when many wild chicks disperse well away from their natal territory.

If juveniles are raised entirely in captivity or in food-rich crèche or kohanga kiwi sites, they are often obese, in which case the recommended weight for release to the mainland is 1200 g, to provide them with a weight buffer while they learn to find their own foods in a new and often less productive environment.

Release sites **must** have a proven history of at least 3 years of predator control to an adequate standard for kiwi to survive and successfully recruit the next generation. This requires a description and independent audit of the trapping and/or poisoning regime before birds can be released. The 3-year lead-in requirement provides an indication of the commitment of the individual or organisation to continue the pest control programme into the future. There is little point releasing valuable birds into an area where predator control is not ongoing and where there are very slim chances of offspring from the released birds ever being recruited into the new population.

To ensure that the genetic structure of a new population is suitably diverse, the release site **must** interconnect with an existing large population, or a minimum of 40 unrelated founders (including any pre-existing birds at the release site) will be required at isolated release locations.

For brown kiwi, releases of subadults from captivity or crèches can take place at any time of the year, but preferably in the autumn and early winter (March to May) when the ground moisture levels are higher and the nights are getting longer. For South Island taxa, summer and early autumn releases have proven most successful, with chicks growing faster because less energy is spent keeping warm.

Experience with North Island brown kiwi indicates that chicks and juveniles can be released into the territories of existing adults with no aggression being shown. However, for kiwi in the South Island, it is preferable to release chicks and juveniles into vacant areas or near territorial boundaries, because the adults of some taxa regard all kiwi that are not in their family group as intruders and can sometimes kill them.

8.2.8 Release of adults to the mainland

At some crèche sites and kohanga kiwi, not all subadults will be captured for release on the mainland during the first collection attempt and so some will start to breed, sometimes at a much younger age than usually occurs on the mainland (e.g. a male brown kiwi bred on Motuora Island at 11 months old, Rogan Colbourne, pers. obs.). During subsequent round-ups, fully-grown birds aged 4 years or older should be banded before release on the mainland, even though many of them will also have a transponder.

The same site requirements apply as for releasing subadults in terms of a proven and ongoing pest control programme, and a genetically robust population size (see Section 8.2.7).

9. Kiwi dogs

Trained dogs have been used to locate kiwi for a long time. Richard Henry pioneered this technique back in the late 19th century as he shifted hundreds of kiwi from the mainland to many islands in Fiordland. Since the Kiwi Recovery Programme started in 1991, there has been a burgeoning use of trained dogs, from c. 5 certified dogs in 1991 to c. 30 in 2016. Most dogs are used solely for finding kiwi in their daytime shelters, but a small number of dogs are specially certified to be used at night to indicate the presence of kiwi nearby.

9.1 General requirements

It is important for kiwi dog handlers to understand that dogs are a predatory animal and their inherent instinct is to hunt. Therefore, it is essential to ensure that the highest standards of obedience are met, and that handlers have command and control of their dogs at all times. Dog handler teams need to maintain a high level of professionalism and demonstrate good knowledge of dog welfare.

The Department of Conservation regards the handler and dog as a team, and this team must be duly certified and permitted under the Wildlife Act 1953 before working with kiwi. The certification process, standard operating procedures and reporting forms are available in DOC's *Conservation dog/handler Standard Operating Procedure*⁹.

Since the dog and handler team is the certified unit, you **must not** work another dog unless you are certified to use it. Therefore, **do not** let other people 'borrow' your dog, even if they have a certified dog that may be sick or injured. They will not have a bond with the dog or understand the finer signs exhibited by the dog that the usual handler has come to know. Note: Some dogs can be certified to work for multiple handlers depending on the dog and the capability of the handlers.

The dog **must** be trained to work within sight and sound of the handler, working close enough to allow contact to be maintained when it locates a kiwi. All dogs **must** be bird safe and remain quiet and/or on point when they locate a kiwi so that they do not cause the bird to flush. Dogs **must not** lunge at or chase a kiwi and **must not** make physical contact with a kiwi.

In many areas, kiwi live in habitats that are thick with scrub, vines and fallen trees, or in tussockland, where visual contact with the dog cannot always be maintained, and so it is important to know that a dog will be bird safe at all times, and will hold its position or return to you quietly while you make your way to the bird. This is particularly important when dealing with 'flighty' species such as great spotted kiwi, or where birds are sheltering above the ground (e.g. chicks) or actively feeding by day (e.g. Rakiura tokoeka).

When working with a group of people, the dog handler **must** remain focussed on their dog and not become distracted by their assistants. It is recommended that the dog and handler lead the search group, and the assistants follow 10–20 m behind, until such time as the handler indicates that they should approach to surround a bird or to assist with the extraction of a bird from its burrow. The handler must be in control of the whole group at all times, and work to ensure that the dog does not show 'pack-mentality' and become hyped-up or feel that there is a competition to find a bird.

www.doc.govt.nz/Documents/science-and-technical/sops/dog-handlers/sop-conservation-doghandler-team.pdf

Dogs must be worked only in daylight hours when kiwi are generally sheltering, unless given a special exemption is given for working the dog at night after assessment by a DOC species dog certifier.

Dogs **must not** work in packs. Only one dog should be worked in an area at a time. Other dogs, such as those in training, may accompany the team, but should be on a short lead well back from the working dog. Hierarchies and competitiveness can develop in the dogs, which completely changes their personalities.

All kiwi dogs must be muzzled when working to minimise the risk to kiwi if they should encounter a bird. Muzzles **must** have a minimum of three points connecting the muzzle to a purpose-fitted collar, and **must not** be able to be slipped off under any circumstance. The muzzle type will vary according to the breed of dog used, but should not cause discomfort such as abrasion of the skin on the face. Some dogs have allergic reactions if metal or painted metal contacts their skin, in which case it may be necessary to wrap electrical tape around the parts that can contact the skin. The muzzle should have soft, wide straps across the bridge of the nose, and **must not** interfere with drinking or panting. Dogs need room to expose their tongue to regulate their body temperature because, unlike many other mammals, they do not sweat to stay cool.

Dogs **must** be tied up, kennelled or confined to a tent at the campsite when not directly supervised. Do not tie your dog up outside in areas that are prone to mosquitoes or sandflies – the dog's welfare is important. Confine your dog if there is a chance that kiwi will wander within range – several pet dogs are known to have killed kiwi that have wandered within the reach of a dog chained up outside.

