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Best practice techniques for the translocation of kākā (*Nestor meridionalis*)

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Cover: The first wild juvenile kākā fledgling in 2009 at Orokonui Ecosanctuary. *Photo: S. Jaquiery.*

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Kevin A. Parker[1], Denise Fastier[2], Tineke Joustra[3], Matu Booth[4], Sue Dryden[5], Todd Jenkinson[6], Matthew Lark[7], Chris Smuts Kennedy*, Elton Smith[8]

[1] Parker Conservation, PO Box 130 Warkworth 0941, New Zealand
k.parker@parkerconservation.co.nz

[2] Department of Conservation, Napier Ahuriri District Office, PO Box 644, Napier 4140, New Zealand

[3] Institute of Natural and Mathematical Sciences, Massey University, Private Bag 102904, North Shore Mail Centre, Auckland 0745, New Zealand

[4] Nga Manu Nature Reserve, PO Box 126, Waikanae 5250, New Zealand

[5] Cape Sanctuary, C/-Lowe Corporation, 499 Coventry Road, Hastings 4156, New Zealand

[6] Pukaha / Mount Bruce, PO Box 680, Masterton, New Zealand

[7] 15 Rangatira Dtreet, Taupo 3330, New Zealand

[8] Orokonui Ecosanctuary, 600 Blueskin Road, Dunedin 9081, New Zealand

* Deceased

Abstract

This document details best practice techniques for the translocation of kākā (*Nestor meridionalis*) as of 2018. It contains a range of methods used in the translocation process, including selecting an appropriate release site, forming a translocation team, obtaining birds for release, captive husbandry, post-release management and post-release monitoring. It is intended that this information will help to increase the success of future translocations of kākā. However, translocation techniques are constantly being refined. Therefore, while this document provides a comprehensive starting point, contact should also be made with experienced practitioners when planning new kākā translocation programmes.

1. Introduction

The first successful kākā (*Nestor meridionalis*) translocation[1] was North Island (NI) kākā (*N. m. septentrionalis*) to Mount Bruce Scenic Reserve in 1996–2000 (Berry 1998; Miskelly & Powlesland 2013). Since then, NI kākā have been established at Zealandia (2002–2007), Maungatautari (2007–2009), Cape Sanctuary (commencing in 2012) and Boundary Stream (2013–2016) (Miskelly et al. 2005; Miskelly & Powlesland 2013; Smuts-Kennedy & Parker 2013). South Island (SI) kākā (*N. m. meridionalis*) have been established at Orokonui Sanctuary (commencing in 2008) (Miskelly & Powlesland 2013) and there has been a supplementary release of female kākā in Abel Tasman National Park as part of Project Janszoon (2015 and 2016), although the outcome of this release is unclear as of 2018.

Kākā translocations have generally been successful. However, they are resource intensive. This is because in contrast to most New Zealand bird translocations, which usually involve capturing wild birds and moving and releasing them within a relatively short time frame (2–10 days), kākā translocations have mostly used captive-reared birds and delayed release tactics. Captive-reared birds have been bred at established captive institutions (e.g. Auckland Zoo) for holding

[1] Translocation is defined by DOC as the managed movement of live plants or animals (taonga) from one location to another. Translocation covers the entire process, including planning, transfer, release, monitoring and post-release management (up to some predetermined end point). A translocation can consist of one or more transfers.

and release at a restoration site (e.g. Zealandia) or bred in aviaries at the release site (e.g. Maungatautari and Cape Sanctuary) with the subsequent offspring then released. Translocations of wild-caught birds have been rare, with just a few juveniles released at Mt Bruce Scenic Reserve (Berry 1998) and at Cape Sanctuary. Some sites have used a combination of methods. For example, at Cape Sanctuary birds have been bred and released on-site, but wild-bred juveniles from Zealandia have also been translocated to the Cape, held in aviaries and then subsequently released. Following release, kākā are supplementary fed to ease their transition into the wild and to minimise dispersal away from the release site. Artificial nest boxes are also often installed at the release site.

This combination of captive-rearing, translocation from wild to captivity, long holding periods, release and intensive post-release management (feeding and provision of nest boxes) might take 2–10 years. In addition, at some sites, post-release feeding and nest box management might have to be maintained indefinitely. However, if a large, well-protected release site is available, along with sufficient ongoing management support, kākā are a good translocation candidate. They likely play an important ecosystem role as pollinators, seed predators, invertebrate predators, habitat modifiers and as indicators of the effectiveness of pest control, especially as they can carry a transmitter for several years which is particularly useful for monitoring vital rates (survival and productivity). They are engaging, noisy and easily viewed by the general public. Kākā will also benefit from carefully considered conservation management because, while historically widespread and abundant, kākā populations have disappeared from most of their former range (Heather & Robertson 2015). In addition, successful kākā breeding is now likely confined to a relatively small number of protected island and mainland sites.

The information presented in this document has been compiled from reports on kākā translocations between 1996 and 2018, with additional information on kākā translocations provided by experienced practitioners. It is intended that this document will be used by people planning kākā translocations and/or assessing translocation proposals. The translocation techniques used for NI and SI kākā are identical and no distinction will be made in this document. In addition, genetic evidence does not support sub-specific status for NI and SI kākā, although there is a trend for increasing body size moving north to south and phenotypic differences are maintained between NI and SI kākā, despite evidence of gene flow (Dussex et al. 2015; D. Martini & M. Knapp, unpubl. data). This has important implications for sourcing birds for translocation projects.

The methods described here are based on those with proven success during previous translocations. Therefore, they are recommended as current best practice techniques for kākā translocations. Where there is no single best way of doing something, a range of techniques are described and, in these instances, the preference of the team that is translocating kākā comes into play. However, it is important to note that the behaviour and reaction of birds to captivity, translocation and release can vary between individual birds, locations, seasons and years. A good translocation practitioner will always closely monitor the birds in their immediate care and respond to their needs accordingly. In addition, active, ongoing exchange with other practitioners will be essential in maintaining high welfare standards and successful translocation outcomes.

Confidentiality of information in this document:

1. The information made available through this document is provided on the basis that it may assist with future translocations and is shared with people carrying out translocations and research for that purpose.

2. All information referred to within this document remains the property of the people reporting or contributing the information, and this report must be properly referenced if the information is cited in other publications.

Any new information or suggested improvements to this document can be sent to the Technical Advisor – Systems Improvement, Terrestrial Ecosystems Unit, Science and Capability Group, Department of Conservation (DOC) (coordinator of DOC's translocation process) – as of 2016 this is Troy Makan (email: tmakan@doc.govt.nz).

2. Animal welfare requirements

To ensure that high welfare standards are maintained throughout the translocation process and to maximise the chance of a successful translocation outcome, the translocation team needs to include people with suitable training and experience in the capture, handling, husbandry and release techniques that will be used. These expert operators are needed on site to demonstrate techniques and provide advice to less-experienced team members.

When handling wildlife, the animal welfare provisions of the Animal Welfare Act 1999 and its welfare codes[2] (e.g. Transport within New Zealand) must be met. Note, this best practice guideline has been produced to improve the likely success of kākā translocations, and thus promotes a high level of care of the birds and a consideration of general animal welfare. However, it does not attempt to address each of the minimum standards listed in welfare codes.

3. Assessing the suitability of a release site for establishing a kākā population

The most critical factor before proceeding with a kākā translocation is assessing the potential release site. Critical habitat criteria include robust protection from introduced predators, a diverse array of flowering and fruiting plant species, suitable cavities for nesting and sufficient area (c. 1000 ha; Greene et al. 2004) to allow for rapid population growth to a large size (100s–1000s of individuals). In addition to the habitat variables, release sites must be well managed in perpetuity, and have suitable staff and infrastructure in place to manage captive birds, post-release feeding stations, nest boxes (if required) and to ensure ongoing pest control to the level required for successful kākā establishment and breeding (Greene et al. 2004). Greene et al. (2004) also recommend that kākā should be extinct within the area, or very rare, to reduce the possibility of resident birds luring translocated birds away from protected release sites, particularly if they are contiguous with much larger areas of potential habitat. However, there were two small relict populations of kākā (Maungataniwha and Kaweka) c. 20–25 km from Boundary Stream at initial release and this did not hinder establishment of a translocated kākā population at Boundary Stream. In addition, there are likely genetic and behavioural benefits from translocated birds mixing with wild birds.

Kākā are extremely vulnerable to exotic mammalian pests when breeding, with females, eggs and chicks especially at risk in the nesting cavity, and chicks at risk immediately after fledging when they might spend up to a week on the ground (Moorhouse et al. 2003). Given this vulnerability, all translocations (with the exception of Mount Bruce Scenic Reserve, Boundary Stream and Abel Tasman National Park) have been to predator-fenced sites where most introduced mammalian pests are maintained at zero density (mice (*Mus musculus*) are present at several release sites). There is currently no formal definition of zero density for exotic mammalian pests. However, for management purposes it is useful to think of zero density as a contrast between suppressed introduced predator populations, i.e. those that are always present, albeit at low density, and those that are absent, i.e. they remain undetected most of the time but monitoring devices (such as tracking tunnels, traps, bite tags, cameras) detect animals when incursions occur (Parker et al. 2015a). Translocated kākā have established at unfenced sites where intensive pest control maintains introduced mammalian pests at low densities, for example Pukaha / Mount Bruce and Boundary Stream, but intensive pest control is critical over the breeding season, particularly in the establishment phase of a new population (5–10 years). Introduced *Vespula* wasps are also potentially significant competitors with kākā (Beggs & Wilson 1991; Wilson et al. 1998) and should be considered in translocation planning.

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[2] www.biosecurity.govt.nz/regs/animal-welfare/stds/codes

Kākā feed on a wide variety of fruits, nectar and insects (Heather & Robertson 2015) and have been released to sites with a diverse range of vegetation assemblages. However, all sites have comprised a mix of mature and regenerating native and exotic vegetation. There are unlikely to be particular plant species that are critical to reintroduction success but a diverse range of species that can supply fruit, nectar and insects year round is essential, i.e. a site comprising mostly young replanted habitat will be unsuitable for a kākā release. Similarly, a site that is dominated by a small number of species of relatively even age is also unlikely to be suitable for kākā. Masting is associated with kākā breeding, further illustrating the need for diverse mature vegetation at the release site, especially large seed crops (Greene et al. 2004). Supplementary feeding (refer to Section 8 – Post-release management) is a component of all successful kākā translocations but it should be supplementary to, rather than a replacement for, a natural wild diet. Kākā will readily feed on cultivated fruit, nut and specimen trees. This is an important consideration if a potential release site is surrounded by neighbours with cultivated trees. Kākā can be destructive and in some communities, e.g. Wellington City and Great Barrier Island (Aotea Island), this has led to conflict with property owners and occasional kākā deaths (refer to Section 7 – Post-release management).

Kākā are cavity nesters and generally use large, old and dead trees for nesting, typically at heights of 5–20 m above the ground, although ground-level nests have been recorded at protected sites (Heather & Robertson 2015). Ideally, a release site will have an abundance of natural cavities. However, birds will also use artificial nest boxes which can in themselves be useful tools for managing translocated populations, e.g. for monitoring breeding success and banding chicks (refer to Section 7 – Post-release management). Note, large numbers of nest boxes might need to be provided, and they require suitable protection from predators at unfenced sites (Greene et al. 2004) and ongoing maintenance (annual cleaning).

