Kākā (*Nestor meridionalis*) Husbandry Manual

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South Island Kākā. Image: **Project Janzoon**

NOTICE OF APPROVAL

The Kākā (*Nestor meridionalis*) Husbandry Manual is a statement of standards of care for kākā held in captivity. It reflects the collective experience of many individuals and organisations that have held kākā in captivity nationally and seeks to document current best practice in husbandry of captive kākā. It also reflects the collective knowledge of researchers and field workers working directly with kākā *in-situ* and, as such, aims to increase the standard of care the species receives in captivity.

The manual establishes clear minimum standards for some aspects of kākā husbandry.

These minimum standards have not been established with the purpose of eliminating all variations on how holders keep and care for kākā (and/or present them for display). Rather, the standards are there to reassure all those with an interest in kākā, including the captive management community, the Department of Conservation, iwi groups, and the public of New Zealand, that the fundamental requirements of kākā husbandry are being met by all holders.

This manual has been produced by the Institute of Veterinary and Biological Sciences at Massey University and the peer review was led by the Zoo and Aquarium Association of New Zealand. The manual has been reviewed by captive holders. In terms of the Department of Conservation's Captive Management SOP it is approved for implementation by the Department of Conservation.

Director, Terrestrial Science

Statement of Acknowledgement

Kākā are a taonga species for Māori and a commitment for care and support is part of the tikanga of iwi.

Kākā are a Taonga species for Ngai Tāhu and are recognised as such in the Ngai Tāhu Claims Settlement Act 1998. The commitment of Ngai Tāhu whanau to care and support for kākā is part of the tikanga of Ngai Tāhu.

Contents

1. PREFACE

This husbandry manual was compiled by postgraduate students undertaking the Massey University course (captive breeding and management of New Zealand Wildlife) under the tutelage of Dr Brett Gartrell and has been formatted and updated by Todd Jenkinson (Zoo & Aquarium Association [ZAA]).

This document details husbandry techniques for the captive husbandry of kākā (*Nestor meridionalis*) and contains a range of methods used in the husbandry of kākā. It reflects the current standards and practices of captive management of the species. However, the contents of this document should be used as a guide only and no liability is assumed with respect to the use of the information contained herein.

Importantly, this husbandry manual promotes a high level of care of the birds and the consideration of their general welfare in line with the ZAA welfare framework that is underpinned by positive animal welfare.

ZAA takes the position that all zoos, wildlife parks and aquariums have a responsibility to ensure a high standard of animal welfare for all animals in their care.

The framework established by ZAA recognises the importance of animal welfare and provides a model that the zoo industry can apply to support positive animal welfare.
Whereas traditional assessments of animal welfare have relied on avoidance of negative states, ZAA has employed a body of knowledge called the Five Domains and actively investigates positive experiences for individual animals.

The Five Welfare Domains and examples of related positive states are:

PHYSICAL DOMAINS

- **Nutrition:** e.g. appropriate consumption of nutritious foods is a pleasurable experience.
- **Environmental:** e.g. benign conditions offer adaptive choices and variety.
- **Health:** e.g. physically sound (uninjured, disease-free) animals enjoy good health.
- **Behaviour:** e.g. environment-focused and inter-animal activities are satisfying and engaging.

MENTAL DOMAIN

- **Mental or Affective State:** e.g. animals experience comfort, pleasure, interest, and confidence.

2. INTRODUCTION

Generally heard before they are seen, kākā are found on all three main islands of New Zealand and on several offshore islands. Much reduced in range and abundance in the North and South islands due to forest clearance and predation by introduced mammals, kākā are most abundant on offshore islands that have no introduced mammals, or at least no stoats. They can be found in a wide variety of native forest types including podocarp and beech forest and remain locally common at some sites on the main islands that are close to offshore island refuges and have increased in abundance at others where mammalian pests have been controlled. Often mistaken for their larger alpine cousin the kea, kākā are a large, olive-brown parrot with grey-white crown, red-orange underwing and deep crimson belly and under-tail coverts. Males have a noticeably longer and deeper upper mandible and bigger head than females, but this is generally only apparent when the two sexes are seen side by side.

Voice: a harsh, repeated, rhythmic "ka-aa" when flying above the forest canopy, harsh grating "kraak" alarm call when disturbed. Also, a variety of loud, musical whistles, but these vary markedly from place to place. Males give a soft "tsee-tsee-tsee" call during the pre-copulatory display and when showing potential nest sites to females. Females soliciting food from their mates, and juveniles soliciting food from their parents, utter a guttural, repeated "aa-aa" call.

Kākā are seasonal specialists, moving from food source to food source as different fruits, seeds, nectar and wood-boring invertebrates become available and they likely play an important ecosystem role as pollinators, seed dispersers, invertebrate predators and habitat modifiers making it a pivotal species for the continual health of the forest, making its preservation of far-reaching importance.

2.1 Taxonomy

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Psittaciformes
Superfamily:	Strigopoidea
Family:	Psittacidae
Genera:	*Nestor*
Species:	*Nestor meridionalis*
Common Names:	North Island Kākā, South Island Kākā, Brown parrot or Bush Parrot (Olliver, 2011).

There has been much debate historically when subdividing the Kākā species (*Nestor meridionalis*): into sub-species using morphological characteristics. There were three species listed in 1865 (*N. meridionalis*, *N. superbus* and *N. occidentalis*), then two in 1873 (*N. meridionalis* and *N. occidentalis*), then back to one in 1888 (*N. meridionalis*). In 1905 *N. meridionalis* was again split into two sub-species (*N. meridionalis and N. esslingi*) (Sainsbury, Greene, Moorhouse, Daugherty & Chambers, 2006).

There were two recognised sub-species of kākā: the North Island kākā (*N. meridionalis septentrionalis*) and the South Island kākā (*N. m.meridionalis*) (Heather & Robertson, 2015) however a recent publication on taxonomy (Dussex et al., 2015, cited in Moorhouse, 2013) found no genetic basis for the current recognition of North and South Island subspecies and that kākā increase in size with latitude, particularly in the South Island (Moorhouse, 2013).

Both North Island and South Island kākā have brown/green feathers with orange and scarlet colorations under their wings, however the North Island kākā has darker plumage (Higgins, 1999) while the South Island kākā is more brightly coloured and is larger in size (Department of Conservation [DOC], 2009, 2012). Kākā fossils were found on the Chatham Islands, being a possible extension of the South Island Kākā which is thought to have possibly gone extinct in this region by 1871 (Higgins, 1999). A Norfolk Island species (*Nestor productus*) has also been described but is now extinct (DOC, 2009, 2012).