Regularly worm dogs to ensure that parasites are not taken onto farmland or DOC-controlled land, particularly offshore islands. Also control ectoparasites such as fleas and be vigilant that ticks are not transported from one kiwi area to another by dogs – kiwi are vulnerable to some tick-borne diseases. Inoculate your dog against canine distemper, parvovirus, adenovirus, parainfluenza, *Leptospira* and *Bordetella* because these may cause serious health issues and also be spread to endangered mammals such as fur seals, Hooker's sealions and, possibly, bats.

Handlers need to provide an annual activity report to the DOC Dogs Programme Manager, reporting how the dog is performing and any incidents, and requesting advice to improve an aspect of the behaviour. The certifiers are there to encourage and improve the trainer/dog relationship.

The Department of Conservation recognises the importance of having well-trained dogs for kiwi and other threatened species work. Opportunities should be provided for approved handlers to train their dog, for dogs to be kept fit between field-trips, and where practical, allow facilities at places of work for the trainer to spend time with their dog rather than leave them locked away at home all day.

9.2 Requesting to use a kiwi dog/handler team

In 2016, there were 31 dog/handler teams involving 29 different handlers that were fully certified to work on kiwi; however, most of these teams were certified to work on a single species. Some of these teams are available for contract work nationwide, while others are focussed on a specific project but may be willing to assist with other projects from time to time.

The Species Dog Certifiers will be able to help to put you in contact with potential kiwi dog handler teams. They will know the various teams, and will also be able to advise on which breeds of dog are most suited to the conditions and the species involved; for example, herding dogs are not suitable for night work with little spotted kiwi because of the risk of serious injury or death if the dog comes into contact with such a small bird.

10. Radio-telemetry

Because kiwi are cryptic, nocturnal creatures with limited home ranges, radio-telemetry has revolutionised research on them. Adult kiwi are large enough to carry transmitters that last more than 1 year and these provide a signal that is strong enough to be picked up several kilometres away (line-of-sight distance). Signals are also adequately broadcast from underground, although the signal strength becomes weaker with increasing depth. Hills and ridges block the signal, however, particularly if the bird is deep in a gully.

10.1 Ground tracking

Most kiwi radio-tracking is done from the ground because kiwi are relatively sedentary – birds rarely move out of a 500 m radius once they have reached adulthood. The signal is picked up on a receiver (e.g. Telonics TR4) with a three-element Yagi hand-held aerial. The signal is strongest when the aerial is pointing directly at the bird, but is also moderately strong when pointing away from the bird (back-signal), but weak when pointed at 90° to the bird. The central and front elements of the Yagi aerial are the most critical, and the base ones (closest to your head) can normally be folded away without losing ability to detect signals; however, the back-signal is reduced when the base elements are extended. Always replace elements if they are damaged, and check connections if no signals can be detected.

The closer you get to the bird the stronger the signal, until you are very close to the bird, when the sound is almost the same strength in all directions.

On flat ground radio-tracking is simple, but in hilly country signals can bounce and disappear altogether. The main source of confusion is when the bird is uphill, because the signal sometimes disappears completely or seems stronger downhill – persist in climbing and the signal will suddenly appear strongly, unless of course the bird really was at the bottom of the hill!

Assuming that you have worked your way close to the bird and the signal is now very strong in all directions even with the ‘Gain/Volume’ turned down, and no obvious burrow is in sight, remove the aerial from the receiver and turn up the ‘Gain/Volume’ – if you are within 5–10 m of the transmitter, you should be able to hear the signal. The receiver minus the aerial can be used like a Geiger counter and swept over the ground to pinpoint the transmitter (fallen off, or on a bird in a hole whose entrance is obscured or some distance away – e.g. in an under-runner). Be aware that the transmitter may be up a tree in a stoat den, or the bird may have climbed up the inside of a hollow tree.

When searching for missing birds, try to get high up a hill some distance away from where the transmitter is expected to be – it is often hard to pick up a signal directly below the top of a hill, because the convex curve near the top of the hill prevents a line-of-sight contact.

Keep the receiver dry (inside a plastic bag on a wet day) and be aware that the fine-tuning on receivers can vary slightly, and transmitter frequencies can change slightly with battery age, especially in the first few minutes after being activated, and then again when they are about to fail.

For information on ground-based radio tracking, see: www.doc.govt.nz/get-involved/run-a-project/our-procedures-and-sops/ground-based-radio-tracking-protocol/

10.2 Tracking from the air

Some kiwi, particularly juveniles and subadults, can wander over long distances (20+ km), and so the only effective way to find them is to detect their signal and identify their general location from an aircraft. The Civil Aviation Authority has approved the attachment of a radio-antenna system to the struts of Series 172 Cessna aircraft. The approved antenna system and clamps are available for hire or purchase (e.g. from Sirtrack), but **must** be fitted by an aeronautical engineer the first time they are used on a particular aircraft—aeronautical engineers are present at airports where there are commercial flights and possibly at some smaller airports.

Some observers have found that there is considerable signal interference on TR4 receivers (which have limited filtering), but that TR2 receivers are fine (but use a different numbering system to TR4s and so each signal has to be translated), as are TR5 receivers and ATS scanning receivers. The latter is pre-programmable to search for missing transmitter frequencies, and is recommended if you expect to do much tracking from aircraft for multiple birds. You can pinpoint the location of birds by switching between aerials mounted on either side of the aircraft through a simple switching box that is part of the air-tracking kit.

The mounting of aerials on other types of aircraft or on helicopters is not currently approved by the Civil Aviation Authority in New Zealand.

10.3 Sky Ranger

A recent major advance in the study and management of kiwi has been the development of an aircraft-based monitoring system that can be programmed to automatically radio-track multiple kiwi in a single flight by Wildtech New Zealand Ltd. This system involves a receiver ('black box') mounted in a fixed-wing aircraft that uploads information broadcast by Egg Timer and/or ChickTimer transmitters, and integrates these data and signal strengths with continuous GPS locations of the aircraft. Before each flight, software allows managers to upload information on the transmitters to be searched for and their approximate locations, and to set the GPS coordinates of the flight path to be able to intercept signals from all transmitters of interest.

11. Sick, poisoned, injured, or dead kiwi or their eggs

11.1 Sick or poisoned kiwi

11.1.1 Decision process

It is rare to find sick or poisoned kiwi in the wild; for example, we have encountered only one sick bird in a combined 50 years of kiwi work. There have been more reports of kiwi suffering from eating plant toxins such as karaka berries than of sick birds. If you do encounter a sick bird, you should attempt to get it to veterinary care as quickly as possible or, if the bird is unduly distressed and clearly beyond recovery, it should be humanely euthanised by a blunt force stunning blow to the head followed by cervical (neck) dislocation or a further blow to destroy the brain.