The minimum area required for a successful kākā translocation is unclear, although Greene et al. (2004) suggest c. 1000 ha, depending on habitat quality. However, in very general terms a successful translocated population should comprise at least several hundred birds to maintain long-term genetic diversity. Unlike many translocated species, where natural dispersal between populations across modified landscapes is unlikely, kākā are very capable dispersers (Moorhouse & Greene 1995). There is evidence of mixing between kākā populations (Dussex et al. 2015) and there is anecdotal evidence of wild birds joining translocated populations. This might lead to genetic exchange between otherwise isolated populations. However, it would be unwise to translocate birds to small sites (< 500 ha) where the translocated population would always stay small (c. 100 birds) and be isolated from other kākā populations. Zealandia Sanctuary (220 ha) and Orokonui Ecosanctuary (307 ha) are the smallest sites to which kākā have been translocated, although it should be noted that released birds use the surrounding habitats outside of the respective predator fences. In addition, kākā have bred outside Zealandia in nest boxes erected by Wellington City Council.

4. Translocation team

A kākā translocation team will require a diverse range of expertise, including skills in captive husbandry and breeding, capture, handling and banding and post-release monitoring (sometimes including radio tracking). In addition, kākā translocation teams might include external expertise and input from established captive institutions (e.g. zoos) and ongoing veterinary support from staff with experience with wild birds.

The key component for most kākā translocation teams will be to have at least one experienced aviculturist who will be responsible for maintaining kākā in aviaries at the release site. This will include overseeing daily feeding, behavioural enrichment, hygiene, breeding and monitoring of bird welfare and health. Inexperienced staff and volunteers can be incorporated into these roles and trained over time to take on greater responsibility. However, at the outset of any programme it is essential to have experienced staff on hand. Monitoring the behaviour of captive animals and ensuring they remain healthy (particularly as they will often hide ill health until symptoms are advanced) requires the ability to recognise subtle signs, so the need for experienced staff cannot be overstated.

Kākā are large powerful birds and can inflict serious injuries on inexperienced handlers or be injured themselves. Therefore, if wild birds are captured as a component of the translocation programme it will be essential to have people with a high degree of capture (including mist netting), handling and banding experience. Staff will also need experience in transporting birds between capture and release sites, which is one of the riskiest stages of any translocation.

Post release monitoring is a critical component for determining the success of a translocation project, particularly at a new site (Parker et al. 2013). Kākā can be monitored at feeders post release, by applying radio transmitters, and by monitoring nests and banding offspring. All of these tasks require experienced staff to maintain high welfare standards and obtain useful data. Again, inexperienced staff and volunteers can play a vital role in post-release monitoring, particularly as their own skill levels grow, but experienced staff will be needed at the beginning.

Finally, kākā translocation teams should develop and maintain good relationships with the kākā captive co-ordinator, institutions experienced in dealing with captive kākā, veterinarians and other restoration sites that have translocated kākā. This will likely naturally happen through the translocation process, particularly when sourcing captive birds for release. However, having clear lines of communication in place will be essential for quickly responding to any husbandry, health or behavioural issues that might develop at the release site.

5. Sourcing kākā for translocation projects and ensuring appropriate genetic diversity in founder populations

The number of founders required to establish a new bird population that maintains genetic diversity in the long term (c. 10 generations) is variable and dependent on survival, productivity and population size (Weiser et al. 2012; Weiser et al. 2013). However, it is rarely less than ≥40 unrelated birds. No kākā reintroduction programme has released ≥40 unrelated founders. The long-term impact of this on population persistence is unclear but there is a current research project examining genetic diversity within and among kākā populations (D. Martini & M. Knapp, pers. comm. 2018).

Most kākā translocations (through to 2018) have used captive-reared birds as a major component of their reintroduction programme. This has been carried out in two ways. First, captive-reared juvenile kākā have been sourced from established captive institutions that hold and breed kākā, including Auckland, Wellington and Hamilton Zoos, the Otorohanga Kiwi House and Pukaha/Mount Bruce. Second, some restoration sites, including Maungatautari and Cape Sanctuary, have borrowed established breeding pairs from a captive institution, bred them onsite and then released their progeny.

This is an effective means for initially establishing kākā at a release site. However, the captive kākā population is relatively small (c. 40 NI birds in 2018) and is scattered across a number of institutions. In addition, not all institutions have active breeding pairs, some birds are unsuitable for breeding for release (due to genetic or health issues) and breeding can be sporadic and unpredictable in captivity. Therefore, there is a limited capacity to supply captive-reared birds to restoration programmes and, as of 2018, the captive NI kākā programme is under review with an intention to assess this capacity. It is likely that some birds will be available for ongoing release but priority will go to sites with incomplete kākā translocation programmes and to new sites that are considered highly suitable for kākā.

While they have formed only a limited component of kākā translocations so far, wild-caught birds can also be used for establishing new populations. Of five juvenile kākā captured on Kapiti Island and released at Pukaha/Mount Bruce, four survived for at least 18 months, and were regularly sighted at the release site, while one disappeared c. 4 months after release (Berry 1998). Ten juvenile wild-bred kākā were also captured in Wellington in 2016 and translocated to Cape Sanctuary, although it should be noted that these birds were part of the Zealandia Sanctuary meta-population and were captured at a feeder site on a private property. As with captive-reared kākā there will be a limited capacity for harvest of wild kākā populations as few populations are large enough and productive enough to sustain harvest of large numbers of birds. In addition, capturing wild kākā requires skilled personnel and is resource intensive and time consuming. An alternative to capturing wild independent kākā is to harvest wild clutches or young chicks from nests, hand-rear the birds (or use foster parents) and then release juveniles. This is currently being planned for a SI kākā translocation project (R.J. Moorhouse, pers. comm. 2018) but again requires skilled personnel for locating nests, collecting eggs or young and hand-rearing chicks, and will be expensive and time-consuming. Egg translocations between translocated and wild populations are another option for increasing genetic diversity. However, they will be resource intensive and might have a lot of uncertainty around success, as hatched chicks need to survive to independence, recruit into the translocated population and successfully breed at the release site.

An alternative to capturing wild kākā is providing a safe release site for wild kākā that have ended up in captivity for other reasons. For example, orphaned chicks from Great Barrier Island (Aotea Island) were released at Cape Sanctuary and injured and rehabilitated kākā from Fiordland and Stewart Island were released at Orokonui Ecosanctuary.

Wild kākā have also been recorded at restoration sites following the release of captive-reared birds. For example, in 2016, a wild kākā was observed at Cape Sanctuary for over 2 months and was regularly seen interacting with released birds. In 2015, wild kākā interacted with translocated birds confined in aviaries at Zealandia and continued to do so for up to 2 years post-release. A wild kākā was also captured and banded at Zealandia in 2003. At Maungatautari, at least three wild kākā were observed interacting with captive kākā for several months in 2007. It is not surprising that wild kākā appear at release sites. They are excellent dispersers, covering distances up to 400 km (Moorhouse & Greene 1995) and share a large proportion of genetic diversity (c. 80%) among populations (Dussex et al. 2015; D. Martini & M. Knapp, unpubl. data), which indicates some ongoing mixing between populations. At least one wild bird has bred with a translocated bird at Zealandia and it is possible that there is some level of ongoing mixing with wild Kapiti Island birds. However, it is currently unknown if this is occurring at other sites.

Ultimately, a sensible approach for new reintroduction programmes would be to release birds from both captive and wild sources. This could be combined with effective post-release monitoring to detect if any wild birds have joined the translocated population, either through direct observation of unbanded birds joining a banded population, or through genetic analysis of birds produced or captured at the release site. There are also likely behavioural advantages in using both captive-reared and wild birds. The data is sparse, but captive-reared birds seem to be less prone to post-release dispersal, more inclined to use supplemental feed stations and nest boxes, but also more likely to feed on the ground, exploit a narrower range of natural foods (Berry 1998) and interfere with management devices. In contrast, wild birds seem to disperse further, are less inclined to use supplemental feed stations or feed on the ground, use a wider range of natural foods (Berry 1998) and rarely interact with management devices. Therefore, the two groups are complimentary. Captive-reared birds might assist in minimising post-release dispersal of wild-caught birds whereas wild-caught birds might be beneficial in teaching captive-reared birds to exploit a wider range of natural foods. If wild birds join the translocated population this will further increase genetic diversity and possibly offer additional behavioural advantages, particularly with regards to feeding and use of natural nest cavities. Supplemental translocations of kākā, especially females which are more vulnerable to predation, into small relict populations of wild kākā might also be a restoration option and this has been put into practise at Project Janzoon, Abel Tasman National Park. However, this approach requires very careful investigation and thorough knowledge of the population dynamics of any relict population before proceeding with supplemental translocations.

6. Captive husbandry

6.1 Banding

All captive and released birds must be banded by an approved bander, generally with a single stainless L metal band, although at Project Janzoon L bands seemed to be a bit tall, leading to a recommendation to use V bands instead – both can be obtained from the DOC Banding Office. Birds can also be given individual colour combinations using plastic wrap around bands, metal colour-coated half bands or Polish numbered and coloured interrex bands. However, note that kākā often remove plastic bands. Chicks can be banded in the nest at c. 30 days, i.e. when their tarsi are large enough to prevent the band slipping down over their foot.

6.2 Sexing and aging

Male kākā are typically larger than females in weight, bill size and bill shape (Moorhouse et al. 1999). Table 1 shows size differences relative to sex in North Island kākā from Moorhouse et al (1999).

Additional means of sexing birds include DNA sexing (by the Equine Parentage & Animal Genetic Services Centre at Massey University – requires either a small blood sample or a freshly plucked feather) or laparoscopy. Note, blood sampling and feather plucking should only be conducted by experienced handlers to ensure bird welfare and useful samples. Laparoscopy can only be performed by a suitably qualified veterinarian and requires the bird to be anesthetised. It is impractical when catching wild birds and is more invasive than DNA sexing.

Juvenile kākā up to 1 year of age can be distinguished from adult birds by the yellow tinge to exposed skin around the eye and bill along with having protruding feather spines on the ends of their tails (Moorhouse et al. 1999). However, note that many breeding females also develop a distinct yellow ring around their eye (M. Booth, pers. obs.).

Table 1. Sexual differences in NI kākā (reproduced from Moorhouse et al. (1999))

VARIABLE	MALES			FEMALES		
	n	MEAN (S.I.)	RANGE	*n*	MEAN (S.I.)	RANGE
Culmen length (mm)	32	49.1 (0.43)	44.6–55.0	36	42.4 (0.3)	37.8–46.7
Culmen depth (mm)	32	18.5(0.17)	16.3–20.7	33	16.2 (0.3)	11.8–18.0
Culmen width (mm)	29	12.6 (0.13)	11.1–14.0	31	11.9 (0.1)	10.5–13.4
Tarsus length (mm)	19	35.4 (0.27)	33.3–37.9	17	34.7 (0.4)	32.0–38.6
Weight (g)	18	458 (10.38)	402–555	21	400 (5.8)	358–450

6.3 Transfer

While kākā have been moved considerable distances between sites using a variety of methods (car, boat and plane), moving animals is one of the riskiest elements of any reintroduction programme. This is because the process is inherently unpredictable with exposure to varying temperatures, noises and sounds (Parker et al. 2012; Parker et al. 2015b). Therefore, any movement of kākā needs to be carefully planned to minimise time in transfer boxes and exposure to novel stimuli. Captive kākā must also be accompanied by an experienced handler throughout the entire moving process. They can be provisioned with appropriate foods throughout moves (e.g. fruit, vegetation or nuts) but this is generally not required for short moves (< 4 hours). Any liquid foods should be removed while in transit to prevent plumage from being soiled. Spare food, water and dishes should be carried whenever moving kākā and a contingency plan should be in place to deal with unexpected delays. Kākā should be transported in secure, solid but well-ventilated transfer boxes with an internal perch, such as those used at Cape Sanctuary (Fig. 1). The International Air Transport Association (IATA) has guidelines for the construction of transfer boxes for parrots and these should be followed if birds will be regularly transported by air. Specific recommendations

Figure 1. Kākā transfer box. These boxes are suitable for relatively short moves, but additional venting is recommended, particularly for moves in northern parts of the country or over warmer months. *Photos: Sue Dryden*.

include solid wood framing (minimum 20 mm x 40 mm), ply or solid wood sides (6 mm), floor (12 mm) and door (12 mm), a maximum of three perches, a minimum of 75% of the front covered in mesh or metal bars and a light material over all mesh that maintains good air flow and reduces light (e.g. muslin cloth). Note, the boxes used by Cape Sanctuary have been used for air travel.