2.2 Conservation Status

The kākā *(Nestor meridionalis)* is an endemic forest-dwelling parrot of New Zealand (Heather & Roberston 2015) and was classified as a threatened species in 1991 (O'Donnell & Rasch, 1991). By 1994 it was classified as vulnerable and in 2005 it gained an endangered status. The endangered status has been given based on the declining abundance indexes. Estimated population reductions have been ≥ 50% over the last 10 years, or three generations, and the causes may not cease or be reversible for the population to replenish (BirdLife International, 2012).

The South Island kākā is ranked as at risk (recovering) with a partial population decline (50-70%). The North Island kākā is ranked as nationally vulnerable with a partial population decline of only 10-50%.

Translocations of kākā

The first successful kākā (*Nester meridionalis*) translocation was North Island (NI) kākā to Mount Bruce Scenic Reserve in 1996-2000 (Berry, 1998; Miskelly & Powlesland, 2013). Since then NI kākā have been established at Zealandia Karori Sanctuary (2002-2007), Maungatautari (2007-2009), the Cape Sanctuary (commenced in 2012) and Boundary Stream (2013-2016) (Miskelly et al., 2008; Miskelly & Powlesland, 2013; Smuts-Kennedy & Parker, 2013). South Island (SI) kākā 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.

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. the Auckland Zoo) for subsequent holding and release at a restoration site (e.g. Zealandia) or bred in aviaries at the release site (e.g. Maungatautari and the Cape Sanctuary) and then the offspring have been released. Translocations of wild caught birds have been rare with just a few juveniles having being 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 caught juveniles have also been translocated to the Cape, held in aviaries and then subsequently released. Following release kākā have

been supplementary fed to ease their transition into the wild and to minimise dispersal away from the release site (Berry, 1998). Artificial nest boxes are also often installed at the release site (Berry, 1998).

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, with sufficient ongoing management support, kākā are a good translocation candidate. They are engaging, noisy and easily viewed by the 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.

2.3 Captive Management Co-ordinators

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2.4 Timeframe of the plan

The Husbandry Manual will be reviewed every 5 years by the captive coordinators; kākā holders will be notified when an updated version is available. Those involved with kākā captive management are encouraged to comment on or submit new information for updates of the husbandry manual at any time to the captive coordinators

3. IDENTIFICATION METHOD

3.1 Individual Identification

Birds may be able to be identified from other birds using visual characteristics. Juveniles (and fledglings) can be distinguished from adults by many characteristic features. Kākā less than 12 months old have a pale ring of skin around each eye, called a periophalmic ring (Moorhouse & Greene, 1995). Kākā less than 5 months old have a yellow tinge to their periophalmic rings, as well as a tinge on their cere, gape and soles of their feet (Moorhouse & Greene, 1995). Juveniles may also be distinguished from adults by the presence of begging behaviour, and differences in feather shape (Moorhouse & Greene, 1995).

Leg-bands, microchips and radio-trackers have been used successfully in the past for identification of kākā both in the wild and in captivity (Higgins, 1999). Leg-bands are the best suited form of identification for kākā in captive environments. This method allows identification from a distance without contact with the animals and is a low cost and long-lasting method.

Banding

The New Zealand National Bird Banding Scheme is administered by the Banding Office of the Department of Conservation (Melville, 2011). Anyone wishing to band birds must have appropriate certification and permits, which can be obtained from and must be sent to the Banding Office for approval (Melville, 2011). All qualified banders have an obligation to submit banding data (band number, species, date and place of banding, age, sex, and method of capture) to the Banding Office (Melville, 2011). See Melville (2011) for more information on banding requirements.
It is recommended that both North Island and South Island adult kākā are banded with type 'L' bands (Melville, 2011). Type 'L' bands are made of stainless steel metal, have an internal diameter of 11.0mm, height of 12.0mm, and thickness of 1.0mm (Melville, 2011). Type 'V' bands, with a slightly larger internal diameter of 12.0mm and shorter height of 7.0mm, have sometimes been used by experienced banders to band birds with shorter tarsus length (Rosemary Vander Lee, pers. comm., 11-9-2018). Each band has a prefix which indicates the size, a unique individual serial number and a return address (Ornithological Society of New Zealand [OSNZ], n.d.).

Coloured bands may also be used to identify individuals from a distance. This is recommended for captive individuals as it reduced the need for frequent recapture, which minimises the stress placed on the birds (OSNZ, n.d.). Plastic coloured leg bands can be used to identify chicks in a clutch, and these are made to increase in size as the chicks grow (Berry, R., *pers. comm*., 12-8-2012).

Banded South Island Kākā. Image: **Project Janzoon**

Micro-chipping

Microchips are another method that can be used but are much more expensive so are used less frequently. Microchips must be inserted by a qualified veterinarian, and this can be performed at the captive facility (Hoffmeister, 2011). Microchips need to be placed in the pectoral muscle of the bird under a general anaesthetic to prevent migration of the chip.
South Island kākā are not recommended for microchipping – please contact the South Island Captive coordinator for advice on identification.
See kea transponder example in **Appendix 1**

Minimum Standard 1.

Identification.

All kākā held in captivity must be individually identified by band and banded by a suitably qualified operator within three months of hatch, or within three months of being transferred into captivity (for wild caught birds) and/or the implantation of a recommended brand of microchip/transponder (e.g. Trovan/Allfex) .

3.2 Sexing Methods

Sexing

Sexing of captive birds is important to ensure that the sex ratio is up to date but may not always be necessary, for example when they are too old so will not be able to breed. When sexing is required, there are a few different methods that can be used.

3.2.1 DNA Feather Sexing

DNA analysis

DNA analysis for sex determination is much less invasive and more accurate than other traditional methods (Cahill, n.d). DNA sex determination can be done through the Massey University Equine Parentage and Animal Genetic Services Centre in Palmerston North. DNA should be extracted from the birds by taking two of their secondary tail or wing feathers, while taking care not to contaminate the samples, especially when taking samples from multiple birds (Cahill, n.d.). Samples from each bird should be submitted in individual paper envelopes, along with identification information including species name, band number etc (Cahill, n.d.). Sex determination currently costs $35 per bird, and a cheque addressed to “Massey University” needs to be enclosed with the sample (Cahill, n.d.). DNA samples should be sent to:

Massey University Equine Parentage and Animal Genetic Services Centre
Drysdale Drive PN811
Massey University
Palmerston North

Minimum Standard 2.

Sexing.

All kaka that hatch in captivity or are brought into the captive population from the wild (excluding birds held temporarily for medical treatment (i.e. held under an injured wildlife permit)) must be sexed using molecular techniques (DNA feather sexing).