Sick or poisoned birds are more often encountered in captivity, where birds are under much closer observation but also exposed to some additional hazards, such as discarded nails, wire or onion weed. Again, any sick kiwi should be isolated and placed in veterinary care as soon as possible.

11.1.2 Information collection

You should note down the symptoms of the illness compared with your experience of normal healthy birds – remember that the nearest veterinarian may not have encountered kiwi before and so may not know what is normal, e.g. that blowing bubbles is a common minor stress response. After an initial assessment by your local veterinarian, the kiwi will have the best chances of recovery if handled at a veterinary hospital that is familiar with managing kiwi if it needs a more specialist opinion and/or treatment. Wildbase at Massey University (wildbase@massey.ac.nz; Ph (06) 350 4525), the New Zealand Centre for Conservation Medicine at Auckland Zoo (Ph (09) 353 0753) and The Nest Te Kōhanga at Wellington Zoo (wellingtonzoo@wellingtonzoo.com; Ph (04) 381 6755) have plenty of experience in dealing with kiwi and should be contacted in the first instance. Department of Conservation staff should also contact the DOC veterinarian for advice: kmcinnes@doc.govt.nz ; Ph (04) 471 0726.

A range of blood normals for wild kiwi has now been obtained for all taxa, which should assist veterinarians in diagnosing illnesses. Ask the veterinarian to keep detailed records of their diagnoses and treatment schedules, as this may help with the treatment of similar cases in the future. Records of successful and unsuccessful treatments should be sent to the Kiwi Recovery Group Leader and DOC's veterinarian, and preferably be published in a veterinary journal such as *Kokako* so that other vets can easily access the material.

Measure, weigh, sex and band the bird, collect 6–8 pin feathers for DNA analysis, and complete the form shown in Appendix A3.1. This form should then be sent to the Kiwi Recovery Group Leader.

11.1.3 Release and monitoring

Once a bird is suitable for release, it should be banded, have a transponder inserted, or be wing-tagged. After being given an overall health clearance, the bird should be returned as close as possible to the site where it was found. In some cases, there is an advantage in having a transmitter on the bird to see if it copes with the transition back to the wild following serious illness, because this will assist the decision-making process in future. Where a bird is released away from its original location, it should be radio-tagged to see whether it tries to return home. It is a good idea to invite the person who handed in the sick or poisoned bird to attend its release.

11.2 Injured kiwi

11.2.1 Decision process

Most injured kiwi that are encountered have either been caught in a leg-hold trap or hit by a car. Sometimes field workers will discover an injured study bird and will need to decide whether it is best to treat the injury in situ or ex situ, bearing in mind that there can be problems with removing a territorial bird and then returning it to the same territory after treatment. If the bird is to be removed, you should get it to veterinary care as soon as possible, preferably in an enclosed box or bag. If you do not have access to a proper transfer box, place the kiwi in a cardboard box, such as a cat carrier box, as soon as possible, tape up the holes so that the bill cannot protrude, and puncture it with multiple small holes to allow adequate ventilation. Also, strengthen the base of the box with tape. Once in veterinary care, the bird should be held in isolation away from cats, dogs and other kiwi until a detailed assessment of the extent of its injuries is made. Kiwi can be resilient birds and can self-recover from a broken leg in the wild (e.g. a bird that was killed in a leg-hold trap in 1999 was found to have previously broken its leg, probably in another encounter with a trap; and birds with missing toes used to be frequently encountered in the wild, although such an injury is thankfully rare these days). On the other hand, seemingly minor injuries can become infected and lead to death.

Work with the veterinarian to make a professional judgement about whether to euthanise the bird; the general rule of thumb is that the bird should be euthanised if it is unlikely to be able to be returned to the wild and breed successfully, without suffering, once the injury has healed. As per the Department of Conservation's Captive Management Policy (2003), if an animal cannot be released, it **must** be placed in an approved captive management programme (which applies only to 'eastern' brown kiwi), or euthanised. It is best to evaluate early what the likely outcome is, else a lot of time and emotion can be spent on an animal that then requires euthanasia. Spending a life as a crippled kiwi in captivity is not necessarily fair on the bird and also directs resources away from higher priority conservation work in captive facilities; however, there is a place for a few injured kiwi to be used to tell conservation messages about topics such as the reasons why leg-hold traps should be raised off the ground.

Following an initial assessment by your local veterinarian, which may include having the bird X-rayed to determine the extent of the injuries, the bird may need to be transferred to a veterinary hospital that is familiar with managing kiwi, as outlined in section 11.1.2.

Following initial treatment, the bird may need to be held while the injuries heal, in which case it should be transferred to a permitted kiwi display facility or other recognised carer for injured birds and held off display in predator-proof facilities.

11.2.2 Information collection

Thank the person who has handed the injured kiwi to the Department of Conservation or to a veterinarian, and try to determine the date, circumstances and exact location where an injured bird was found (this may not be possible in some cases as leg-hold traps are often set illegally to protect marijuana crops, or hunting dogs may have been used where they should not have been). Explain the importance of trying to release the bird back into its normal territory.

Measure, weigh, sex and band the bird, collect 6–8 pin feathers for DNA analysis, and complete the form provided in Appendix A3.1. This form should then be sent to the Kiwi Recovery Group Leader.

11.2.3 Release and monitoring

The same process should be followed as for sick kiwi (see Section 11.1.3).

11.3 Dead kiwi

11.3.1 Decision process

It is important that all kiwi deaths are documented and, where possible, specimens are collected for scientific, pathological and cultural use.

Field workers will occasionally come across dead kiwi, which will mainly be radio-tagged juvenile birds that have been killed and eaten by predators. If possible, take a photograph of the dead kiwi *in situ* and search the nearby area for clues about the cause of death (e.g. predator faeces, dog footprints). Sick or injured kiwi being treated at a veterinary clinic may also die or be euthanised; however, even where the cause of death is strongly suspected, it is still worth sending the specimen away for official diagnosis and pathology screening, because this will add to our knowledge of kiwi and help to develop future treatments.

If cyanide or phosphorous poisoning is suspected, **DO NOT** touch the bill, head or digestive system with bare hands. Immediately place the bird in a plastic bag, seal it and label it clearly with warnings about the possible cause of death.

If the specimen is simply skin and bones, or a suppurating mess, there will often be little value in collecting it because it will be impossible to detect toxins or disease and difficult to obtain useful material for cultural uses. However, it may still be possible to detect signs of predation such as puncture marks and broken bones, or to grow bacteria from inside the bones. Put on a pair of latex gloves and check the specimen (particularly the back of the head and neck, or remnant bones) for tooth marks and broken bones, and measure the space between any paired canine punctures.