6.4 Housing

It is impossible to fully mimic the expansive forest habitats of wild kākā in captivity. However, kākā aviaries should be as natural as possible to ensure high welfare standards when in captivity. They should also be as large as is practicable. Some captive institutions have aviaries up to 50 m long, 30 m wide and 20 m high; however, this size will be both impractical and unnecessary for most restoration sites. Captive institutions, and restoration sites with active kākā programmes, can offer useful guidance for aviary construction and they should be consulted alongside this document before building aviaries (refer to Appendix 1 for various aviary designs). The cost of building aviaries varies between sites, but in some cases they have been very expensive ($20,000–$150,000).

In choosing a site for the aviary consider the predominant wind and exposure that each flight will be subjected to. Wild birds can tolerate a range of climatic conditions, but they do this by moving in response to changing weather. Therefore, it would not be sensible to face an aviary directly south on an exposed ridge. Similarly, an exposed aviary facing directly north will be prone to overheating. The ideal positioning will avoid extreme heat, cold and wind and will be surrounded by the immediate release habitat, ideally in a fairly central location rather than right on the edge of the release site. Some aviaries (at Maungatautari, for example) have been built under forest canopy. This is suitable as long as the aviaries are not too dark and damp. Aviaries should also be positioned in a quiet spot away from both the public and general human activity, including site staff and operations. There is often a desire to display captive birds to the public. However, where the primary objective is to rear birds for release this is best avoided to minimise habituation to people, which is often detrimental to the birds' post-release survival (refer to Section 6.9 – Avoiding habituation to people).

Kākā are very curious, have powerful bills, and are naturally inclined to chew on soft materials. Therefore, careful consideration must be given to aviary construction materials. If a timber frame is used the timber should be untreated. Birds will likely chew on any exposed timber. They can do considerable damage in a short space of time so the aviary should either be constructed to allow easy replacement of damaged timber or, ideally, the framing should be covered to prevent damage. Tanalised timber can be used for framing but only if it is completely covered to prevent birds chewing it and ingesting toxic material. Steel pipe framing can also be used for aviary construction. Aviaries should also be very carefully checked after construction, before they contain birds. This ensures that anything that birds might injure themselves on, including loose fixtures, protruding edges and wires or construction debris (e.g. nails, wire, metal and tanalised shavings) can be either fixed or removed before birds are held in the aviaries.

A variety of different mesh sizes and constructions have been used, ranging from Excluder mesh (Maungatautari), 6 mm square mesh (Zealandia), 12 mm square mesh and 18 mm chain link mesh with 2.5 mm gauge wire. The main consideration is that the mesh is robust enough to endure chewing and biting and is non-toxic. Poorly galvanised mesh has been implicated in parrot deaths, with cheap Chinese-made mesh considered especially suspect. Preference is given to local or Australian-made mesh that has been weathered prior to being used on aviaries (weathering breaks down the toxic surface layers). Mesh can also be washed down with a vinegar and water solution to remove toxins from the wire surface. Non-fenced release sites should also consider incursions by unwanted pests such as mice, rats (*Rattus* spp.), mustelids (stoats (*Mustela erminea*), ferrets (*M. putorius furo*), weasels (*M. nivalis*)) and sparrows (*Passer domesticus*). This might necessitate using a smaller gauge of mesh and either burying the mesh or having a concrete foundation c. 600 mm deep to avoid pests digging into the aviary. Smaller mesh, or a double wall, might also be necessary between flights to prevent birds in adjoining flights biting each other's toes.

As a bare minimum, two birds could be housed for short periods (weeks) in an aviary approximately 7 m long, 2.5 m wide and 2.5 m high. For longer periods, larger aviaries are preferable as they allow captive kākā to maintain strong flight muscles. For most bird species, rectangular aviary designs are preferable to square (Parker et al. 2012) and each flight should have a double entrance door to prevent birds escaping when aviaries are serviced. At Zealandia, holding aviaries are timber framed and consist of three flights approximately 6 m long, 4 m wide and 3 m high. At Maungatautari, birds are both bred and held in a large aviary with three flights 12 m long, 4 m wide and 3 m high. The framing is round tanalised timber that is protected from captive birds by metal sheathing. All flights are accessed from an internal work area and only have a single door. However, the internal doors all have strip screens to prevent birds flying into the internal work area and the doors have rubber strips along the top to prevent damage to birds' feet if a door accidently shuts while they are perched on it. At Boundary Stream the holding aviaries consist of two steel-framed flights, each 10 m long, 5 m wide and 3–3.5 m high. At Orokonui the corrugated iron-clad steel-framed holding aviaries consist of two flights, each c. 5 m long, 3 m wide and 2.5 m high. At Cape Sanctuary, birds are both bred and held in steel-framed aviaries consisting of two large flights (both 12 m long and 4 m wide) and a smaller flight 9 m long and 3 m wide; with all flights a minimum of 3.3 m high. At Pukaha / Mount Bruce, birds were held in two different aviaries prior to release, one measuring 16 m long, 9 m wide and 4 m high (up to six birds) and the other 6 m long, 2 m high and 2 m wide (up to four birds).

Each flight should have at least one large area where birds can shelter from inclement weather, aviary mates or other stimuli they find unsettling. Any shelter should not be too enclosed as most birds feel unsafe if they cannot monitor their immediate surroundings. Therefore, all shelters should provide clear views and escape routes into the main flight. Some sites have also provided roost boxes (essentially, open-faced wooden boxes) as additional shelter options, with birds often favouring the top of the roost boxes as resting spots throughout the day. Several sites, including Maungatautari, Cape Sanctuary and Orokonui, have a work room attached to the aviary. This provides a secure area where food, food dishes and aviary equipment can be prepared, stored and cleaned. The work room can also provide safe access to and from flights.

Some consideration should be given to how birds will be either released from aviaries or captured in them. The simplest solution is to have a hatch, door or windows that can be opened to release birds directly from the aviary. They should be high and wide and open down and out. The hatch, door or windows should be at the height that kākā normally sit in the aviary and they should be easily opened using a ladder from the outside of the aviaries. They should also face in the direction that released birds should move, i.e. towards the centre of the release site rather than towards release site boundaries. Variations of these methods have been used at Zealandia, Boundary Stream and Cape Sanctuary. Kākā often take some time to realise that the release hatch, door or windows are open. At Zealandia and Boundary Stream, large bunches of vegetation and a food tray were placed at the entrance and at Cape Sanctuary perches were added to the outside of the release hatch to coax birds out and provide a ladder for them to climb to the aviary roof. Alternatively, birds can be captured with hand nets in the aviary and then released, although this can be difficult in very large or high aviaries and is likely very stressful for the birds and therefore counterproductive at release. Aviaries can also be designed so that birds can be captured in feeders within the aviary. For instance, a feeder might be placed in a small cage that is open most of the time but that can be converted to a trap if a bird needs to be captured, either for release or a health check. However, some birds will learn to avoid traps, even within an aviary.

The flights and shelters should have a variety of perches at different heights and diameters, although perches should not be placed directly underneath other perches and careful consideration should be given to flight paths within the aviary. For example, perches might be installed in the shelter and at either end or the corners of the flight to maximise flight paths for captive birds, thereby maintaining flight muscles. Natural branches with the bark intact should be used for perches as they are easy for birds to settle on. They should be at least 30 mm in diameter, but much larger branches (≥100 mm) are fine as well. Perches should be fixed in place, although some hanging perches are also acceptable, as long as they are secure. Birds will chew on the perches so they should be installed in such a way that they can be easily replaced. For example, at Boundary Stream chains were suspended from the roof. These allowed fresh logs to be easily installed and when one side of the log had been stripped it could be easily turned over so kākā could gain access to the other side. At Boundary Stream, captive kākā showed a preference for logs suspended ≥1.5 m from the ground, so while some low perches should be installed, the priority should be for higher perches that imitate the arboreal habits of kākā.

A variety of flooring materials have been used for kākā aviaries, including concrete, earth, sand, bark and gravel. For instance, at Maungatautari the aviaries have a full concrete floor with internal drainage to a cleanable sump and each flight is fitted with a tap and hose for washing. At Cape Sanctuary the floor underneath the covered portions of the flights is concreted, whereas the rest is earth, and at Zealandia and Boundary Stream the floors are all earth. Concrete is often perceived as being easier to clean but concrete surfaces are rarely smooth and pathogens and parasites can build up on rough surfaces, thereby requiring regular cleaning with an appropriate disinfectant that is non-toxic to birds, e.g. Simple Green. As an alternative, the top layer (50–100 mm) of natural earth floors can be periodically replaced to prevent the build-up of pathogens and parasites. For instance, at Boundary Stream the holding aviaries are lined with a thick layer of leaf litter which is replenished while birds are captive and removed and replaced between uses. Ultimately, decisions about flooring material will depend on how long birds are held, i.e. for short-term holding (c. 2 months) an earth floor might be fine whereas for longer term holding a hard surface might be considered.

6.5 Feeding

Captive kākā, whether at a captive institution or a release site, are typically fed subtle variations on a standard diet of fresh fruit and vegetables, specifically formulated parrot pellets, liquid foods (Wombaroo nectivore mix and honey water) and lots of fresh natural browse. Fresh, clean water must also be available at all times. Appendix two lists kākā diets and feeding protocols from several different locations.

Robust feeding dishes that can be easily cleaned are essential. Many sites use a ‘Grandpas Feeder’ which is a metal poultry feeder that opens when a feeding bird stands on the attached treadle. The advantage of this feeder is that it is also suitable for feeding birds after their release (refer to Section 7 – Post-release management). Metal dishes have also been used but these should be reasonably large and heavy, or secured, to prevent birds alighting on the edge and tipping them. Some sites use metal feeding dishes inside a large tray which catches spilt food and facilitates easy cleaning. Liquid foods are usually provided in rabbit bottles with metal spouts. At Cape Sanctuary these are placed inside short sections of PVC pipe, thereby securing the bottles and preventing kākā from easily damaging them (Appendix 3). At Zealandia and Boundary Stream, liquid feeders had to be modified to prevent other species, such as tūī (*Prosthemadera novaeseelandiae*) and saddlebacks (*Philesturnus* spp.), from eating food intended for kākā. A flap was placed over the nozzle and kākā had to pull on a piece of string with a stick on it to gain access to the feeder. However, at Zealandia, saddlebacks still gained access by hanging two at a time on the stick. Fruit and vegetables can be secured on spikes in the aviary although care must be taken to ensure they are not so sharp that they could injure a bird. Fresh browse and rotten logs can be scattered throughout the aviary or placed in purpose-built holders. For example, at Boundary Stream vegetation is placed in PVC pipe (c. 150 mm diameter) that is capped and buried in the ground with c. 100 mm protruding. This provides a solid base in which to place vegetation along with water to extend the life of fresh browse (note, any vase type holder should not be large enough that a curious kākā could climb into it or should be jammed full of branches so that this is not possible). In placing feeding dishes and forage throughout aviaries give some consideration to their positioning. For example, if they are placed under a perch they will be quickly fouled by perching birds.