4. NATURAL HISTORY

4.1 Adult wild weights and measurements

Although males and females look very similar (Higgins, 1999), there are still some slight differences that are noticeable in the different genders. Bill measurements can be used, as males are known to have a culmen-length 13.6% larger than that of females, and culmen-depth 12.4% larger (Higgins, 1999). It is important however that the age class of the bird is known, as this rule only applies to adult and subadult birds (Moorhouse, Sibley, Lloyd & Greene, 1999). See section *2.0 Identification Methods* for information on how to determine age classes of kākā. Measurements that can be used for sexing based on length of exposed culmens are as follows:

- Subadult/adult = Males ≥47mm, females <47mm
- Juvenile = Males ≥44mm, females<44mm

Males are also much heavier than females, weighing up to 475gms/575gms (North Island/South Island), while females only weigh up to 425gms/500gms. Using weight is however much less reliable as it can still change a lot throughout the adult life of the bird (e.g. disease, reproductive stage, malnourishment or obesity).

4.2 Distribution and habitat

The New Zealand kākā (*Nestor meridionalis)* is endemic to New Zealand and its offshore islands (Higgins, 1999). It was once historically widespread; however, numbers have reduced due to habitat modification by humans, resource competition from introduced fauna, and predation (DOC, 2009). Three generations ago over 90% of the kākā population were present on the mainland; currently less than 50% is found here (BirdLife International, 2012), being mainly restricted to predator-free offshore islands. It seems that kākā almost disappeared from the mainland except for at a few intensely managed sites, and valleys that currently remain free of predators such as in Fiordland (BirdLife International, 2012).

There is evidence of breeding from Waipoua Forest in the far north to Stewart Island, although their distribution is now highly fragmented. They are now mainly found on Hen and Chicken Islands, Kapiti Island, Little Barrier Island and Great Barrier Island (Higgins, 1999). They are rare in almost all districts

of the North Island due to mass deforestation events, leaving localised, patchy populations remaining in unmodified native forests (Sainsbury et al, 2006). They are more prevalent in the South Island, particularly on the west of the Southern Alps down to Fiordland (DOC, 2009; Higgins, 1999) as the terrain is largely unsuitable for human settlement so is largely unmodified (O'Donnell & Rasch, 1991). Low numbers now exist however in all areas **(**BirdLife International, 2012).

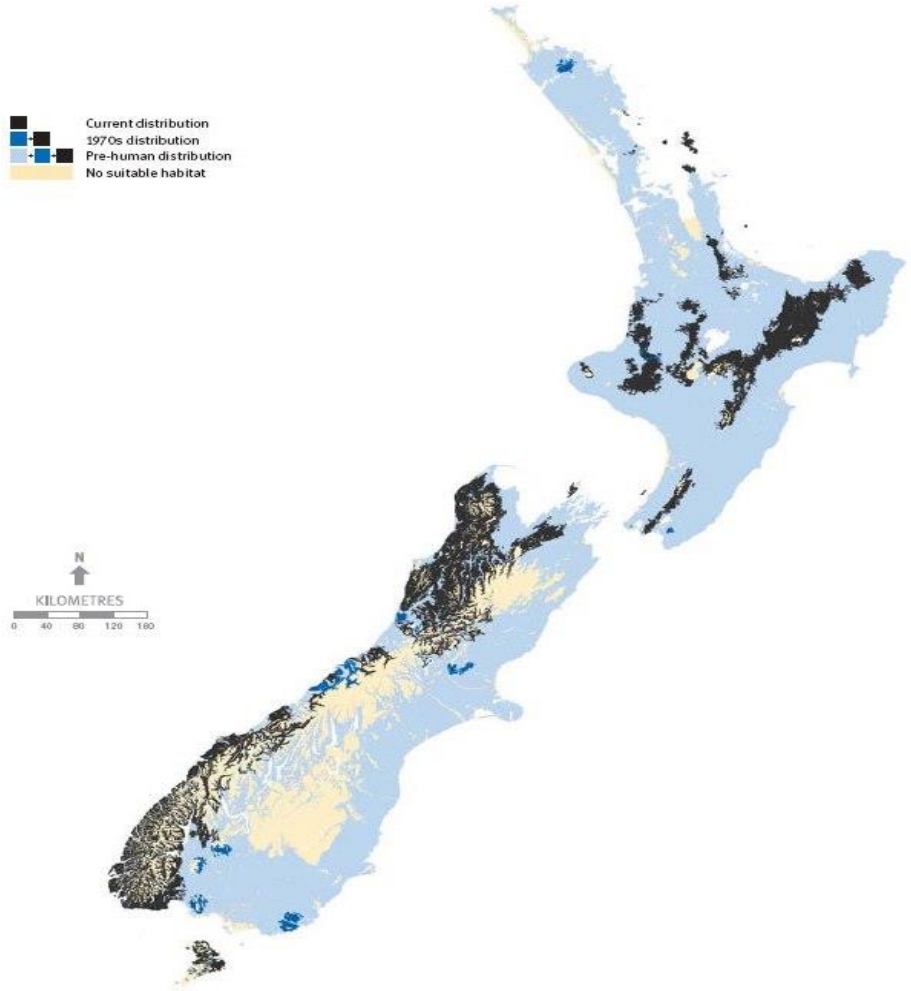
The North Island sub-species (*N. meridionalis septentrionalis)* exists in forests from the Coromandel to Wairarapa with two main viable populations remaining in Pureora and Whirinaki Forests (BirdLife International, 2012), although numbers are thought to be declining (DOC, 2009). Moderate numbers are also found in Waihaha and there are also three large populations inhabiting offshore islands in the north such as Little Barrier, Great Barrier, and Kapiti Islands (O'Donnell & Rasch, 1991). They are also found in moderate numbers on Mercury Island and Hen and Chicken islands, although little is known of their population stability (DOC, 2009).

The South Island sub-species *(N. m. meridionalis)* have two viable populations in southern south Westland and Waitutu. One large population also exists on Codfish Island due to conservation efforts (O'Donnell & Rasch, 1991).

Precisely, in the North Island, kākā can found in small populations between Rangaunu Harbour and Maungataniwha Range, down to Dargaville and rarely near Kaipara Harbour. They are common however around Whangarei. A few scattered records have been made on the Auckland Isthmus: on the mainland adjacent to Barrier Island: Tawharanui Peninsula and Snells beach, and from Manukau Heads, through suburban Auckland to Hunua Ranges, and on several islands in the Hauraki Gulf and the Coromandel Peninsula (Higgins, 1999).

In the Bay of Plenty, kākā occur in small numbers on Mayor Island, Tauranga Harbour Opotiki, Pauanui and the Kaimai Ranges. They are rare on the east coast although isolated populations have been observed in the Raukumara Ranges, Gisborne, Whakaki and Wairoa. They are however widespread from the volcanic plateau to Hawkes Bay, Waikato, Taranaki, north Whanganui and Manawatu (Higgins, 1999). There have been a few sightings around Hamilton, New Plymouth and Hawera, and scattered records near Hunterville to Waipukurau (Higgins, 1999). They are sparse around the Manawatu, Wairarapa, and Wellington areas, including the Rimutaka Ranges (Higgins, 1999), and the Tararua Range (O'Donnell & Rasch, 1991).