Note: If you dissect a kiwi, you **must** wear latex medical gloves and a medical mask.

If the kiwi has been killed only recently, swab the area around the wound with a cotton bud and store the cotton bud in a clean plastic bag because the DNA in the saliva of the killer may identify the culprit down to species level, and maybe even down to the individual level (e.g. to determine if one dog or ferret is decimating a population). These saliva swabs can be analysed by Ecogene (ecogene@landcareresearch.co.nz ; (09) 574 4225).

If you find a dead kiwi juvenile, measure its bill length to try to estimate the age at which it was killed – the bill lengths of brown kiwi increase at a remarkably constant rate, e.g. the bills of young ‘eastern’ North Island brown kiwi grow at 0.17 mm per day during the first 100 days (McLennan et al. 2004), and so if the bill had grown 1.4 mm since it was last measured, it probably died c. 8 days later. For adult kiwi wearing mortality transmitters, record the ‘time since death’.

If the specimen is still fresh or moderately so, place it into a plastic bag and seal it, label the bag clearly with your name and date, the species name and any permanent identification such as band number or transponder number, and **chill it** in a refrigerator at 4°C as soon as possible. To prevent a ‘helpful’ colleague from freezing it, mark the bag with a ‘**DO NOT FREEZE**’ label, because freezing will damage cells and tissues and make the diagnosis of cause of death more difficult, even if it does improve the smell!

The Department of Conservation has a contract with Wildbase, Massey University, which covers the costs of gross necropsies and histopathology of all threatened species, and some non-threatened species, such as little spotted kiwi, or those found in areas where there are threatened species at risk.

All dead kiwi can be sent to Wildbase, Massey University, for necropsy. Where poison is suspected, Wildbase vets will collect and forward the appropriate samples to Landcare Research if you have indicated this on the submission form. If predators are suspected, take DNA swabs before sending the body away and request that the Wildbase vets look for predator sign on the

body during the necropsy, without telling them what predator you think killed it, so that their diagnosis is independent of yours. If disease or misadventure is suspected, or the cause of death is unknown, request a necropsy and provide as much background information as possible. Even where the cause of death is obvious (e.g. hit by car, predation by dog), there may be something to learn from performing a necropsy, including the detection of other health issues that were affecting the bird at the time of death.

11.3.2 Information recording

A leg label should be attached to all dead kiwi that are found by field workers, or handed in dead to DOC, providing details of the date of death, location of death, apparent cause of death, person who found the bird, person who reported the death (if different) and person who filled in the tag. In addition, a 'Kiwi Deaths' data sheet should be completed (see Appendix A3.2) and sent to the Kiwi Recovery Group leader.

11.3.3 What to do if poisoning is possible

Where poisoning is possible (e.g. after a pest control operation in the area), you should:

1. Immediately place the specimen in a **refrigerator, NOT in a freezer**. Maggots can be killed with fly spray or be picked off.
2. Contact Wildbase, Massey University, Palmerston North (wildbase@massey.ac.nz ; Ph (06) 350 4525) to arrange for a necropsy, and alert them that they will be requested to collect samples for toxin analysis.
3. Send the chilled specimen to Wildbase as quickly as possible in a chilly bin with an icepack to keep the specimen cool while in transit. Mark the chilly bin with 'Perishable' stickers. Do not send specimens on a Friday or Saturday, else they will decay over the weekend.
4. Contact the Kiwi Recovery Group Leader to check whether the specimen is needed for any particular priority research purpose and arrange transportation of the specimen with a request, where applicable, for it to be returned for local disposal
5. Results of toxin assays from Landcare Research NZ Ltd will be sent to Wildbase, Department of Conservation, and to the original sender.

11.3.4 What to do if disease is suspected

Where disease is suspected as the cause of death (e.g. the bird is in poor body condition, has superficial lesions or lumps, other symptoms were recorded before death, or is a radio-tagged bird that has died for no obvious reason), you should:

1. Follow the steps 1–4 outlined in Section 11.3.3.
2. Request that the results of the necropsy be sent to you and the DOC veterinarian, including a non-technical summary.

11.3.5 What to do if predation is suspected

Where a kiwi is believed to have been killed by a predator, and where poisoning or disease is not suspected, the specimen may still be suitable for a variety of purposes, e.g. research, cultural materials, museum specimens or advocacy specimens. If the specimen was handed in and witnesses saw it being killed by a dog, go straight to step 6. Otherwise, you should:

1. Carry out a scene examination, particularly looking for and collecting faeces or hairs of the likely predator. Photograph the kiwi body as you find it.
2. Examine the body of the kiwi for puncture wounds – mustelids generally attack the back of the neck or head, whereas dogs generally grab a kiwi around the body or a leg.
3. If the kiwi is found freshly dead, swab the area around the wound to try to gather DNA in the saliva of the predator. With good-quality DNA, this test can identify not only the species involved, but also the individual animal, and so potentially be matched to known

dogs in the neighbourhood, or can determine that one individual predator killed e.g. two kiwi 5 km apart. Seal the swab in its container, refrigerate and contact Ecogene (ecogene@landcareresearch.co.nz ; (09) 574 4225) to arrange examination.

4. You can either send the specimen to Wildbase for a necropsy and request that they collect samples for predator testing, or carry out the analysis yourself. If you cannot necropsy the specimen in the laboratory immediately then freeze it.
5. When trying to determine the predator involved, carefully peel back the skin where any puncture wound is visible. Measure the distance between paired puncture wounds caused by canine teeth – the inter-canine distance can be diagnostic. Dog kills often do not result in an obvious external wound, but do cause extensive bruising, which is visible when the bird has been skinned. It is usually possible to see paired ‘bite’ marks, and broken ribs, neck and legs as a result of the bird being shaken. Although kiwi can suffer bruising from fights with conspecifics, these are usually isolated single wounds rather than paired punctures or a large wound.
6. Contact the Kiwi Recovery Group Leader to check whether the specimen is needed for any particular priority research or advocacy purposes (e.g. as a mounted specimen) and arrange transportation of the specimen with a request, where applicable, for it to be returned.
7. If the specimen is not required for a priority research purpose, contact the local DOC district/region in which the specimen was found to arrange for the transfer of the specimen. (Note: This is not necessarily the district where the bird was handed in, e.g. dog-killed birds can be handed in many kilometres from where they were killed.)
8. Forward frozen specimen in a clearly labelled chilly bin marked ‘Perishable’.