Captive kākā should be fed at least daily, with some sites feeding birds twice a day, particularly over the summer months (this will be especially important where any foods that are prone to spoilage are given, e.g. Wombaroo nectivore mix). All captive animals benefit from a regular, predictable schedule (Parker et al. 2012), so feeding times should be standardised where possible along with feeding staff and/or volunteers and feeding protocols. If possible, this schedule should also be maintained for supplementary feeding post release. Fresh browse is an essential component of any captive kākā diet and ideally should be sourced directly from the release site so that captive birds can become familiar with the natural foods they will encounter in the wild. Most native vegetation, but particularly any with fresh flowers, fruits, leaves, seeds and bark is suitable, with species such as *Coprosma* spp., kāmahi (*Weinmannia racemosa*), tōtara (*Podocarpus* spp.), pōhutakawa (*Metrosideros excelsa*), Northern rātā (*Metrosideros robusta*), māhoe (*Melicytus ramiflorus*), kaikōmako (*Pennantia corymbosa*), ngaio (*Myoporum laetum*), miro (*Prumnopitys ferruginea*), flax (*Phormium tenax*), patē (*Schefflera digitata*), mānuka (*Leptospermum scoparium*) and pūriri (*Vitex lucens*) regularly fed out. Masting species, such as beech (*Fuscospora* spp.) in the South Island and rimu (*Dacrydium cupressinium*) in the North Island, make key foods for captive birds destined for translocation. Rotting logs of both native and exotic trees are also favoured by kākā and they will spend hours tearing them to pieces in search of invertebrates such as huhu grubs (*Prionoplus reticularis*). However, some care must be taken to avoid supplying any toxic plants including onion weed (*Asphodelus fistulosis*), black nightshade (*Solanum nigrum*), bittersweet nightshade (*Solanum dulcamara*), Jerusalem cherry (*Solanum pseudocapsicum*) and karaka (*Corynocarpus laevigatus*). Care should be taken in feeding out exotic plants to prevent unwanted dispersal of potential weed species.

In the past, captive diets often contained cheese, corn and large quantities of nuts or peanuts. Cheese and any other dairy products not specifically formulated for birds should be avoided, as they are not compatible with avian digestive tracts. Nuts, peanuts and corn still feature in some captive diets. However, they should only be small components of a varied diet as they are associated with metabolic bone disease, particularly in chicks and young birds.

6.6 Maintaining hygiene in aviaries

Strict hygiene protocols are essential for maintaining good health in captive kākā. All sites currently holding birds emphasise the need for careful daily cleaning and checks of aviaries. Simple steps, such as hand washing, are essential before entering an aviary and/or preparing food. Footwear and clothing should also be clean before working with kākā, especially if it has been worn around pets and/or livestock. Some sites use a foot bath containing a sterilising agent (e.g. Trigene) so that footwear can be sterilised before entering aviaries. It is preferable that staff and volunteers do not own captive birds, particularly parakeets and parrots, as there is a risk of transmitting disease to captive kākā. However, if staff and volunteers do own pet birds they should avoid handling them prior to working with kākā and should wear clean clothing that has not been exposed to the pet birds.

All old food, obvious concentrations of faecal matter and mouldy vegetation should be removed from aviaries daily and all feeding dishes, water dishes, bottles, buckets and trays cleaned. Most sites use a hot wash in a non-toxic detergent for the initial clean followed by a rinse in clean water before drying and/or sterilisation with products such as Milton, Trigene or SteriGENE® (note, dishes should be carefully rinsed after washing in products such as Trigene and SteriGENE®). Some sites only sterilise feed and water dishes once a week or after heavy soiling but note that any feeders used for Wombaroo should be carefully cleaned daily with particular care to ensure rabbit feeders with spouts or nozzles are completely clean and sterile. All food preparation equipment (e.g. dishes, utensils, knives and cutting boards) and surfaces should also be cleaned daily. Ideally, all utensils will only be used for kākā and those used for waste food will be kept separate from those used for fresh food. All perishable kākā food (e.g. fruit, vegetables and liquid foods) should be refrigerated, particularly during summer months, or if prepared prior to feeding. Pellet foods should be kept in sealed containers in a cool dry place to prevent insect, mould or fungal damage.

Concrete floors are usually swept daily and washed down at least 1–2 times a week, depending on soiling. Either water or a non-toxic detergent can be used for cleaning floors. Sites with earth floors can periodically replace flooring materials. For example, leaf litter at Boundary Stream is removed form aviaries after birds are released or removed and the ground is left fallow until the next use.

6.7 Behavioural enrichment

As with most parrots, kākā are very intelligent. Therefore, they need stimulation to keep them busy in captivity. This will be especially important for juvenile birds and is likely an essential aspect of their growth, development and, for birds released to the wild, survival. All sites holding kākā provide fresh browse at least several times a week. This obviously provides diverse feeding opportunities. However, it is also an effective minimum for behavioural enrichment as kākā will spend hours fossicking through fresh vegetation. Rotten logs are also provided at most sites, with kākā actively tearing into them in search of invertebrates.

At Cape Sanctuary, kākā are provided with either egg cartons or cardboard cylinders which they tear apart. They are also provided with ‘rummage boxes’ – cardboard boxes filled with items such as leaves, fruit and pinecones. On occasions they are also given ‘flax balls’ – small woven flax baskets, each with a nut or huhu grub inside, which are suspended from perches in the aviaries. Kākā haul them up like fish on the end of a fishing line and love to unravel them (various captive institutions do similar things with enrichment toys). At Boundary Stream and Orokonui Ecosanctuary, food treats are hidden throughout the aviary for kākā to find. Several captive institutions also give kākā suspended treats, puzzle feeders, savoury or fruit ice blocks, hanging corn on the cob, rolled treat balls, roll cages with fruit inside them, fruit kebabs and pinecone kebabs. In designing behavioural enrichment for translocated kākā it might be best to use natural items as much as practicable, i.e. while they will frequently encounter flax and huhu grubs in the wild, corn on the cob and manufactured enrichment toys will be non-existent. The key element is providing the birds with a challenge to obtain a food treat, and useful problem-solving skills for life in the wild.

6.8 Breeding

The captive NI kākā population is managed by a national species coordinator who is appointed by the Zoo and Aquarium Association (ZAA) Australasia in consultation with DOC. The coordinator maintains a studbook, and via analysis of the studbook, produces an annual report and recommendations, endorsed by programme participants. This is necessary to ensure that all captive NI kākā are managed as a single population (flock), thereby ensuring appropriate genetic diversity is maintained. The captive NI kākā programme is under joint review by ZAA and DOC (as of 2018) and it is currently unclear if breeding pairs will be available to produce birds for sites wanting to establish NI kākā populations. In addition, breeding kākā on site requires technical skills, extensive experience, and extra resources relative to simply holding captive birds for release.

As of 2018, the SI kākā captive coordinator (appointed by DOC) is Rosemary Vander Lee.

6.9 Avoiding habituation to people

Avoiding excessive habituation to humans is one of the most difficult challenges when holding kākā in captivity. They are intelligent, engaging birds and will quickly learn to associate staff, volunteers and visitors with food and treats. They will also learn to actively solicit attention and treats. However, becoming excessively familiar with humans is poor preparation for establishment in the wild and will ultimately be detrimental to kākā health, wellbeing and survival.

Habituated birds are at risk in several ways. They might gain access to inappropriate foods which can lead to obesity or ill health, particularly in chicks or young birds. For instance, a kākā chick that was euthanised in Wellington was likely being fed an inappropriate diet of nuts that its parents were obtaining from people who were feeding them. Kākā could be injured when attempting to land on people, especially as they can become persistent, or even aggressive, when soliciting food. They might also contract disease from, or spread it to, people. Habituated birds will also be more likely to enter houses and gardens, putting them at risk from pet dogs and cats, along with being more inclined to investigate novel objects such as traps and bait stations (refer to Section 7 – Post-release management). Kākā can also be severely injured or even killed by people who become intolerant of their presence, especially if the birds start damaging property or vegetation.

Ultimately, all captive kākā should be discouraged from interacting with people and people should be discouraged from interacting with kākā. They should be gently brushed or shrugged off if they land on aviary staff or volunteers and they should not be fed by hand. Aviary visits should be restricted to feeding, cleaning and essential health checks, with birds otherwise left alone. As noted in Section 6.3, aviaries should ideally be in a quiet place away from regular human activity. If the release site is close to houses or private properties, effort should be made to engage the local community. Local people should be discouraged from feeding released kākā.

6.10 Health management

All kākā release sites should establish a working relationship with an experienced avian veterinarian to facilitate optimum health in captive birds. A change in day-to-day activity or behaviour is the first indication that a captive bird might be unwell. This change might be behavioural, e.g. due to harassment from aviary mates, or physiological following contraction of parasites or disease-causing pathogens. General signs of poor health in birds include lethargy, a fluffed-up appearance, an open bill and raspy breathing, abnormal faeces, drooping wings and tail, and/or hiding, particularly on the ground.

If the problem is behavioural it might be quickly solved by moving the bird to a different aviary. For instance, a female bird at Cape Sanctuary had to be moved to a different aviary when it was noted that she was being constantly harassed by a male bird. The female had become very reclusive, hiding in her nest box and growling at the male when he approached. However, care needs to be taken in distinguishing actual harassment from normal breeding behaviour.

Alternatively, if a captive bird appears to have contracted a disease or parasite it will require immediate attention from an experienced veterinarian. This is because most birds will hide poor health for as long as possible and any disease will often be quite advanced when symptoms become apparent. Several diseases have been recorded in kākā, including psittacine beak and feather disease (PBFD), aspergillosis, avian tuberculosis and parasitic worms. However, diagnoses can only be made by an experienced veterinarian, often following laboratory analyses.

Kākā should also be subject to health checks, ranging from a simple physical exam through to screening for disease-causing pathogens, and possibly quarantine, especially when they are being moved between captive holding sites or from captivity to the wild. Most captive institutions will have quarantine protocols in place, but these will be subject to ongoing review and will also vary depending on the source and release site. Any translocation from wild-to-captivity or wild-to-wild release will be subject to the standard DOC translocation approval process, which sometimes includes health screening protocols.

7. Post-release management

7.1 Release protocols

Birds have been held onsite from 2 weeks to 8–9 months prior to release and released at 6–10 months of age, although the ideal holding period or age for release is unclear. At some sites, birds are captured in the holding aviaries, transmitters attached and then they are released. At other sites hatches or doors have been opened, with adjacent perches, vegetation or food dishes used to encourage and allow kākā to leave the aviary when they are ready (refer to Section 6.4 – Housing). Aviaries are often left open for several weeks after release with food provided both inside and out for newly released birds.

The data are sparce, but it seems beneficial to have some birds remain in the aviaries for initial releases, even if only for a week or two, with the captive birds possibly encouraging released birds to remain in the vicinity of the aviary. Retaining captive birds is probably not as important for subsequent releases, assuming earlier releases have been successful and there are free-living kākā at the release site.

Post-release feeders should be operational prior to releasing kākā, ideally of the same design used in captivity and with the same food (refer to Section 7.2 – Supplementary feeding). Birds should be released early in the day to give them time to investigate the release site and find somewhere safe to roost. Releases should also be timed to avoid inclement weather, particularly high winds or heavy rain. Any tikanga (custom/protocol) should also be carefully organised with the appropriate iwi or hapū to meet cultural requirements whilst maintaining bird welfare. Releases are often popular events, but it is probably better to avoid having a very large crowd observe a kākā release, especially of captive birds. A large crowd might prevent captive kākā from leaving their aviaries or encourage them to move away from the release site to avoid people. However, if this is well managed, i.e. the crowd is kept quiet and is positioned so that the released kākā have a clear unimpeded escape route, it might not be problematic, at least for captive-reared birds.