The South Island kākā is still widespread throughout most forests (O'Donnell & Rasch, 1991). Higgins (1999) stated kākā were widespread through most of Nelson to Abel Tasman National Park, Takākā and Wakamarama Range, however DOC (2009) report they are now rare in Nelson and Marlborough. There are scattered records on Chetwode Island, in Blenheim and the Richmond Range, becoming more widespread from Waihopei to Canterbury and are seen occasionally in Hanmer and Waimakariri, with recent sightings in Christchurch (Higgins, 1999). On the west coast there are isolated populations of kākā north of Paringa River (O'Donnell & Rasch, 1991). They are presently absent in Otago (Higgins, 1999), however occur in Aspiring National Park, Hawea, Wanaka and Wakatipu. There are isolated populations in Taieri Bay, Papatowai and Tautuku Peninsula. They are widespread in Waitutu Forest and Fiordland (Higgins, 1999) as pests have not managed to invade the valleys in this area. The kākā is also widespread on Stewart Island, and is present on Ulva Island, and Codfish Island (DOC, 2009).



This map shows the estimated pre-human (1970s) distribution and the recent (2007) distribution. The habitat has reduced largely with the Kākā now occupying less than 20% of its original range. Sourced from http://www.mfe.govt.nz.

Kākā wild population estimates

The current population status of kākā in the wild is poorly known as it is difficult surveying and monitoring a cryptic species of low density and variability in diurnal and seasonal behaviours (Moorhouse, 1997). They are constantly facing predation from such organisms as the introduced stoat (*Mustela erminea*), the brush-tailed possum (*Trichosurus vulpecula),* and black rats (*Rattus rattus).* They also compete for resources with introduced wasps (*Vespula* species), and bees. Predation of female kākā and juveniles on nests causes a highly skewed sex ratio on the mainland, of three males to every female (Moorhouse, 1997), resulting in a rapid population decline (BirdLife International, 2012).

Latest estimates report that the overall kākā population is declining, although population numbers have increased in some areas due to conservation efforts, including on the West Coast, Waikaremoana, and on offshore islands.

The total number of kākā has been estimated at fewer than 10 000 birds **(**BirdLife International, 2012), with the largest populations being on predator-free offshore islands The most recent estimate of kākā numbers is between 2,500-9,999 mature individuals, equating to 3,750-14,999 individuals overall, or rounded on the IUCN red list as being between 1,500-7,000 individuals in total (BirdLife International, 2012).

4.3 Habits, social structure

Social structure

Kākā will often be seen flying above the canopy in groups of 3-5 birds, occasionally more. They usually forage alone but will congregate in groups when there is a large amount of food available such as when supplemental food is provided (Higgins, 1999).

Social Structure in breeding season

Kākā are mostly monogamous but can change mates between breeding seasons. In captivity, kākā may reach sexual maturity at 4 years old but difficult to know in wild. They are often found in pairs leading up to breeding season. After breeding, adults and fledging chicks will form family groups till the young are independent. The male feeds the female while she incubates, but both adults will feed the young. Young will beg for up to 6 months before becoming independent (Higgins, 1999).

Sex Ratio

It has recently been discovered that there is a skewed sex ratio in the North Island kākā population because of predation on females during nesting (Greene & Fraser, 1998). A study in the Waihaha Ecological Area in the Pureora Forest Park found that between 1994 and 1995 the observed sex ratio of the kākā was 3 males to 1 female. This skewed sex ratio suggests female kākā suffer higher mortality than males (Greene & Fraser, 1998).

Adult Behaviour

Because kākā are arboreal it is difficult to observe their social behavior in the wild, however it has been discovered that they have some display behaviours similar to the kea (*Nestor notabilis*) (Diamond & Bond, 2004). Kākā usually don't come together unless mated or feeding, males can be very protective of mates and will drive away other birds. However, nests can be as close as 30m apart, and the pair will defend their nest before and during incubation (Diamond & Bond, 2004). But otherwise kākā are not highly territorial. Regarding aggressive behaviour, kākā threat displays involve facing the other bird and raising wings with a harsh grating call (Higgins, 1999). So far there has been no observed dominance hierarchy related to sex.

Juvenile behavior & play

Play is mostly restricted to juvenile kākā (Diamond & Bond, 2004). Juvenile kākā have been observed mock or play fighting, similar to kea juveniles. Diamond & Bond (2004) found play is mostly arboreal, with no observation of the social object play which has been seen with keas. In contrast to kea, kākā associate with adults for a shorter time as juveniles and they are less flexible and more specialized in their foraging behaviour; they can also be quite neophobic (Diamond & Bond, 2004).

Activity

Most birds are usually very active morning and evening. They can rest for 2 hours during day, often in the middle of day and longer at night. However, kākā have been seen to be active at night as well, usually in hours after sunset.

Vocals

Recent research has discovered kākā have five distinct calls associated with different behaviours (Van Horik, Bell & Burns, 2007). Behavioural observations while calling showed that each of these five calls were usually associated with specific behaviours. One known as the 'snicker' call was strongly associated with copulatory behaviour and also when pairs were physically close. This suggests it is important in pair bonding. The 'bark', 'gurgle' and 'shrak-woo' calls were commonly given by solitary birds while perched or foraging. The most distinctive call is the 'shraak' which was used when birds took flight in groups. This call may then facilitate the cohesion of loosely interacting flocks (Van Horik et al., 2007).

4.4 Feeding behaviour

Kākā are omnivorous parrots, consuming a very diverse range of foods, including fruit, seeds, invertebrates, nectar, and pollen (Heather and Robertson, 2015). A large portion of their time includes active foraging, but they will also feed opportunistically. Kākā forage most actively at dusk and dawn but also frequently forage during the day and the night. While kākā are usually solitary in their feeding, congregations can occur around areas of high food abundance (Higgins, 1999). Kākā have a wide variety of foraging methods that allow them to take advantage of the wide varieties of food available. Ground foraging is common and kākā will search for fallen fruit, berries, seeds, and invertebrates. They have been observed to search exposed tree roots, fallen logs, and even use their feet to kick up old leaf litter to expose the ground below. Kākā also forage in the canopy for seeds, fruit, berries, flowers, and invertebrates. Tree trunks are searched for presence of sap (Beggs & Wilson, 1991; O'Donnell & Dilks, 1994; Moorhouse, 1997; Higgins, 1999). The five most important components of a kākā diet are invertebrates, nectar, sap, honeydew, and seeds (O'Donnell & Dilks, 1994; Moorhouse, 1997).