11.3.6 Other known causes of death

Where a kiwi is known to have died from another cause (e.g. trap, car, drowning in a water trough) and where poisoning or disease is not suspected, the specimen can be used for a variety of purposes, e.g. research, cultural materials, museum specimens or advocacy specimens. You should:

1. Follow steps 1–4 outlined in section 11.3.3.
2. If the specimen is required for priority research or advocacy purposes, discuss this with local iwi and arrange transportation of the specimen in a clearly labelled chilly bin with a request, where applicable, for the specimen to be handled sensitively and preferably be returned for local uses.
3. If the specimen is not required for a priority research purpose or once it has been returned from a priority research need, contact the CMC in the district in which the specimen was found to arrange for the transfer of the specimen. (Note: This will not necessarily be the district where the bird was handed in, e.g. road-killed birds can be handed in many kilometres away from where they were found.)
4. Forward the frozen specimen in a clearly labelled chilly bin marked ‘Perishable’.

11.4 Dead kiwi eggs

During research and management work, kiwi eggs are sometimes discovered that have been abandoned, gone well past their due hatch date, been displaced from nests, or failed to develop in captivity. Be aware that during the first week or so of incubation, the first egg of a clutch can be left unattended during the day, meaning that a cold, unattended egg has not necessarily been abandoned.

With practice, it is possible to determine whether an egg was fertile and at what stage the egg died. Even broken or excessively rotten eggs are of interest, but determination of the fertility or age at death of such an egg is not guaranteed.

METHOD:

1. Secure a broken egg with electrical tape to prevent further breakage and to block any puncture holes.

YOU WILL NEED:

- Electrical tape
- Callipers
- Pesola spring balance
- Soft lead pencil
- Plastic bag

2. Measure the egg with callipers to the nearest 0.1 mm, recording the maximum length and two width measurements at 90° to one another. Weigh to the nearest gram, either by placing it in a plastic bag or by hanging it from a tab in a tape running right around the egg (remembering to subtract the bag or tape weight).
3. Label the egg with the locality, date, observer, and nest identifier and/or band number of the parents using a soft lead pencil.
4. Place the egg in a clean plastic bag and carefully transport it back to the office. Store the egg in a container in a refrigerator, **not a freezer**, with the container labelled 'FRAGILE', 'PERISHABLE' and 'Refrigerate, DO NOT FREEZE'.
5. Take the egg to an expert to identify the fertility and age of death. Most captive facilities involved in ONE have plenty of experience in assessing dead eggs.
6. Complete a 'Kiwi Deaths' data sheet (see Appendix A3.2), and send a copy to the Kiwi Recovery Group Leader.

12. Captive management programme

Any person or organisation that wishes to hold kiwi in captivity **must** first obtain all necessary permits to hold and handle absolutely protected wildlife under the Wildlife Act 1953.

In 2016, 14 captive facilities in New Zealand were permitted to hold kiwi, 13 of which displayed kiwi in nocturnal houses. The New Zealand captive population is maintained at c.100 individuals which is sufficient to maintain a genetically robust and sustainable population.

The captive breeding programme is concentrating its efforts on the 'eastern' brown kiwi, with all other species, geographical forms of brown kiwi, and hybrids from different geographical provenances being phased out (Barlow 2011). Therefore, no new stock of kiwi other than 'eastern' brown kiwi will be brought into captivity for breeding or display purposes. The management of the New Zealand captive population is coordinated by a Captive Management Coordinator who is jointly appointed by the Zoo Aquarium Association of New Zealand (ZAA) and DOC.

In August 2016, 55 brown kiwi were also held at 14 facilities in Europe and North America, the management of which is overseen by a species coordinator who is appointed jointly by the European Endangered Species Programme (EEP; Europe) and the Species Survival Plan Programme (SSP; USA). New stock from New Zealand is added from time to time to ensure that this overseas population is genetically secure, but disease risk profiles indicate that it is highly unlikely that any overseas stock would ever be returned to New Zealand.

The holding of kiwi in New Zealand is controlled under Section 53 of the Wildlife Act and permits are issued by DOC. The primary purpose for holding and displaying kiwi is for advocacy, and so it is a requirement that the captive holding of kiwi must be accompanied by appropriate advocacy messaging about the conservation of kiwi. In 2014, all existing holders and the Kiwi Recovery Group approved a document entitled *Advocacy Messaging for Kiwi in Human Care* (du Bern 2014), which provides context and key messaging that should be used by captive facilities that have kiwi on public display. Captive birds are also valuable subjects for research work (e.g. incubation behaviour, vision, olfaction and non-toxic bait trials), and the programme is able to provide a modest number of captive-bred kiwi to supplement release and restoration projects.

The captive management of kiwi in New Zealand **must** be carried out in accordance with the *Captive Management Plan for kiwi 2010–2015* (Barlow 2011) and any subsequent revisions, which sets the strategic direction for the population, such as population management goals, research, advocacy and husbandry procedures. In addition, all holders of kiwi, whether on public display or not, **must** follow the *Brown Kiwi (Apteryx mantelli) husbandry manual* (Fraser & Johnson 2015) and any subsequent revisions. Both of these documents have been endorsed by DOC.

12.1 Information collection

Each New Zealand institution that is permitted to hold kiwi **must** keep accurate records of the age, size and weight of all eggs, chicks, juveniles, subadults and adults, which **must** be made available to DOC on request. They **must** also report all eggs hatched, transfers completed and any deaths within 2 weeks of each event, and send an annual report detailing the total number and identity of kiwi, the number and identity of pairs held during the year, the number of eggs laid, the number of eggs hatched, the number of kiwi released, the number of deaths, and the causes of deaths to the Kiwi Captive Coordinator.

The Kiwi Captive Coordinator sends out standard reporting forms to all holders in around February/March each year, who then collates these data, updates the SPARKS Studbook database and runs analyses through PMx (Population Management software) to produce a report and generate recommendations for the forthcoming season.

The Kiwi Captive Coordinator is responsible for:

- Liaising with kiwi captive-breeding institutions in New Zealand (and via the EEP/SSP coordinator for the overseas programme), whether members of ZAA or not, to ensure that current best practice is maintained and that annual recommendations are implemented.
- Coordinating information requests to captive institutions and research work on captive kiwi.
- Maintaining up-to-date and accurate records in the Kiwi Studbook (SPARKs software). (Note: This excludes ONE holdings.)
- Supplying information from the Kiwi Studbook to permit holders and DOC, on request.
- Generating an 'Annual Report and Recommendations' paper in March/April each year, which reports back on the overall results and implementation of the previous season's recommendations, and provides new pairing, transfer and release recommendations for the forthcoming season. This document delivers the strategic direction set in the current Captive Management Plan as an annual work plan that is fully endorsed by ALL captive facilities holding kiwi in New Zealand and by the Kiwi Recovery Group. The ZAA standard template and analysis is used in accordance with international best practice for genetic and demographic management to maintain a fully sustainable captive population.
- Supplying the Kiwi Recovery Group with an annual report on the progress of the captive population.