7.2 Supplementary feeding

Post-release supplementary feeding has been used at all kākā releases sites, either for the initial release period (Boundary Stream and Abel Tasman until the birds no longer visit feeders on a regular basis), or on a permanent basis (Maungatautari, Cape Sanctuary, Zealandia, Orokonui). This likely eases the transition from captivity to the wild, encourages birds to remain at the release site, provides a focal point for post-release monitoring, encourages local breeding and provides a place where the public can observe released birds.

The supplementary feed stations should have feeders that are identical to those used in captivity. For the initial release period they should also be provisioned with the same food provided in the holding aviaries, although the variety and quantity will be reduced over time to encourage released birds to find their own food. Ideally, the feeders will also be provisioned on a similar schedule to captive birds and the same hygiene protocols should be adhered to (refer to Sections 6.4 and 6.5 – Feeding and Maintaining hygiene in aviaries).

The design and number of feeders provided varies between release sites and will need constant monitoring, especially as the translocated population grows. For example, a breeding pair or particularly aggressive individual might monopolise a feeder and exclude other birds, so multiple feeders are usually required. At Zealandia there are two feeder sites, each mounted on a covered post and comprising two Grandpas Feeders provisioned with a 50/50 mix of Harrison's Bird Foods Adult Lifetime Coarse pellets and Harrison's Pepper Lifetime Coarse pellets (approximately 400 g per feeder). Sugar water and Wombaroo Lorikeet and Honeyeater Food is also provided on separate posts in rabbit bottles with sipper spouts (for sugar water and Wombaroo recipes refer to Appendix 2 – Captive diets and feeding protocols). The bottles are held in place with simple spring clips inside a plastic cowling made from an upturned 3 L plastic bottle. The cowling is to prevent tūī from using the feeders. The food is replenished by volunteers at midday and, with the exception of Wombaroo, is provided ad lib. Only 500 ml of Wombaroo is provided at each feeding station and it is usually exhausted within an hour.

Cape Sanctuary has established a second feeding site following the release of 10 Wellington-sourced juvenile kākā. Each site has a Grandpas Feeder and two rabbit bottles in PVC pipe holders that dispense Wombaroo Lorikeet and Honeyeater Food. Kākā are given Harrison's pellets, dates and 600ml of Wombaroo per bottle. The amount of Wombaroo will be reduced over time. Food is replaced daily in the morning.

At Orokonui Ecosanctuary there are four feeding stations and they are provisioned with an identical diet to that provided in captivity (refer to Appendix 2 – Captive diets and feeding protocols).

At Pukaha / Mount Bruce the supplementary feeding station comprises circular feeders with four compartments, each containing bowls and rabbit feeders with trays at the bottom of each feeder catching any dropped food. Each feeder is mounted 2 m off the ground and secured by a bolt that can be removed so the feeder can be lowered for feeding and cleaning. The station was used in aviaries prior to the birds' release and then provisioned daily following release (Berry 1998).

7.3 Nest boxes

Ideally, a kākā release site will have abundant natural nest cavities and artificial nest boxes will be unnecessary. However, nest boxes might be required at release sites where natural cavities are scarce. Nest boxes also offer several other advantages. First, nest boxes can be built to be relatively predator proof, an important consideration for unfenced mainland release sites where PVC pipe nest boxes and an overhanging roof (≥ 170 mm) will be critical in excluding stoats (Greene & Jones 2003). Second, they can be a useful monitoring tool that allows quantification of breeding effort and success, along with facilitating easy banding of nestlings. Third, captive-reared birds might show a preference for nest boxes if they themselves have been reared in nest boxes.

Nest box design and construction has varied between sites, with several designs and mounting methods described in Appendix 4. However, the basic principle is to construct something that resembles a natural kākā nest cavity (Greene & Jones 2003), i.e. a long cavity c. 500–1200 mm deep, c. 375 mm internal diameter, an entrance hole at the top of the cavity and a lining of natural woodchips or sawdust. Additional features on kākā nest boxes include an internal 'ladder' of timber or heavy knotted polypropylene rope (so that females and chicks can easily enter and exit the nest cavity and/or chew the timber ladder for nesting material) and an inspection door on the lower end of the nest box (to allow nest inspections, chick banding and cleaning). Zealandia and Cape Sanctuary have used PVC pipe for constructing nest boxes whereas at Orokonui, and for initial releases at Zealandia, boxes were constructed out of untreated timber (macrocarpa). PVC pipe nest boxes will likely last longer whereas timber boxes will be chewed and deteriorate over time due to weathering.

While nesting females can be protected with a suitable nest box design, particularly a PVC nest box with a large overhanging roof (Greene & Jones 2003), nest boxes should only be placed in areas with sufficient predator control. This is because chicks will be at risk of predation immediately after fledging when they might spend up to a week on the ground, with subsequent impacts on population survival and growth. For instance, cats have been filmed in the immediate vicinity of active kākā nest boxes in Wellington City Council Reserves (Ratley 2015).

Nest boxes have generally been placed 1–3 m above the ground but positioned such that they can be easily and safely accessed for nest checks and cleaning. However, some consideration should also be given to security, particularly if nest boxes are placed outside of the release site; i.e. they should not be easily found or opened by people other than those checking or servicing the boxes. Nest box placement should also give some consideration to prevailing weather, i.e. avoid direct wind and rain, and they can be camouflaged with paint or vegetation.

The number of nest boxes required at any release site is difficult to predict as it will be dependent on the availability of natural cavities, the size of the release site, the number of kākā pairs present and the ability to service and maintain nest boxes. At an absolute minimum there should be one box per pair, at least in the early stages of a reintroduction programme, although more boxes are likely beneficial through providing breeding pairs with varying options. As a guide, there are currently 36 nest boxes within Zealandia (225 ha), and all were used during the 2015/16 breeding season.

Nest boxes will become heavily soiled with use and should be cleaned once a season to minimise pathogen and parasite build up. Ideally, cleaning will occur as soon as possible after the breeding season, as prospecting pairs will inspect nest boxes throughout the winter. Most nest boxes have had removable solid floors with a few holes drilled in them for drainage. However, a recent innovation at Zealandia involved replacing solid nest box floors with a mesh floor secured by three wire pegs. This reduces the build-up of faecal matter and moisture in the nest box, along with infestations by maggots. The wire floor can also be easily removed for cleaning.

7.4 Kākā interference with management devices

Kākā are naturally curious and will readily investigate new objects. This has led to interference with predator control devices at several release sites. For instance, at Cape Sanctuary a released kākā ('Blackie') managed to open a cover on a stoat box by removing a nail. It then got its head caught in a Fenn trap. Remarkably, the bird survived and recovered and all trap boxes at Cape Sanctuary are now secured with screws. The same bird also gained access to a long drop toilet by coming in under the door (now covered with mesh) and removed the lids from kākāriki nest boxes at the release site (now secured with screws). At Zealandia, toxic baits for mouse control used to be delivered via ice cream containers. However, kākā were observed removing lids from the containers and disturbing the bait, so bait is now delivered via Novacoil bait stations. These stations have had to be modified several times, specifically to exclude kākā. There have also been reports of kākā accessing 'hockey stick' bait stations in Wellington City Council reserves, with autopsy revealing the deaths of three birds following the consumption of toxin. At Pukaha / Mount BrucePhilproof bait stations had to be modified following kākā accessing baits, with several birds dying. Kākā at Orokonui have pulled tracking cards out from tracking tunnels and have also been seen inside kiwi feeding boxes within the Orokonui kiwi crèche. At Boundary Stream, a bird was observed investigating a self-setting trap (Fig. 2) and it is likely this same bird was killed in one of these traps a short time later.

Figure 2. A kākā investigating a self-resetting trap at Boundary Stream. A bird, likely this one, was killed in one of these traps shortly after this photo was taken. *Photo: Peter Abbott*.

It is unclear whether wild birds interfere with management devices to the same extent as captive-reared and released birds, or those that are familiar with humans. For instance, on Te Hauturu-o-Toi / Little Barrier Island, wild kākā do not seem to interfere with bait stations and traps, with the exception of a humanised bird ('Ratbag') who likely died after consuming toxin. Similarly, at Tāwharanui, where wild kākā are naturally present, there have been no recorded instances of bait station or trap interference by kākā, despite a large number of management devices and a moderate breeding population of kākā. In addition, Greene et al. (2004) state that secondary kill is rare in wild kākā following aerial operations, with only two birds from Nelson Lakes National Park, and four birds on Kapiti dying at 11 sites where birds were monitored throughout pest control operations. Ultimately, it seems prudent to avoid humanisation of kākā wherever possible as this might lead to an increased propensity to interfere with management devices and be injured or killed (refer to Section 6.8 – Avoiding habituation to people).

7.5 Negative kākā impacts outside protected areas

Kākā can potentially damage private property surrounding a release site. For example, there have been well publicised problems in Wellington where kākā from Zealandia have damaged exotic trees, fruit trees and some houses, specifically roofs with lead nails (Linklater 2016). This has generated debate as to the appropriateness of releasing kākā in an urban setting (Daugherty 2016; Linklater 2016), although it should be noted that wild kākā at more remote sites, for instance Great Barrier Island (Aotea Island), also come into conflict with people. Therefore, it will be critical for any group planning a kākā translocation to carefully assess the potential for conflict with people and private property in the area surrounding the release site. In doing so it will be important to consider the eventual size of the reintroduced kākā population and the distance that birds might move to forage and breed (at least tens of kilometres). It also further illustrates the need to avoid humanising kākā as a means of reducing or minimising negative interactions with people (refer to Section 6.8 – Avoiding habituation to people).

8. Post-release monitoring

8.1 Purpose

Post-release monitoring informs future management about translocated populations and can help to answer questions (after Parker et al. 2013) such as:

- Will the reintroduction be successful?
- Is management needed/sufficient?
- Will supplementary translocations be needed?
- Is genetic diversity sufficient?
- Do the translocation techniques need to be refined?
- Does release site selection need to be refined?

Monitoring must also relate back to the operational targets in the translocation proposal. Therefore, the design of post-release monitoring needs to match the questions you are trying to answer, and the subsequent intended use of the data.

The need for monitoring is related to uncertainties about the translocation. For example, it is known that kākā are good dispersers (Moorhouse & Greene 1995) and therefore have the potential to move a large distance from the release site, particularly in large contiguous patches of forested habitat. It is also known that female kākā are very prone to predation by introduced mammals when nesting (Moorhouse et al. 2003). Therefore, if a reintroduction project was planned for a large contiguous habitat adjacent to unprotected habitats transmitters might be needed to locate birds and/or protect nest sites.

Post-release monitoring can be used to determine where translocations have failed (Fig. 3), whether a different management approach would prevent failure if the species was translocated to the same site again and, if not, the feasibility of future translocations. For example, if monitoring shows that only males are present, there may be an issue with predators; or if pairs are present and breeding but all the offspring have disappeared, there is likely to be a problem with the retention and/or recruitment of juveniles.

On the other hand, successful translocations provide useful information for similar projects in the future.