One of the main components of the male kākā diet is wood-boring invertebrates, mainly in the form of beetles (Coleoptera) and their larva (predominantly Cerambycidae and Coccoidea families). In the North Island, the most sought-after larva is the huhu grub (*Prionoplus reticularis*), and in the South Island the huhu grub, and the kanuka longhorn grub (*Ochrocydus huttoni*) (Beggs & Wilson, 1987). Kākā use their beaks to strip away bark and chisel at the wood to expose the larva (Beggs & Wilson, 1987; Beggs & Wilson, 1991; Higgins, 1999). While male kākā may spend on average 35-40% of their foraging time searching for beetle larva, the energy expended searching and retrieving the beetles is often more than what the kākā gain from eating; in searching for larva, the kākā have a net energy loss. These larvae are however good sources of protein and fat and have the highest nutritional content when compared to other insects (Beggs & Wilson, 1987; Beggs & Wilson, 1991; Higgins, 1999). It is suggested that although foraging for larva and invertebrates occurs year-round, it is more of an alternative option when the abundance of seeds, nectar, and sap are low (Moorhouse, 1997). Moth

and butterfly larva (Lepidoptera) are less commonly eaten by males but are more commonly eaten by females because of their smaller beak size (Beggs & Wilson, 1991; Moorhouse, 1997).

Other important components of the kākā diet are sap, nectar, and honeydew. These three foods are very high in energy and provide much of the nutritional energy requirements that kākā need. Kākā have a specialised 'brush' tongue which increases feeding efficiency on these types of food by utilising small hairs to pick up drops of sap (Higgins, 1999; O'Donnell & Dilks, 1989; O'Donnell & Dilks, 1994). These three foods are most abundant at different times of the year, so there is some seasonal variation between when the three are consumed, but this provides the kākā with a good energy supply year-round. Sap is most abundant and important for kākā in mid-late winter and spring, when flowers have not yet bloomed. Kākā utilise a number of different trees for collection of sap (Table 1), the most common being rimu (*Dacrydium cupressinum*) and different species of beech (*Nothofagus sp.).* Kākā obtain the sap by stripping away bark and tapping at the tree to determine where the flow of sap is greatest. They will again strip away more wood to make a 'trapdoor' which they can open and lick the sap from. Flower nectar is most abundant in spring and through summer, and kākā will feed on many different species of flower (Table 1) (O'Donnell & Dilks, 1994). Kākā lick the nectar using their brush tongue straight from the flower but may also use their feet to pull the flower closer, or pull the flower off and hold it with their foot while using their beak to split it open before discarding it (Higgins, 1999). In areas of the South Island where possums are absent, mistletoe nectar is the main component of the summer diet, and kākā can spend up to 60% of their foraging time feeding on this one species (Beggs & Wilson, 1991). In the North Island, nectar is present in small amounts from the winter-flowering puriri (*Vitex lucens*) and kohekohe (*Dysoxylum spectabile*).
The last high-energy component is honeydew, a sugary liquid excreted by scale insects. It is most abundant in spring, and kākā will spend a large amount of time licking it off beech trees or even eating the entire scale insect. Honeydew excreted towards the tops of the trees on average have a higher net energy return, so kākā will spend most of their time in the canopies when foraging for honeydew. Kākā can obtain their daily energy requirements from just three hours of honeydew foraging (Beggs & Wilson, 1991; O'Donnell & Dilks, 1994).

Fruit and berries are mostly eaten in autumn and winter when abundances of sap, nectar, and honeydew are low. Kākā will eat fruits and berries opportunistically, searching for the fruiting trees as they fly overhead or following the calls of other kākā already feeding. The fruit and berries are usually eaten by peeling off the flesh, and leaving the seeds, although these are often eaten as well. Berries are usually eaten whole, but for larger fruit, kākā will hold the fruit in its feet as many parrots do (Higgins, 1999). Fruit is often the food of choice for adult kākā feeding their young, as faecal samples from juvenile kākā usually show a large amount of fruit and berry seeds present (Moorhouse 1997; Higgins, 1999).

Seeds are also one of the most important food sources, especially in winter when most other food sources are scarce. Kākā will forage on many different plant species for seeds (Table 1), however rimu (*Dacrydium cupressinum*) and various beech species (*Nothofagus sp*.) are often the most preferred seed species. These species are also very important, as irregular seed-masting events in these species are important for breeding seasons (O'Donnell & Dilks, 1994; Higgins, 1999).While these food items are the most consumed and preferred by kākā , they will also consume other items such as leaves, lichens, mosses, and live or dead wood (usually white-coloured woods, most likely due to the presence

of fungal bodies) (Higgins, 1999; O'Donnell & Dilks, 1994). Kākā also are assumed to feed on a larger variety of species than given in Table 1, however these plants do not usually exceed more than 1% of foraging time so are not considered major food sources. In general, kākā will tend to forage more (relative to other activities) from May – August, due to either a decrease in food abundance, or an increase in nutritional/energy demands for moulting. Foraging time also increases around the breeding season so the kākā are in their best condition for breeding (O'Donnell & Dilks, 1994; Moorhouse 1997).

Table 1. Main vegetation species that have been observed to be food sources for kākā in studies from the North and South Islands, including seeds, fruit, nectar, and sap. A 'Y' is given for each species where a kākā has been observed feeding on one of the food types.

Plant species	Seed	Fruit	Nectar	Sap
Beech (*Nothofagus spp*.)	Y	-	-	Y
Five-finger (*Pseudopanax arboreus*)	-	Y	Y	-
Hinau (*Elaeocarpus dentatus*)	Y	Y	Y	-
Kahikatea (*Podocarpus dacrydioides)*	Y	Y	-	-
Kamahi (*Weinmannia racemosa)*	-	-	-	Y
Kapuka (*Griselinia littoralis*)	-	-	-	Y
Karaka (*Corynocarpus laevigatus*)	Y	Y	-	-
Karo (*Pittosporum crassifolium*)	-	Y	Y	-
Kawakawa (*Macropiper excelsum*)	-	Y	-	-
Kiekie (*Freycinetia banksii*)	-	Y	Y	-
Kohekohe (*Dysoxylum spectabile*)	Y	-	Y	-
Kohuhu (*Pittosporum tenuifolium*)	-	Y	-	-
Lancewood (*Pseudopanax crassifolium*)	-	Y	-	-
Mahoe (*Melicytus ramiflorus*)	-	-	Y	-
Matai (*Prumnopitys taxifolia*)	Y	Y	-	Y
Miro (*Podocarpus ferrugineus)*	-	Y	-	-
Monterey Pine (*Pinus radiata)*	-	-	-	Y
Mountain five-finger (*Pseudopanax colensoi*)	-	-	-	Y
Mountain totara (*Podocarpus hallii)*	-	-	-	Y
Northern rata (*Metrosideros robusta*)	-	-	Y	-
Pigeonwood (*Hedycarya arborea*)	-	Y	-	-
Pukatea (*Laurelia novaezelandiae*)	Y	-	-	-
Puriri (*Vitex lucens)*	-	-	Y	-
Mistletoe (*Peraxilla spp.)*	-	-	Y	-
Rewarewa (*Knightia excelsa*)	Y	-	Y	-
Rimu (*Dacrydium cupressinum*)	Y	-	-	Y
Southern Rata (*Metrosideros umbellata)*	-	-	-	Y
Tawa (*Beilschmiedia tawa*)	Y	Y	-	Y
Totara (*Podocarpus totara)*	Y	-	-	-
Tree Fuschia (*Fuschia excorticata)*	-	Y	-	-
Vine Rata (*Metrosideros fulgens)*	-	-	-	Y
Wharangi (*Melicope ternata*)	Y	-	-	-