12.2 Husbandry

The welfare of the kiwi **must** be paramount at all times. Permit holders **must** follow the recommended practices in the latest version of the *Brown Kiwi* (*Apteryx mantelli*) *Husbandry Manual* (Fraser & Johnson 2015), except where specific exemptions are given by the Kiwi Recovery Group to allow controlled trials of new husbandry techniques.

The husbandry manual is written and peer-reviewed by experienced technical experts, and is updated from time to time. These updates will be sent to each permit holder and will then become the best practice manual for captive management. ZAA members must go through an accreditation process that measures positive welfare outcomes.

12.3 Transfers between institutions and breeding recommendations

Before each kiwi breeding season, all transfers between captive facilities, pairings (e.g. recommendations for best genetic pairings of kiwi to breed) and display birds are recommended by the Kiwi Captive Management Coordinator, and endorsed by all holders and the Kiwi Recovery Group. All holders must inform the Kiwi Captive Management Coordinator of all transfers in or out of their facility so that the SPARKS studbook database can be kept up-to-date.

All holders **must** follow the annual breeding recommendations and **must not** create opportunities for pairs to breed that do not conform with the annual recommendations. Any breaches of recommendations will be reported to the DOC permitting authorities

12.4 Release to the wild

One objective of captive breeding is to be able to release appropriate stock to the wild, and so help with wild conservation of kiwi. With the concentration on managing just the 'eastern' form of the brown kiwi, and phasing out other species and geographical forms of brown kiwi, and hybrids from different geographical provenances (Barlow 2011), the captive programme will have some birds that are no longer required for captive breeding or advocacy purposes, and so can be made available to supplement wild populations at managed restoration sites. Furthermore, as the programme with 'eastern' brown kiwi grows, there will be opportunities to provide some captive-bred kiwi to suitable managed sites. The captive programme is managed genetically by the Kiwi Captive Management Coordinator, and any release opportunities will be undertaken in liaison with DOC and the Kiwi Recovery Group, and will require an approved translocation plan. All recommendations for release will be outlined in the 'Annual report and recommendations' document and reported back on the following year.

Any kiwi that are identified for release from the captive management programme **must** undergo the agreed DOC and ZAA procedures for disease-screening pre-release (Kate McInnes, Kerri Morgan and Richard Jakob-Hoff, unpubl. data), a copy of which is available from the Kiwi Captive Management Coordinator. These protocols were based on those developed for ONE birds (Bassett 2012). In particular, all captive kiwi that are identified for release **must** be held in an outdoor pen for a minimum of 30 days before release (to ensure they are adjusted to the natural photoperiod and have the ability to forage naturally outside), and undergo disease screening and obtain veterinary clearance.

13. Handling kiwi at public and commercial advocacy events

The Kiwi Recovery Programme protects threatened iconic and taonga species, and so has received a very high profile. This attention brings with it particular political and commercial sensitivities within Government (including DOC), with sponsors, and with iwi and external stakeholders. It also brings high levels of interest in kiwi from members of the public. The welfare of the birds **must** be paramount when kiwi are being handled for any reason, but extremely high standards are required during public or commercial handling of kiwi.

Providing an opportunity for the public to see a live wild kiwi is increasingly acknowledged as an effective mechanism for supporting kiwi recovery. Kiwi are able to ‘touch people’s hearts’ and enhance the desire to make a difference, or put pressure on family, friends and neighbours to change their behaviours. This is particularly valuable when advocating for dog control, and with foresters and landowners who may require an additional level of motivation. Close encounters with kiwi are also an important way of rewarding project members carrying out trapping, tree planting or undertaking advocacy work to protect kiwi. Increasingly, these encounters can assist with thanking and profiling sponsorship support for local projects, and generating news stories and associated conservation messaging, and can be used to generate funds and gain additional supporters for kiwi projects.

The welfare of the birds **must** be paramount when kiwi are being handled for any reason, but extremely high standards are required during public or commercial events involving kiwi. Such events will usually involve the release of ONE birds, a rehabilitated injured bird or birds being transferred to a new site, but may also include an organised or commercial operation where people are shown wild kiwi being handled for routine checks or to change transmitters or their attachments, for biometric and health checks, research, or the collection of eggs for ONE.

13.1 Handling advocacy birds

Kiwi are more delicate than they appear because they lack the sternum and associated musculature that is present in most other birds, which protects the ribcage and vital organs. Kiwi can also be feisty and kick out quickly, injuring themselves or their handler, and can easily shed feathers.

Therefore, when kiwi are to be handled for advocacy purposes, the following Department of Conservation protocols developed by the Kiwi Recovery Group in consultation with the DOC veterinarian, **must** be followed:

- Where kiwi have transmitters on predominantly for advocacy purposes, including commercial viewing opportunities run by community groups or individuals, a maximum of 10 people are allowed to view, and possibly touch, each bird at each handling session.
- **Only** adult or subadult birds (over 6 months old) are to be used as ‘advocacy birds’.
- Kiwi **must not** be regularly taken out of their burrows just for the purposes of allowing people to see and touch them. The birds are to be handled no more frequently than usual (2–3 times per year for adults, 6-weekly for subadults weighing 800–1200 g, and quarterly if > 1200 g).
- Adult kiwi **must not** be handled or disturbed in nests in the month before or during the normal breeding season (approximately mid-May to January – see Table 5.1 for exclusion periods for each kiwi taxon and locality), except where eggs or chicks are being collected as part of a permitted ONE programme, or for the annual change of a transmitter where an Egg Timer or Chick Timer transmitter indicates that a male bird is not nesting. Be aware that these transmitters do not switch to incubation mode until at least 5 days after the first egg is laid, and usually 8–12 days later).