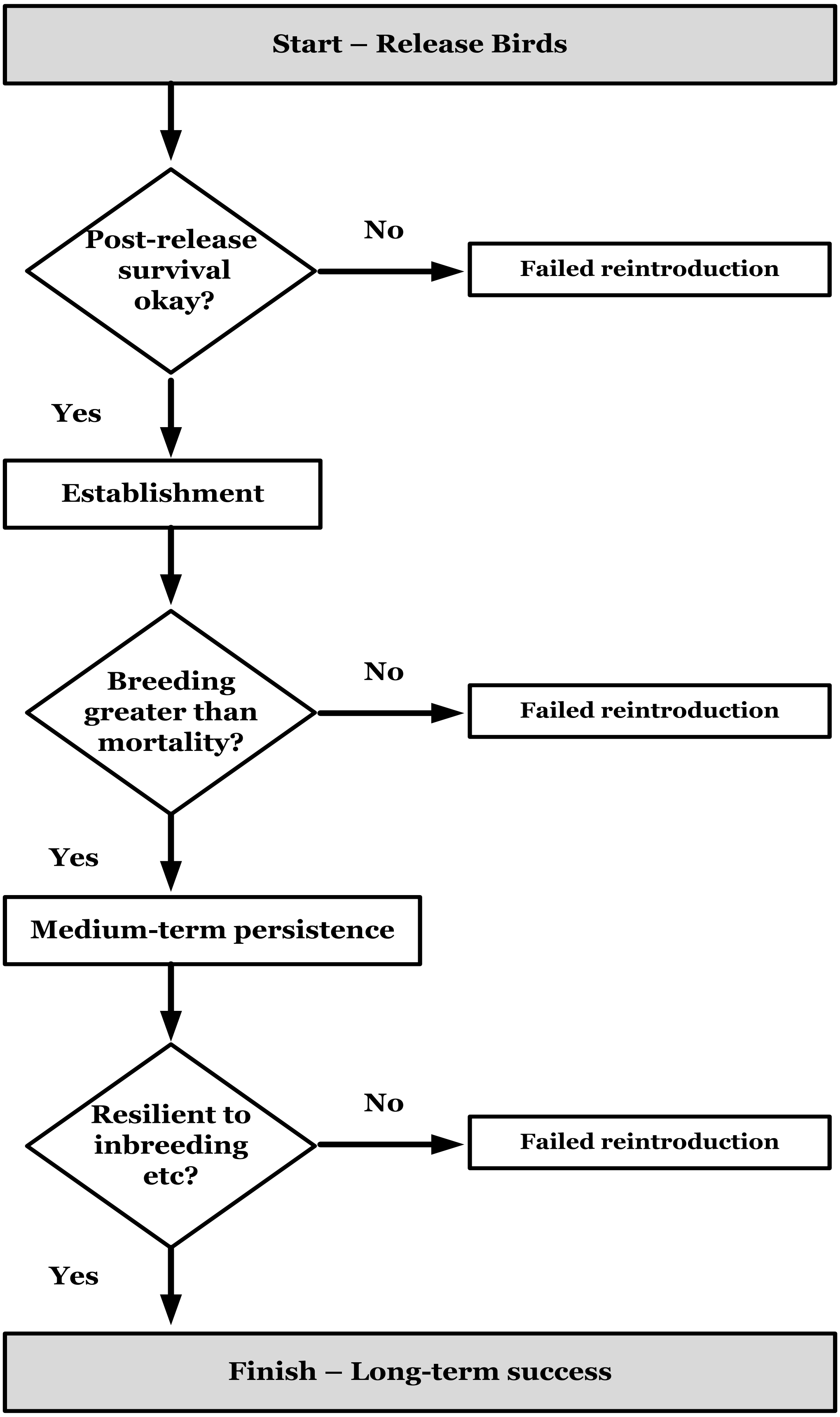

Figure 3. Determining the success or failure of a translocation (from Parker et al. 2013).

8.2 Recommended monitoring

Kākā are relatively easy to monitor as released birds are usually cued into post-release feeding stations, although in some cases significant dispersal has occurred following release. Most kākā release sites have used a combination of recording band combinations at post-release feeding stations, monitoring breeding, banding chicks and juveniles and, in some cases, applying transmitters to released birds (refer to Section 8.3 – Post-release monitoring). At Zealandia, nestlings were also routinely microchipped (injected subcutaneously at the base of their necks) from 2008 to 2014. The microchipped bird's identity was then remotely recorded when they used sugar water feeders at Zealandia. However, microchipping was discontinued in 2014 following three cases where microchips migrated from their insertion site into the sinus cavities of microchipped kākā.

Recording band combinations at post-release feeding stations can be done anecdotally by release site workers, volunteers or visitors, with all sightings recorded and stored in a secure digital database. Alternatively, a specific time can be set aside for kākā monitoring, for example 30–60 minutes at each feeder on a regular schedule (e.g. weekly or monthly). Ideally, both methods will be used, especially as some birds might be irregular visitors to post-release feed stations. Some sites (e.g. Orokonui) also do an annual winter census from which they generate estimates of survivorship, juvenile recruitment and population size.

Monitoring breeding birds provides very useful data on survival and productivity. It requires commitment and skilled personnel to monitor nests, although it is easier at sites where nest boxes are used as nests can then be easily located and inspected. It also gives an indication of the ability of the release site to provide the resources required for successful breeding and the effectiveness of predator control. Juveniles can also be captured and banded post-fledging, especially if they are habituated to feeders.

Media campaigns are an additional useful tool for gaining knowledge on kākā dispersal and habitat use, along with raising local awareness and creating opportunities for advocacy. For instance, Maungatautari has issued media releases asking for kākā sightings with subsequent responses from throughout the Waikato, including several places ≥50 km from Maungatautari. Several respondents also said that kākā were annual visitors to their area and provided useful records of kākā feeding on a variety of native and exotic vegetation. All these records are valuable, although emphasis should be placed on the public recording banded birds, even if correct band combinations are not obtained, because this will at least distinguish between translocated kākā and wild kākā, which naturally visit many areas.

8.3 Transmitters

Transmitters provide very fine scale data on location and dispersal behaviour. However, they entail two significant costs. The first is purchasing the transmitters and monitoring equipment (receivers and aerials), employing suitably qualified staff to apply transmitters and then actually monitoring the birds (this might be especially difficult at large sites, as kākā can move considerable distances in a short space of time; in some cases, it might be more efficient to use an aircraft, or even a drone, to monitor transmittered kākā). The second cost is the energetic and welfare cost to the birds to which transmitters are applied, especially as they might wear the transmitters for a very long time, potentially for life (although note that birds that have carried transmitters for many years have survived and bred). Therefore, very careful thought needs to be given to the costs and benefits of applying transmitters to kākā.

As noted above (refer to Section 8.1 – Post-release monitoring), transmitters will be very useful at sites where significant dispersal might occur or breeding birds will be difficult to locate (if transmitters are applied to monitor breeding they can just be applied to females). However, if a new release site has similar characteristics to previous release sites, release methodologies are similar, and significant dispersal is not expected, then transmitters might not be worth the additional expense.

Where transmitters have been used they have been applied with a backpack harness with a weak link that is meant to weaken over time, eventually allowing the transmitter to fall off. Batteries can be set on an intermittent cycle to extend transmitter life (e.g. a day/night setting or a specified time period each day).

It is vital that transmitters are applied by somebody with experience putting them on kākā to prevent hurting the bird or losing the transmitter. Several release sites have reported problems with transmitters dropping off early, harnesses breaking but not being shed by the birds carrying them, and significant difficulty catching birds to remove transmitters that are no longer working. At least one site has birds that are still carrying transmitters, despite the transmitters failing several years ago. Back-mounted GPS units have been trialled at Zealandia, although again, considerable effort was required to recapture birds and retrieve the data.

9. Record keeping

It is important that good records are kept throughout the translocation process, so that methods can be assessed, techniques refined and practices improved for future translocations. Knowledge sharing becomes even more important where multiple and often independent groups are translocating species.

The way in which methods and results are documented is also important. Standardisation of documentation allows factors that promote or inhibit translocation success to be evaluated and leads us further towards evidence-based conservation. For example, while anecdotal accounts of ‘bad weather’ affecting the result of a translocation may not be helpful, quantifiable information describing the weather conditions (e.g. ‘a gale-force southerly for 5 hours’) will allow people to make a sound evaluation of whether this influenced the success of the project.

You should aim to record everything that is done – especially if things are done slightly differently from how they were planned. Also, it is important that records are thorough, with all components of a procedure explicitly stated, so that it is possible to differentiate something that did not happen from something that did happen but was not written down. For example, when recording the presence of ectoparasitic mites on birds during health examinations, record ‘seen’ and ‘not seen’ for each bird, so that a summary of ‘five birds had mites’ is meaningful; this makes it clear that every bird was actually checked for mites, so the data indicate the true prevalence of mite infection (proportion of all birds with mites), rather than potentially reflecting haphazard observations where mites were recorded if they happened to be seen but may also have been present on other birds that were not searched (giving a false prevalence).

Alongside good record keeping, reporting is also important, as this enables project managers to fully evaluate a translocation and its outcomes, and others to learn from your experience and improve the chances that future translocations will be successful. DOC’s reporting instructions (Collen & Cromarty 2011a) include a reporting template, which shows all of the information that is required to produce an informative report. This document should be read in advance of the translocation, so that you are familiar with the standardised information that needs to be included in a transfer or monitoring report. In addition, record sheets that clearly list the data to be collected during the translocation should be prepared in advance, so that everyone involved in the translocation understands what information they need to record.

Translocation practitioners from various organisations have proposed a set of minimum requirements for documenting translocation planning, release methods, post-release monitoring and the writing of informative reports on project outcomes (Sutherland et al. 2010). These can be achieved by:

- Documenting the planned translocation (by completing DOC’s translocation proposal form; (Collen & Cromarty 2011b))
- Documenting release methods and conditions (using DOC’s reporting instructions (Collen & Cromarty 2011a) as a guide)

- Documenting post-release monitoring (see Section 8 – 'Post-release monitoring')
- Providing reports on the translocation using DOC's reporting format (Collen & Cromarty 2011a).

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Ron Moorhouse and Rosemary Vander Lee (Project Janzoon and DOC) reviewed this document and provided many helpful comments. Denise Martini and Michael Knapp provided very useful genetic information.

11. References

Beggs, J.R.; Wilson, P.R. 1991: The kaka *Nestor meridionalis*, a New Zealand parrot endangered by introduced wasps and mammals. *Biological Conservation 56*: 23–28.

Berry, R. 1998: Reintroduction of kaka (*Nestor meridionalis septentrionalis*) to Mount Bruce Reserve, Wairarapa, New Zealand. *Science for Conservation 89*. Department of Conservation, Wellington.

Collen, R.; Cromarty, P. 2011a: Reporting instructions for 2011 Translocation SOPs/Guide. 10 p.

Collen, R.; Cromarty, P. 2011b: Translocation Proposal Form. Department of Conservation internal document. 21 p.

Daugherty, C.H. 2016: Too many kaka? What nonsense. Retrieved January 2020, from http://www.stuff.co.nz/dominion-post/comment/80280276/too-many-kaka-what-nonsense

Dussex, N.; Sainsbury, J.; Moorhouse, R.; Jamieson, I.G.; Robertson, B.C. 2015: Evidence for Bergmann's Rule and not allopatric subspeciation in the threatened kaka (*Nestor meridionalis*). *The Journal of Heredity 106*: 679–691.

Greene, T.C.; Jones, A 2003: Observed responses of captive stoats (*Mustela erminea*) to nest boxes and metal collars used to protect kaka (*Nestor meridionalis*) nest cavities. *New Zealand Jounal of Ecology 27*: 139–145.

Greene, T.C.; Powlesland, R.G.; Dilks, P.J.; Moran, L. 2004: Research summary and options for conservation of kaka (*Nestor meridionalis*). *DOC Science Internal Series*, Department of Conservation, Wellington. 25 p.

Heather, B.; Robertson, H. 2015: The field guide to the birds of New Zealand. New Zealand, Penguin NZ. 464 p.