4.5 Reproduction

Reproductive Behaviour and Courtship

Kākā are monogamous parrots who mainly breed in pairs, though there are reports of one male with two females nesting beside each other (Higgins, 1999; Moorhouse *et al.*, 1999) and of extra pair copulations (R. Berry, pers. comm.). Pairs often breed together in sequential years (Powlesland *et al*., 2009). Kākā become sexually mature by four years old; both males and females have been observed breeding at one year old (Moorhouse & Greene, 1995; Alley & Berry, 2002). Males provide females with food weeks before incubation and the male and female preen each other as part of courtship (Higgins, 1999). Males display to females before copulation by raising their near-side wing, shaking their head, and calling. The female will raise her head and tail if receptive, and flex her wings (Higgins, 1999; Powlesland *et al.*, 2009). After copulation the pair freeze and remain still for several minutes (Higgins, 1999; Powlesland *et al.*, 2009). Generally, copulation takes 8-15 minutes to complete, and can occur many times in an hour (Higgins, 1999; Powlesland *et al.*, 2009). Copulation occurs frequently in the week prior to and during laying.

Breeding Season

Kākā have long breeding seasons. Egg-laying to fledging takes approximately 14 weeks (Powlesland *et al.*, 2009). Some kākā pairs can rear two broods within the breeding season (Powlesland *et al.*, 2009). There are differences in seasons for the North Island and the South Island kākā. Seasons are dependent on the amount of food available and the fruiting season of podocarp trees (Higgins, 1999; Powlesland *et al.*, 2009).

Table 1. Breeding seasons in wild kākā in New Zealand. Information is from Higgins, 1999 and Powlesland *et al*., 2009.

Lifestage	Season (North Island)	Season (South Island)
Laying	Nov-Mar	Sept-Mar
Fledging	Dec-Feb	Deb-Mar

Nesting Sites

Kākā rely on natural cavities in hollows of limbs or trunks of trees for nesting sites (Jackson, 1963; Higgins, 1999; Powlesland *et al.*, 2009). The main tree types used are beech, rimu and matai (Higgins, 1999; Powlesland *et al.*, 2009). There may be just one or many entrances to the nest. The female lines the base of the nest with dry, rotted wood, adding some live wood (Powlesland *et al.*, 2009). Large bits are broken up, so the nest is well aerated (Powlesland *et al.*, 2009). Nests commonly measure approximately 300mm in diameter and 20mm in depth (Powlesland *et al.*, 2009), and are usually 5-11 metres high in the tree, though some have been recorded at ground level (Higgins, 1999). Nesting sites may be used for many years (Higgins, 1999).

Laying and Egg Biology

Females laying eggs can be seen hunching their back and fanning their tails (Powlesland *et al.*, 2009). The female will circle around the nest and push the egg under her body to the rest of the clutch (Powlesland *et al.*, 2009). Laying interval between eggs is generally 3 days (Powlesland *et al.*, 2009). If females fail in their first breeding attempts they can produce another clutch (Powlesland *et al.*, 2009). The female incubates the eggs typically for 3 weeks (Higgins, 1999; Alley & Berry, 2002). During incubation the male feeds the female (Higgins, 1999; Powlesland *et al.*, 2009). The female generally only leaves the nest for short periods of time (eg 5 minutes). Eggs are rounded or slightly oval shaped and have fine pits. Clutch size range is 1-8 eggs (Powlesland *et al.*, 2009). Mean egg weight is 22.4g (Powlesland *et al.*, 2009). This is equivalent to 5.61% of the average female body weight of 400g (Moorhouse *et al.*, 1999). The table below shows the differences in eggs between North and South Island kākā:

Table 2. Egg size and clutch parameters for kākā in New Zealand (Higgins, 1999).

	North Island	South Island
Mean egg length	42.1mm	42.5mm
Mean egg width	30.8mm	31.2mm
Clutch size	3-4	4-5

Parental Care

The female mostly feeds the young (Higgins, 1999). The male will feed the chicks when the female is away from the nest (Higgins, 1999). Males will approach to within 20 metres from the nest. The male will call, and the female will emerge (Powlesland *et al.*, 2009). They fly 50 metres away from the nest, where the male will regurgitate food for the female (Higgins, 1999; Powlesland *et al.*, 2009). When the female is away from the nest the chicks will huddle together (Powlesland *et al.*, 2009). The female leaves the nest more often after the nestlings reach 10 days of age (Powlesland *et al.*, 2009).

Chick Development

Fledging period is normally 73 days old, or 9-10 weeks (Higgins, 1999; Powlesland *et al.*, 2009). Many chicks will fledge before they can fly, spending time on the ground and in low trees. The chicks will start climbing 3 days after fledging and will start flying at 3-8 days after fledging (Higgins, 1999). During fledging the male feeds the chicks more, while the female remains at the nest. The chicks are entirely dependent on the parents for food for one month after fledging (Higgins, 1999). They are largely self-sufficient after 3-4 months, and are independent at 25 months (Higgins, 1999). The table below summarises the development of chicks.

Table 3. Nestling stages and weight in kākā (Moorhouse & Greene, 1995; Higgins, 1999; Powlesland *et al.*, 2009).