- **Only** accredited kiwi catchers (see Section 5) are permitted to catch kiwi during any advocacy, commercial or public event.
- The accredited handler **must** be able to recognise any signs of stress, such as rapid panting or holding the bill open, in which case they should immediately release the bird back to its original location.
- If the accredited handler is satisfied that the bird they are holding is not unduly stressed, people may gently touch or stroke the bird, but **must not** touch the head, facial bristles or bill of the bird.
- There are plenty of good opportunities for people to have their photograph taken standing or sitting next to a kiwi or a kiwi egg being held by an accredited handler, and this is the **preferred** model for public events.
- For release events **only** (i.e. not commercial viewing operations), in recognition of the fact that there is sometimes an extra spiritual connection formed by actually holding a bird, a non-accredited person may hold each bird after an accredited trainer has explained and demonstrated the correct handling technique. The accredited trainer **must** remain close to the non-accredited handler so that they can immediately take the bird back if necessary. The time spent holding a bird or egg **must** be limited to the absolute minimum required to get photographs. **Do not** allow others to touch or stroke the bird while it is being held by a non-accredited handler.
- Extra care **must** be taken if the chosen non-accredited handler is a child. The accredited trainer **must** be satisfied that the child is capable of handling the bird before handing it over, and the child must be sitting down to reduce chances of injury to the bird should it struggle.
- Birds that are being handled by non-accredited handlers under supervision should usually have their legs taped together to minimise the chances of struggling and breaking free of the loose hold; the exception to this is when the bird is being released.
- The exposure/handling of each bird **must** be limited to a maximum of 20 minutes, and a maximum of 45 minutes for all birds combined (e.g. at a release where multiple birds may be handled).
- Limited flash photography is permitted, but request that people take their photographs without flash or have one person take photographs and share these with all others present.

Note: Public or commercial events **must not** be used as part of the process of training people to handle kiwi.

13.2 Reporting

For each wild kiwi that is caught predominantly for advocacy purposes, a calendar year log **must** be kept that shows the names of the accredited catcher, handler and handling trainer present at each event, the names of non-accredited handlers used, the dates of handling, weights and measurements of the bird, and the number of people attending each event, as well as brief notes about each encounter.

For kiwi that are shown to the public *en route* to, or at, release events, a calendar year log **must** be kept that shows the dates of viewing sessions, the names of the accredited catcher, handler and handling trainer present at each event, the names of non-accredited handlers used, the number of people attending each event, the number of kiwi shown, as well as brief notes about each encounter.

These logs must be submitted to the Kiwi Recovery Group annually, no later than 28 February the following year.

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16. Additional resources

Sharing Best Practice (QD: C1329)

National Requirements for Trapping and Cyanide Use (QD: NH1170)

Prevention of Predator Invasion (QD: NH 1262)

Animal Pests, Obtaining Consents (QD: NH3003)

Animal Pests, Accepting a New Toxin for Use by DOC (QD: NH 3006)

Animal Pests, assessing Applications for DOC Consent (QD: NH 3008)

Translocation of New Zealand's Indigenous Terrestrial Flora and Fauna SOP (QD: NH 1042)
(DOCCM-251982)

Inventory and Monitoring Toolbox SOP (DOCCM-259067)

Captive Management SOP (DOCCM-266180)

Wildlife Health Management SOP (QD: NH 1176) (DOCCM-442078)

Avian Blood/Feather & Reptilian Tissue Sampling SOP (DOCCM-531081)

Conservation Dog/Handler Team SOP (DOCCM-749423)

2011 Approved Translocation Process Documents (DOCCM-1089378)

Translocation SOP: Planning through to reporting for DOC translocations (DOCCM-315121)

Translocation Guide for Community Groups (DOCCM-363788)

DOC Wildlife Health SOP

Translocation Health Management Workbook (DOCCM-54393)

Animal Welfare (Transport within New Zealand) Code of Welfare (DOCCM-867331)

Air New Zealand species transport guide (DOCCM-999105)

NOTE: For kiwi practitioners outside of DOC, SOPs (Standard Operating Procedures) and DOCCM documents can be requested through your local DOC office.

Appendix 1

Key contacts

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Appendix 2

Sample data sheets and data files for studying radio-tagged kiwi

A2.1 Sample field data sheet for the study of radio-tagged kiwi

KIWI DATA SHEET										Record number	
Study area											
Observer(s)							Date	/ /			
							dd	mm	yy		
Kiwi Name					Band/ Tip					N/A	
Sex	M	F	Unk	Age	Chick	Juv	Subad	Ad			
Tx freq	+/-			Tx type					N/A		
Tx strap	Okay	New	N/A	Band	Okay	New	Tightened	N/A			
Bill length	mm			Tarsus (w x d x l)	mm				N/A		
Weight	Gross wt _____ g minus tx wt _____ g = _____ g										N/A
Condition	P	PM	M	MG	G	Ex	Gravid	Dead	N/A		
Nest	Y	IN	Unk	Eggs	1	1+	2	Unk	N/A		
				Chicks	1	1+	2	Unk	N/A		
Chick stage	0	1	2	3	4 (10+days)			Unk	N/A		
First record	Yes	No	Father							N/A	
Feathers collected?	Yes	No	Disease screen?			Cloacal swab		Blood sample			
Site description											
Location											
GPS	E		N		Alt	m	Acc/ Est/ Deg				
Notes											
Data entered	Yes	By					Date				

Block descriptors for the field data sheet provided above

Record no.: A unique number for that record. Use the suffix 'A' to indicate another bird handled at the same daytime shelter; e.g. P 911 might be the details of a male, and P 911A those of his partner or chick. The suffixes B, C, etc. are used for subsequent birds. This allows rapid sorting of cases where a male and female share a daytime shelter, or where chicks are in a nest.

Study area: Name of the study site.

Observer(s): Names of those present. The first named person should be the person who took the measurements.