Linklater, W. 2016: Kaka conflict: conservation icon to pest. Retrieved May 2016 from http://www.stuff.co.nz/environment/79817641/kaka-conflict-conservation-icon-to-pest

Miskelly, C.; Empson, R.; Wright, K. 2005: Forest birds recolonising Wellington. *Notornis 52*: 21–26.

Miskelly, C.M.; Powlesland, R.G. 2013: Conservation translocations of New Zealand birds, 1863–2012 *Notornis 60*: 3–28.

Moorhouse, R.; Greene, T.; Dilks, P.; Powlesland, R.; Moran, L.; Taylor, G.; Jones, A.; Knegtmans, J.; Wills, D.; Pryde, M. et al. 2003: Control of introduced mammalian predators improves kaka *Nestor meridionalis* breeding success: reversing the decline of a threatened New Zealand parrot. *Biological Conservation 110*: 33–44.

Moorhouse, R.J.; Greene, T.C. 1995: Identification of fledgling and juvenile Kaka (*Nestor meridionalis*). *Notornis 42*: 187–196.

Moorhouse, R.J.; Sibley, M.J.; Lloyd, B.D.; Greene, T.C .1999: Sexual dimorphism in the North Island Kaka *Nestor meridionalis septentrionalis*: selection for enhanced male provisioning ability? *Ibis 141*: 644–651.

Parker, K.A.; Parker, G.C.; Barr, B.P. 2015a: Bream Head reintroduction plan. 50 p.

Parker, K.A.; Dickens, M.J.; Clarke, R.H.; Lovegrove, T.G. 2012: The theory and practise of catching, holding, moving and releasing animals. Pp. 105–137 in: Ewen, J.G.; Armstrong, D.P.; Parker, K.A.; Seddon, P.J. (eds): Reintroduction biology: integrating science and management. West Sussex, U.K., Wiley-Blackwell,.

Parker, K.A.; Ewen, J.G.; Seddon, P.J.; Armstrong, D.P. 2013: Post-release monitoring of bird translocations: why is it important and how do we do it? *Notornis 60*: 85–92.

Parker, K.A.; Adams, L.; Baling, M.; Kemp, L.; Kuchling, G.; Lloyd, B.; Parsons, S.; Ruffell, J.; Stringer, I.; Watts, C. et al. 2015b. Practical guidelines for planning and implementing fauna translocations. In: Armstrong, D.P.;

Hayward, M.W.; Moro, D.; Seddon, P.J. (eds): Advances in Reintroduction Biology of Australian and New Zealand Fauna. Australia, CSIRO Publishing.

Ratley, N. 2015: Reality TV kaka family face real life battle to survive. Retrieved June 2016, from http://www.stuff.co.nz/environment/73046345/reality-tv-kaka-family-face-real-life-battle-to-survive

Smuts-Kennedy, C.; Parker, K.A. 2013: Reconstructing Biodiversity on Maungatautari *Notornis 60*: 93–106.

Sutherland, W.J.; Armstrong, D.P.; Butchart, S.H.M.; Earnhardt, J.M.; Ewen, J.; Jamieson, I.; Jones, C.G.; Lee, R.; Newbery, P.; Nichols, J.D.; Parker, K.A.; Sarrazin, F.; Seddon, P.J.; Shah, N.; Tatayah, T. 2010: Standards for documenting and monitoring bird reintroduction projects. *Conservation Letters 3*: 229–235.

Wilson, P.R.; Karl, B.J.; Toft, R.J.; Beggs, J.R.; Taylor, R.H. 1998: The role of introduced predators and competitors in the decline of kaka (*Nestor meridionalis*) populations in New Zealand. *Biological Conservation 83*: 175–185.

Weiser, E.L.; Grueber, C.E.; Jamieson, I.G. 2012: AlleleRetain: a programme to assess management options for conserving allelic diversity in small, isolated populations *Molecular Ecology Resources 12*: 1161–1167.

Weiser, E.L.; Grueber, C.E.; Jamieson, I.G. 2013: Simulating retention of rare alleles in small populations to assess managment options for species with different life histories. *Conservation Biology 27(2)*: 335–344.

Appendix 1

Aviary designs

Figure A1.1. Aviary designs. A. Cape Sanctuary aviary. *Photo: Sue Dryden*. B. Cape Sanctuary aviary interior. *Photo: Sue Dryden*. C. Maungatautari Ecological Island Trust aviaries under construction. *Photo: Chris Smuts-Kennedy*. D. Maungatautari Ecological Island Trust aviaries under construction. *Photo: Chris Smuts-Kennedy*. E. Orokonui Ecosanctuary aviaries. *Photo: Elton Smith*. F. Orokonui Ecosanctuary aviaries. *Photo: Elton Smith*.

Appendix 2

Captive diets and feeding protocols

Captive diet and feeding protocol, Boundary Stream

1. Captive maintenance is managed by a paid staff member with assistance from several volunteers.
2. Daily allocation (mid-morning) of Harrison's Pellets, Wombaroo Lorikeet and Honeyeater food, apples, dates and some sunflower seeds in husks.
3. Uneaten food is removed from the aviaries, weighed and recorded.
4. Fresh forage, including nectar, flowers, berries and foliage is provided at least twice a week, including a wide variety of native vegetation such as kawakawa, *Pseudopanax* spp., *Coprosma* spp. and putaputawētā.
5. Fresh kānuka perches and rotting logs are provided every 1–2 weeks and the whole aviary is redressed with fresh kānuka and rotting logs every 1–2 months.
6. Behavioural enrichment/feeding – regular provision of egg cartons and cardboard cylinders, rummage boxes (cardboard boxes filled with leaves, fruit, pine cones, etc.), fresh foliage, including branches of varying sizes, rotting logs and woven flax balls with a nut or huhu grub inside which is suspended from a perch.

Captive diet and feeding protocol, Maungatautari

1. Kākā are fed twice daily by an experienced group of volunteers.
2. On entering the aviary preparation room, volunteers check the main doors to ensure they are shut and secured before they open the flight door. When they enter a flight, volunteers keep birds away from the door so they do not fly into the preparation area.
3. Each volunteer starts by checking the feeding and observation log book kept in the aviary preparation room.
4. They then check each bird's condition and behaviour and record anything that seems unusual or interesting (e.g. a discoloured eye, inactivity or lethargy, missing bands).
5. Uneaten food in each flight is collected and recorded from each flight and then disposed of in a lidded bucket.
6. Feeders and the flights are then cleaned.
7. A selection of corn, apple, pear, carrot, banana, dates, walnuts and sugar water is added to each flight. Quantities are recorded and varied depending on daily consumption.
8. Fresh forage is regularly supplied.
9. Each flight is checked to ensure no items are left inside that could injure the birds and is then exited and securely closed.
10. The flight is then locked and the gas bottle used to heat water for cleaning and food preparation is turned off.
11. The primary aviary entrance (via the preparation room) is then locked.

Auckland Zoo basic daily captive diet

1. One apple or pear washed and cut into a 20 mm cubes.
2. One and a half oranges washed and cut into 20 mm cubes.
3. A half cup of peas.

4. A handful of washed grapes.
5. Washed silverbeet, endive and lettuce.
6. Cooked beans.
7. Cooked rice.
8. A half cup of whole kernel corn.
9. A half cup of soaked sunflower and/or oats.
10. Wombaroo Lorikeet and Honeyeater Food.
11. On Monday, Wednesday and Friday kākā also get carrot, potato, corn on the cob, beetroot and kūmara.
12. On Tuesday, Thursday, Saturday and Sunday kākā also get pumpkin, kiwifruit and melon.
13. Fresh forage is supplied daily.

Orokonui Ecosanctuary basic daily captive diet

1. Daily feed out of Roudybush pellets, cashew nuts, sunflower seeds and various fruits.
2. Regular provision of fresh forage.

Sugar water mixing instructions

1. Use one cup of sugar to 1 L of water. Some sites, e.g. Orokonui, use a weaker mix of one cup of sugar to 2 L of water.
2. Use boiling water to dissolve the sugar and then top up with cold water.
3. Ensure the mix has completely cooled before feeding out to birds

Wombaroo Lorikeet and Honeyeater Food mixing instructions

1. Add a quarter cup of Wombaroo powder to 250 ml of warm water
2. Mix well until all lumps have gone (a whisk is useful).
3. Top the mixture up to 500 ml with cold water.
4. If additional mixing is required put the Wombaroo in a suitable container and shake well.
5. The mix can be refrigerated for up to 24 hours after which new mix should be prepared.

Appendix 3

Post-release feeder designs

Figure A3.1. A. Cape Sanctuary aviary feed station. *Photo: Sue Dryden*. B. Cape Sanctuary post-release feed station. *Photo: Sue Dryden*. C. Cape Sanctuary Wombaroo feeders. *Photo: Sue Dryden*. D. Cape Sanctuary Wombaroo feeder. *Photo: Sue Dryden*.

Appendix 4

Nest box designs

Current Zealandia PVC pipe design

1. As of 2016, nest boxes for kākā are constructed from lengths of 375–400 mm diameter 'BLUE BRUTE' PVC pipes.
2. Each nest box is 500 mm in length and is fitted with two internal chew-boards of untreated pine which are screwed to the internal walls. Recycled solid plastic signs c. 10 mm thick are used for the roof along with an untreated pine (25 × 300 mm rough sawn boxing) ceiling and a large wooden outer cover on the roof (to prevent kākā chewing the plastic roof). The roof is screwed in place with stainless steel screws (8 g × 1). A ring of c. seven screws holds the wooden ceiling in place. The overlapping plastic roof is screwed onto the wooden ceiling (6–7 screws) and then a large overlapping wooden roof is screwed on to protect the plastic roof (8–9 screws). A ring of sealant between the plastic roof and the pipe keeps the nest boxes dry inside. Each nest box is fitted with an external perch below the entrance hole.
3. The nest box is fitted with a solid mesh floor which is covered with a deep bedding of coarse dried mulch (take care in selecting a lining material as aspergillosis and other spores are present in some mulches and will become airborne when very dry). The mesh sits on three wire pegs that can be taken out to allow the floor and nest box contents to be removed and replaced. The mesh floor has been a successful modification that allows faeces to drain through the nesting material, preventing maggot infestations and providing a better environment for nestlings.
4. Each nest box is provided with a door which allows access for monitoring and banding of nestlings. An oval doorway is strong and cut on a bevel (top and bottom) it stops the door swinging in too far and channels out rain. The door is secured with stainless steel piano hinges and a brass door latch riveted on with small pop rivets. A key ring is used through the latch to secure the door.
5. In 2015/16, knotted polypropylene ropes were added to the inside of nest boxes to provide an exit for fledging birds, as sometimes the chew boards are totally destroyed during the nesting phase and are not available to fledging chicks. This is an important concern if nest boxes are not monitored on a regular basis. Nestlings will not be able to climb out of PVC nest boxes without timber chew boards or knotted ropes.
6. Nest boxes are attached to trees with a top bolt and a stabilising bottom bolt. They are installed 1–1.5 m from the ground for ease of monitoring.
7. Nest boxes used to be monitored on a regular basis (weekly to monthly) but they can now go a full season without inspection.
8. At the end of each breeding season old nesting material is removed, the nest boxes are cleaned with Trigene and the bedding material is replaced as soon as possible so that it is in place for prospecting pairs over the winter.