Age (Days)	Description	Weight
1-3	Chicks are covered mainly in down feathers, pale-grey. Eyes are still closed	
7-9	The chick's eyes open.	
11-15	Pin feathers appear on wings, crown and the tail.	296g
15-17	Pin feathers fully emerge.	383g
17-22	Wing, tail and crown feathers fully emerge.	452g, 527g at day 22, 562g at day 26
34-55	Chicks are fully covered in feathers except for the shoulders and flank.	587g

Factors Affecting Success in the Wild

Females incubate the eggs and are at risk of predation during this period. A skewed sex ratio of three males to one female may be due to predation of females sitting on nests (Greene & Fraser, 1998; Wilson, Karl, Toft, Beggs & Taylor, 1998). Research showed 65% of nesting females were preyed on in an area with no predator control, compared to only 5% when predator control was present at the nesting site (Moorhouse *et al.*, 2003). Hatching success varies between 39-66% depending on the season (Powlesland *et al.*, 2009). The survival of fledglings is between 25-85%, depending on the intensity of predator control (Moorhouse *et al.*, 2003). These figures depend on the intensity of predator control in the breeding sites, especially of stoats. Possums and stoats are nest predators and predation is the main reason for low survival of nestlings and eggs (Wilson *et al.*, 1998; Powlesland *et al.*, 2009). Competitors may be a restricting factor on nesting frequency (Moorhouse, 1997; Wilson *et al.*, 1998). There may be insufficient food in breeding areas due to introduced pests. However supplementary feeding the South Island kākā has not increased nesting frequency yet (Moorhouse, 1997).

4.6 Protected species' role in ecosystem

Kākā are omnivores and included in their diet are a number of New Zealand plants. Most significantly, high energy food types such as the endemic mistletoe, rata and honeydew supply sugary food which is an important part of the bird's diet. In addition, kākā consume a large number of seeds from the fruit of native plants. These foods are essential for both the birds to breed and in turn assist with pollination and seed dispersal of these plant species.

4.7 Threats in the wild

The main threat to kākā are introduced predators. The destruction of most lowland forests and the degradation of surviving forest by introduced browsing arboreal and terrestrial mammals has also contributed to the kākā decline through the removal of and competition for key foods and plants (Wilson *et al*., 1998).

Killing by Humans

Since European settlement, a rapid and dramatic reduction in their distribution and range has occurred. In earlier times kākā was a very important food source for the Maori, and they were so abundant they were killed in thousands when flocking onto flowering rata (Wilson *et al*., 1998).

Habitat Loss

Loss of habitat from forest clearance for agriculture and logging was probably the initial cause of population declines among the kākā, as kākā require very large tracts of forest to survive (O'Donnell & Rasch, 1991).

Competition from introduced animals

Browsing by introduced pests such as possums, deer and pigs has reduced the abundance of food. Possums live in the canopy eating flowers, leaves and fruit, and often destroying the plants that produce these foods (DOC, 2009, 2012). Possums therefore eat the same kind of food as kākā, most significantly the high energy food types such as the endemic mistletoe and rata. These are important for the diet in kākā, and may be essential for it to breed in some beech forests (DOC, 2012). Possums are also hole nesters and they may compete for nest sites and are potential predators of kākā (Wilson *et al*., 1998).

The *Vespulid* wasps (*Vespula germanica* and *Vespula vulgaris)* and possums (*Trichosurus vulpecula*) are seen as the main food competitors of kākā in beech (*Nothofagus*) forest infested with native scale insects. The wasps compete with kākā for the honeydew produced by these insects, and probably modify the invertebrate ecology, as these wasps are very abundant in this habitat (Beggs, 2001).

Predation by introduced mammals

Kākā evolved in the absence of mammalian predators; they have certain characteristics that make them susceptible to predation. Kākā nest in deep hollow holes in trees, where they cannot escape if cornered by predators such as stoats, rats and possums (which eat the chicks and eggs) (DOC, 2009, 2012). Nests can be very strong smelling, possibly making them more conspicuous to predators. Kākā have very long nesting periods, about 24 days incubation and 10 weeks as nestlings which makes them vulnerable for a lengthy period of time. Young kākā must also fledge before they can fly, thus they spend some time on the ground which makes them easy prey (O'Donnell & Rasch, 1991). The nesting females are more vulnerable to stoat predation than adult male kākā and this can cause a skewed sex ratio, which is of concern for future breeding (DOC, 2009).

Stoats are the commonest carnivore found in New Zealand forests. They are active hunters and will search for prey through all cover, down holes, up every tree. About half of the diet of stoats in beech

forest is birds. Because kākā is a hole nesting species, it is particularly vulnerable to nest predation (Wilson *et al*., 1998).

Rats eat native plant seeds which reduces the regeneration of the forest and the provision of future food sources (DOC, 2012). Rats are also predators of kākā nests, where they will eat kākā eggs and chicks (O'Donnell & Rasch, 1991).

Summary of Conservation Actions

Predator control

Predation, mainly by stoats of nestlings and particularly breeding females is the ultimate factor in kākā decline, and in many instances, it is also the factor for decline in local extinction (Wilson *et al.*, 1998). The reduction of stoats is necessary for the survival of kākā. Also, the loss of nectar sources, fruits and seed may also compromise the success of kākā breeding attempts, so that productivity will be slow (Wilson *et al*., 1998).

Pest control can be undertaken by extensive trapping and/or bait stations in mainland areas where there is no predator proof fencing. The Project Kākā zone in Tararua Forest Park is treated by aerial applications for 1080 pesticide every three years. This project started in 2010 (DOC, n.d). The aerial application is done in spring to target rats and stoats as well as possums while protecting native bird during vulnerable nesting periods (DOC, n.d). Predators can also be kept out of conservation areas with a predator proof fence, which will also provide protection for kākā.

Captive breeding

Captive breeding is undertaken to increase kākā numbers and decease their risk of becoming extinct. A main component of the captive breeding programme is the reintroduction of kākā into the wild for biodiversity restoration.

Supplementary feeding

Supplementary feeding has been used for kākā that have just been reintroduced or translocated, as it can ease them into their new environment. This technique may also keep them close to the release site, so monitoring them may be easier (Berry, 1998). It can also provide them with another source of food, instead of competing with other species for food. Supplementary feeding can provide the kākā with more food at times when their energy requirements are higher (e.g. during the breeding season), but needs to be managed carefully so nutritional requirements are also met.

Habitat conservation

Habitat conservation involves decreasing habitat destruction and logging. This will help ensure that the kākā, as well as other native birds, will have a greater area where they can live. Habitat conservation can also include making sure that it is the right environment for these birds (i.e. beech forests). Predator proof fencing could also aid in this, by keeping predators out and providing kākā with an optimal habitat.

Translocations and Reintroductions

Currently, and in the future mainland kākā populations will require intensive management to prevent their extinction.

Reintroductions play a very important role in re-establishing kākā within parts of their former range and counter-acting the decline in existing population. Reintroduction usually involves releasing translocated individuals from a source population into a suitable, vacant habitat within the species original historic range (Berry, 1998). To date translocations have mainly been to offshore islands or mainland "islands" where threats are extensively and effectively managed (Berry, 1998). With reintroduction and translocations birds are often monitored, through bird counts or radio transmitters to provide information on post-release survival and dispersal.