Date:	Use the standard English format of day/month/year, so that it is easier to distinguish month from day.
Kiwi name:	Many kiwi are known by a name unique to the study, because transmitter frequencies change with time and band numbers are often obscured by reflective tape.
Band/tp:	Band and/or transponder number.
Sex:	Male/female/unknown.
Age:	Chick (in nest) / juvenile (out of nest to 6 months) / subadult (6 months to breeding or 4 years, whichever comes first) / adult.
Tx freq:	Frequency and fine-tuning, e.g. 25 – 2.
Tx type:	Type of transmitter being used, e.g. chick, Egg-Timer™,
Tx strap:	Note if the strap was okay or new (i.e. fresh or replaced).
Band:	Note if the metal band was okay, new or needed tightening. If a band is replaced, circle new, but note the old band number in the 'Notes' section
Bill length:	Measure in mm (to the nearest 0.1 mm). If exactly a whole number, still enter the zero after the decimal point, e.g. 95.0 mm.
Tarsus:	Measure in mm (to the nearest 0.1 mm) and show as width × depth × length.
Weight:	Measure in grams. Show the calculation by subtracting the transmitter weight (if appropriate), e.g. 1980 – 20 = 1960 g.
Condition:	Poor, moderate, good, gravid, dead, etc.
Nest:	Record the number of eggs and chicks separately.
Chick stage:	0 = hatching; 1 = still wet (0–1 day old), 2 = dry with clear yolk sac and no mud on bill (2–5 days), 3 = signs of yolk sac, mud on bill (6–9 days) and 4 = no yolk sac and mobile (10+ days)
First record:	The first known encounter at this study site (also applies to ONE chicks released at a crèche or subadults released at a site).
Father:	Name or band number, if known.
Feathers collected?	Were feathers collected for DNA testing?
Disease screen?	Was a cloacal swab or a blood sample taken?
Site description:	Site number (if daytime shelters are individually labelled) and a description of the type of site, e.g. hollow log, burrow on steep bank.
Location:	Brief outline of where the site was, e.g. 30 m south of the big rimu in the southern block.
GPS:	Grid coordinates and altitude with accuracy (Acc), projection (Est) for a projected waypoint and degrees (Deg) of angle of the strongest transmitter signal from the noted GPS position.
Notes:	Additional notes about the behaviour or appearance of the bird, such as whether there were any deformities, unusual colours or an exceptional load of ectoparasites; possibility of the site being a new nest; egg measurements; whether eggs were collected for ONE; colour of reflective tape on the band; probable or known cause of death, etc.
Date entered:	For office use, for when the field data have been uploaded onto a computer.

A2.2 Sample individual file columns

Locality:	Site name and descriptor of the usual location.
Mark:	Band, wing tag and/or transponder number.
Side:	Left/right side of the bird is banded, tagged or has a transponder inserted.

Colour:	Combination on band.
Name:	Name by which the bird is commonly known.
Sex:	Male/female/unknown.
Age:	Chick/juvenile/subadult/adult.
Mate:	Band number of most recent partner (if known).
First date:	Date when first found.
Tx:	Transmitter frequency.
Taped:	Date the transmitter was last taped.

A2.3 Sample master data file columns

Study area:	Site name.
Record:	Unique number identifying this record.
Observer:	Name or initials of the people involved, starting with the person who measured the bird.
Date:	Use dd/mm/yy format.
Name:	Nickname of the bird.
Mark:	Band, wing tag or transponder number.
Colour:	Colour combination.
Sex:	Male/female/unknown.
Age:	Chick/juvenile/subadult/adult/unknown.
Tx:	Transmitter number (also add 'on' (e.g. Tx 14 on) when a transmitter was first attached; use 'r/ tx number' (e.g. r/16) when a transmitter was removed and replaced with another tx; and add 'off' (e.g. Tx 16 off) to indicate that the transmitter was removed and not replaced.
Bill:	Bill length (mm).
Tar W:	Tarsus width (mm).
Tar D:	Tarsus depth (mm).
Tar L:	Tarsus length (mm).
Weight:	Weight (g) excluding the transmitter weight.
Condition:	Poor to excellent; gravid; dead.
Nest:	Contents information (yes/no/unknown).
Contents:	No. eggs and/or chicks, if known.
Mate:	Name / band / tp / wing tag number of mate, if known.
Site:	Type of shelter (e.g. burrow, hollow log, under rushes) and number, if applicable.
East:	Grid reference (usually NZ Transverse Mercator, NZTM2000)*.
North:	Grid reference (usually NZ Transverse Mercator, NZTM2000)*.
Altitude:	In metres (optional).
Bearing:	Compass bearing to signal from the above grid reference.
Location:	Brief description of where the bird was.
Notes:	Include brief information on behaviour, appearance, cause and time of death, etc.

* **DO NOT** use latitude and longitude (either decimal or in degrees/minutes/seconds) because the Topo50 and Topo250 maps show NZTM grids, and so it will be very difficult to determine approximate distances between records, and hence detect transcription errors. Also, the NZTM system is the standard used by emergency services, and so your GPS should be on that setting in case an emergency situation arises.

A2.4 Sample nest file columns

Record:	Record number from data file.
Nest:	Site number from data file.
Date:	dd/mm/yy format.
Male:	Band, tp or wing tag number of male.
Female:	Band, tp or wing tag number of female, if known.
Start date:	Estimated start date from Egg Timer™ or Chick Timer™ transmitter. Note that in brown kiwi, and maybe other species with two-egg clutches, these transmitters do not usually show that incubation has begun until c.10 days after the first egg is laid.
No. eggs:	
No. chicks:	
Fate:	In progress/ONE/success/failure/unknown outcome.
Notes:	Include egg/chick measurements, growth stage of the chick(s), and wing tag transponder numbers of chicks.

A2.5 Sample transmitter file columns

Tx:	Frequency (and fine tuning).
Location:	Band of the bird (e.g. R 33333), or present location (e.g. in storage).
Life:	Manufacturer's stated life in days (or a conservative estimate of it, to be safe).
Date On:	Date (dd/mm/yy) when tx turned on.
Off/last:	Date (dd/mm/yy) the Tx was removed and turned off OR the current date (obtained by using 'CTRL+;') [i.e. press Ctrl and semicolon keys simultaneously]" to get the current date for active transmitters (note: this automatically updates to whatever the current date is).
Tx use:	= Date Off - Off/last.
Mort:	Calculated date (dd/mm/yy) the transmitter went into mortality mode (i.e. fell off, the bird died, or the transmitter misbehaved). When a transmitter is in mortality mode, the fast pulse rate shortens the battery life.
Mort days:	Days in mortality mode
Mort use:	Correction made for the reduced battery life caused by running at a faster pulse rate, i.e. Mort use = (Mort days × mortality pulse rate / normal pulse rate) - Mort days. For example, if a transmitter was deployed on 1/6/14 and found in mortality mode on 6/7/14, but had been in mortality mode for 12 days (i.e. Mort = 23/6/14), the normal pulse of that transmitter was 35/min and the mortality pulse is 60/min, and so Mort use = (12 × 60 / 35) - 12 = 8 days.
Session:	The sum of Tx Use and Mort Use, i.e. the corrected time running in each session.
Elapsed:	The cumulative time the transmitter has been running since new or since repotting = sum of the sessions.
Remaining:	Calculated as Life - Elapsed.
Replace:	Calculated from the current date + Remaining. This gives a clear indication of transmitters that are getting close to needing to be replaced.

Appendix 3

Data sheets

A3.1 Data sheet for sick, injured or poisoned (but live) kiwi

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

A3.2 Data sheet for dead kiwi or kiwi eggs

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