Earlier specifications for the construction of pipe nests for kākā at Zealandia

Pipe Type:	UPVC Culvert Pipe – cheap grade (e.g. Marley Agriduct)
Pipe Colour:	Grey or other neutral colour (preferably not white or other light tones)
Pipe Dimensions:	Minimum External Diameter = 400 mm
	Minimum Internal Diameter = 375 mm

Cut pipe to length

1. Four nest pipes of 1.2 m length can be constructed from a standard 5 m length of pipe (note, the current design uses shorter lengths – described above). Using this measurement most of the larger connector end can be discarded simplifying construction.
2. Mark line around pipe using marker pen, tape measure and a bendable straight edge.
3. Cut pipe using a hand saw or similar.
4. Smooth/remove any rough edges with sandpaper.

Base of nest

1. Trace outline of internal circumference of pipe onto suitable material (we use a laminated rigid foam material – Cadco Celluka in 2440 x 1220 mm sheets available from Cadillac Plastics) using a marker pen attached to a stick long enough to reach the base (note the current design uses an improved mesh base – described above).
2. Ensure that the end of the pipe used to trace the base plate is the end of the pipe intended to be at the bottom as most of the pipes are not identically shaped throughout their length/circumference. It is also a good idea to mark the base and the pipe in the same place at this point to assist in the fitting of the base later.
3. Cut the base out with a jigsaw so that it fits tightly inside the base of the pipe.
4. Sand/file any rough edges smooth.

Inspection door

1. Draw a line using a marker pen, tape measure and bendable straight edge 40 mm up from the intended base of the pipe and around half of the circumference. This can be worked out accurately if the external diameter of the pipe is known using the formula for the circumference of a circle (twice pi multiplied by the radius – the product being divided in two to give the length required). For example, for a pipe with an external diameter of 400 mm the length of the line will be 628 mm.
2. From the end of the line measure up 250 mm and mark this point
3. Using a set square and a straight edge mark a vertical line (relative to the base of the pipe) from the base line to the point previously marked.
4. Having drawn in three sides of what will become the inspection door complete the fourth line using the tape measure and bendable straight edge (290 mm from the base of the pipe).
5. Cut both horizontal lines between the vertical lines using the handsaw.
6. The vertical lines are most easily cut using a jigsaw and a plunge cut – considerable care (and a straight blade) is required for a clean cut.
7. Remove door, mark top and bottom for future fit and clean off any rough edges.

Nest basket components

1. Use the previously cut base plate to trace the pattern for the base of the nest basket which will hold the nest material. We use 2 mm PVC sheet (1200 x 2400 mm – available from Cadillac Plastics) for this purpose (note the current design uses an improved mesh base – described above).
2. Cut the base out using a jigsaw.
3. The sides of the basket can also be cut at this point from the same material. A strip of PVC 200 mm wide and sufficiently long to fasten into a circle is required. If the internal diameter of the pipe is approximately 375 mm a piece of PVC 1200 mm long will be sufficient.

Fitting base plate

(note the current design uses an improved mesh base – described above)

1. Test previously cut base plate for fit – it should require some effort to force it into place as the shape of the pipe will have changed slightly following the removal of the door (hence the need to cut the base plate out prior to the removal of the door).
2. Once a tight fit has been achieved remove base plate and coat edges in PVC solvent.
3. With the pipe upside down force the base plate into position using positioning marks for a good fit. The base plate should sit flush with the bottom of the door and be as level as possible (use a tape measure to measure the distance from the base of the pipe to the bottom of the base plate and adjust the latter as required).
4. To ensure a secure floor to the nest box, four or five holes (4 mm) are now drilled through the pipe flush with bottom of the base plate. Blind rivets (aluminium) (Ullrich Aluminium 73-A-S-5-10) are then placed in each hole so that the expansion end prevents any downward movement (when the nest is the right way up) of the base plate. The length of the rivets will be dependent on the thickness of the pipe wall plus the length needed to keep the base plate from falling out.

Nest basket construction

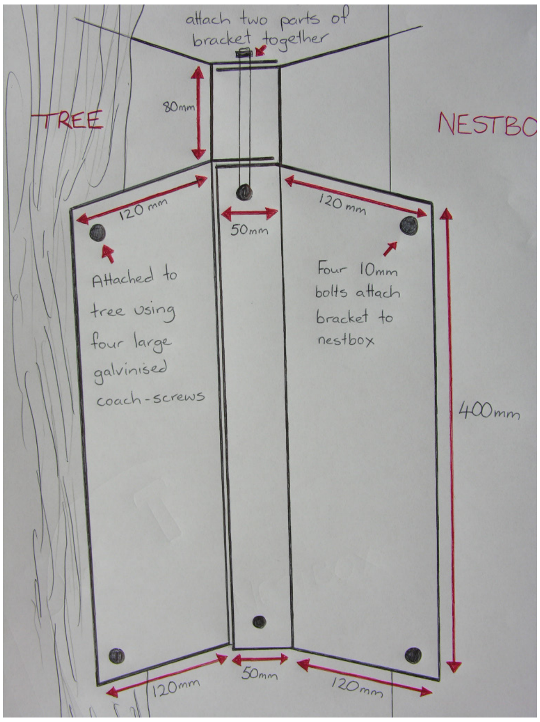
(note the current design uses an improved mesh base – described above)

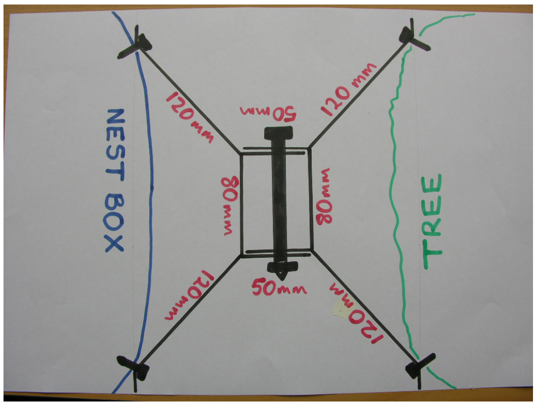
1. Trim (if required) the base of the basket so that it fits snugly into the nest chamber through the door cut into the pipe.
2. Take the strip of PVC to be used as the sides of the basket and form into a circle around the circumference of the basket base and mark the overlap.
3. With the correct overlap positioned drill 3–5 (4 mm) holes through both layers of PVC and fix using blind rivets (Ullrich Aluminium 73-A-S-5-3) so that the expanded side of the rivet is on the interior of the pipe.
4. Position five galvanised/aluminium brackets (right-angled with one 4 mm hole on each face) evenly around the base of the basket.
5. Mark the position of each bracket hole on the basket side and base and drill with 4 mm bit.
6. Using the same length blind rivets used to form the sides of the basket, attach sides and base ensuring that expansion side of rivets are on the interior of the basket.
7. Test for fit in the base of the nest pipe.

Mounting brackets

1. Two types of aluminium profiles are used to form a mounting bracket (see Fig. A4.1) and are constructed using galvanised bolts. Attachment to a tree is achieved using four large galvanised coach-screws.
2. Two 400 mm lengths of each aluminium profile are used. On the top of the U-shaped box sections three 8 mm holes are drilled. The holes on the side of these sections are 10 mm and are best drilled when both sections are clamped together (open side to open side) to ensure a good fit when the bolts are fitted. It should be noted that there is a definite top and bottom to these sections. The end where the 10 mm holes are centred only 17 mm from the end, is the top.
3. Each of these U-shaped profiles is then laid flat-side down (the one with three 8 mm holes) on a section of the other odd shaped profile and the centres of the 8 mm holes marked and drilled in a similar fashion. Four 10 mm holes are also drilled near the corners of this profile.
4. Each of these profiles is then bolted together with the appropriate bolts and washers.

5. One part of the two profiles is then attached to the nest box. The centre and base of the profile is positioned 180 mm from the side of the door that is NOT to be hinged and 350 mm from the base of the pipe. Ensuring that the profile is as vertical as possible the centres of the 10 mm holes near the corner of the profile are marked on the pipe then drilled out using a 10 mm bit.
6. The section of profile used to mark the holes on the pipe is then attached to the pipe using the appropriate bolts and washers.
7. The remaining section of profile will be attached to the tree. Using a hacksaw, a slot is formed by cutting down to the 10 mm hole (17 mm down from top) on both sides of this section of U-shaped profile. This slot will provide a positive positioning point when attaching the nest boxes to the tree.
8. Appropriate 10 mm bolts can now be attached temporarily to keep the two profiles together.





Pipe roof

1. Recent experiments have demonstrated the need for a roof with a substantial overlap if predators such as stoats are to be prevented from entering. To achieve this, a piece of Celluka 600 × 650 mm is cut out, and its corners rounded off using a jigsaw.
2. The roof is then positioned so that there is a minimum 250 mm overlap above the entrance hole and perch and the position marked using a marker pen. Five or six guide holes can then be drilled through the roof into the end of the PVC pipe.
3. A bead of sealant is then applied to the edge of the pipe and the roof affixed with self-tapping screws. Care is required to prevent the screws from being over tightened and breaking through the thin PVC layer. Stainless steel screws and small washers will improve robustness and longevity.
4. If nest boxes need to be transported any distance and/or through dense vegetation it is recommended that the roof is attached at the site the nest box is to be deployed (this will prevent accidental breakage, snagging on vegetation and untold frustration).

Nest entrance

1. The shape of the nest entrance is not as important as the position of the entrance relative to the tree/attachment point and roof. Possible shapes include wedges, ovals and circles etc.
2. Suggested dimensions include a maximum (usable) height of 150 mm and a maximum width of 75 mm.
3. The hole should be positioned in a line directly opposite the attachment bracket and no less than 200 mm from the roof of the nest.
4. Sketch shape of hole on pipe, drill a 10 mm hole and cut out using a jigsaw.

Internal Ladders
(Note, these are critical in PVC boxes to allow safe entry and exit)

1. These should be constructed from untreated timber and attached to the interior of the pipe using coach screws (or similar) prior to the attachment of the roof.
2. Ladders should be provided with grip (e.g. shallow parallel saw cuts) and run from the side and below the nest entrance to just above the nest bucket so that birds in the nest chamber can easily reach them.

Inspection door

1. Using the section of pipe cut from the pipe earlier the inspection door is constructed. It will probably be necessary to bend this piece of PVC using gentle heat in order to match the section with the profile of the rest of the pipe (use the main body of the pipe as a mandrel for shaping it).
2. Once the correct shape is obtained a piano hinge can be attached to the edge of the door (furthest from the bracket) and the appropriate side of the door section using blind rivets. Make sure that the hinge material is rust proof and can handle outdoor conditions (only the solid brass hinges seem to be suitably corrosion resistant).
3. Door stops / draught exclusion strips made from PVC strips can be attached to the door/frame but are not usually necessary.
4. A latch (e.g. EDL Toggle latches and strikes – TL802) can be fitted using rivets. This may have to be bent slightly in order to conform to shape of the pipe.

External perch

1. Suitable natural perch running parallel to the outside rather than at right angles as seen in usual nest box designs.

Ventilation holes

1. Drill a number of 10 mm holes around the top of the pipe approx. 1 cm below roof.

Camouflage

1. Brown off the exterior of the pipe (including roof and floor) with a blow torch. Take care not to burn, melt or make the exterior of the pipe rough.

Nest material

1. Collect damp rotted and powdery wood. No point in placing it in the box until it is in position (weight, etc.).

Appendix 5

Details of kākā translocation and husbandry experts (as of 2018)

Kevin Parker k.parker@parkerconservation.co.nz

Rosemary Vander Lee rosemary@janzoon.org

Ron Moorhouse Ron@janzoon.org

Denise Fastier dfastier@doc.govt.nz

Tineke Joustra tineke.joustra27@gmail.com

Matu Booth Matu1@paradise.net.nz or Manager@ngamanu.co.nz

Sue Dryden drydenstone@xtra.co.nz

Todd Jenkinson todd@pukaha.org.nz

Elton Smith elton@orokonui.org.nz