5. CAPTIVE HUSBANDRY

5.1 Housing/Environment Standards

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 with some captive institutions having aviaries up to 50 m long, 30 m wide and 20 m high. This size can be both impractical and unnecessary for some sites but captive institutions, and restoration sites with active kākā programmes, can offer useful guidance and advice for aviary construction.

5.1.1 Size

Parrots are highly social, diurnal prey animals (Kalmar, Janssen & Moons, 2010) and for captive parrots, physical and mental wellbeing is important. Birds should be able to perform natural behaviour in a captive environment. Therefore, adequate flight and movement possibilities are required; perching and nesting should be made available. In addition, appropriate material, housing, substrate and vegetation must be provided.

Natural foraging, tracking for ripe fruits and seeds, being able to manipulate food in a natural manner and the recognition of roosting assemblages are important components of an optimal captive environment (Collar, 2000).

The minimum size of an enclosure is determined by several basic requirements. Birds need to be able to express natural locomotive behaviour. The spreading of wings and, subsequently, flight needs to be possible (Kalmar *et al*., 2010). If birds are incapable of moving appropriately, flight muscles will deteriorate over time, making release into the wild problematic. Furthermore, the digestive system may need to adapt to a non-flying lifestyle which may result in health problems. An appropriate height and size of an enclosure is therefore essential.

Two enclosure types can be identified: "display" and "off-display".

For the purpose of the enclosure recommendations for the kākā husbandry manual, information is used from a selection of captive facilities throughout New Zealand.

5.1.2 Materials for housing and enclosure location

Kākā are very curious, have a powerful bill, 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. Lead must not be used for in any areas of the of the aviary as it is known to be tempting to kākā and is highly toxic. Steel pipe framing can also be used for aviary construction.

Mesh

The material used for enclosures needs to be strong and safe. In most cases, wire mesh is used for the walls and ceiling. "Zoo Mesh" has also been used by both Auckland Zoo and Pūkaha Mount Bruce. This mesh is expensive compared to traditional mesh types, however it is very safe to use around kākā and lasts for many years longer than wire mesh. Sharp edges of mesh should be avoided in any case, in addition to the possibility of the birds getting stuck or tangled into loose pieces of mesh wire.

A variety of different mesh sizes and constructions have been used ranging from Excluder mesh, 6mm square mesh, 12mm square mesh and 18mm chain link mesh with 2.5mm 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 being 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. To prevent incursions by unwanted pests such as mice, rats and mustelids it is necessary to either bury the mesh or have a concrete foundation c. 600mm 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.

Floor

Social play is important in the social behaviour of kākā, where the floor is often used for the initiation of play and engaging with other individuals (Diamond & Bond, 2004). Leaf litter, bark mulch, grass or wood shavings are appropriate for stimulating courtship behaviour and breeding. These surfaces should also be used when enclosures are on display, where the natural environment is part of the educative experience for the public. In some cases, the enclosure is built upon natural soil, which is the ideal surface for the animals to display natural behaviour, in addition to the public's appreciation. 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 (50-100mm) of natural earth floors can be periodically replaced to prevent the build-up pathogens and parasites.

Entrance safety

For safety purposes, a "double door" or safety area is preferable as entrance for the enclosures, hereby avoiding birds flying out while a keeper, or the public enters the enclosure or walk-through aviary. The entrance area also needs to be large enough to allow logs/ladders/large items to be moved into/out of the aviary with space to open/close the doors.

Site

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, e.g. at Maungatautari, have been built under canopy. This is suitable, as long as they are not too dark and damp. Regular inspection of any external vegetation is required to ensure branches have not grown through the mesh and to review if any overhanging limps do not threaten to damage the mesh if they drop on the aviary in the event of high winds or heavy rainfall/snow. Aviaries should also be positioned in a quiet spot away from both the public and general human activity, including site staff and operations.

Public interaction

Noise and unnatural sounds should be avoided as much as possible in the surroundings of the enclosures. Parrots are naturally noisy, and severe surrounding acoustics will increase vocalization and may increase stress responses of the birds (Kalmar *et al*., 2010). In contrast, complete silence is not desired for parrots, as this may indicate the presence of a predator. This problem would, however, only be an issue in the case of wild-caught individuals.

The position of the enclosure is of importance regarding the disturbance from the public to the birds. The birds need to be able to shelter off from display, to reduce stress and increase wellbeing of the individuals. Walk-through enclosures need to be large enough for the birds to choose interaction with the public, or to hide away. In these enclosures, shelter needs to be appropriately placed to minimize disturbance, including noise and sounds from the public.

5.1.3 Shelter/screening

Shelter

Roofed area and shading cloths for shelter options must be included in kākā enclosures which the birds can use. In some cases, ply walls may be used to provide shelter from climatic conditions, but also from public display (R. Empson, personal communication, August 20, 2012).

Any sheltered area 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 a wooden box with an open side) as additional shelter options with birds often favouring the top of the roost boxes as resting spots throughout the day.

Other natural options include branches of vegetation and covered wooden areas **See also 5.1.6** (vegetation)

5.1.4 Water

Several methods of water supply are used in the captive facilities. Keepers need to be able to reach the water (and food) supply easily in order to refresh and provide the supplies in a safe and non-disturbing manner. Facilities use a range of different water supply in the enclosures of the kākā. The large, mixed-species enclosures at Hamilton Zoo contains a waterfall, but also utilizes a pond system where the animals can drink from and bathe.

Water trays may be used in both display and off-display enclosures. The Isaac Conservation and Wildlife Trust uses a steel sink which is sufficient for the birds, provided that the water is refreshed continuously (A. Richardson, personal communication, August 6, 2012). The Staglands Wildlife Reserve aviary, which is also a mixed-species-exhibit, uses a natural stream that runs through the enclosure, in addition to a small pool (J. Simister, personal communication, August 12, 2012).

Minimum Standard 3.

Enclosures

a) Kākā enclosures must be a minimum of 120^3 for 2 birds. (e.g. 8 metres long x 5 metres wide and 3 metres high. Holders need to provide an additional $50m^3$ for every individual bird after this (this is for long-term holding – aviaries that hold kākā for a delayed release require consultation with the species coordinator for conformation they are appropriate for the number and age of the birds).
b) The material used for enclosures needs to be strong and safe. In most cases, wire mesh is used for the walls and ceiling. "Zoo Mesh" is the preferred material. Lead mush not be used any area of a kākā aviary. Sharp edges of mesh should be avoided in any case to prevent the possibility of the birds getting stuck or tangled into loose pieces of mesh wire.
c) Floor substrate must include leaf litter, bark mulch, grass or wood shavings are appropriate for stimulating courtship behaviour and breeding. Substrate replacement would preferable done when the aviary is empty of birds to minimise the chances of contracting aspergillosis infections. Alternatively any substrate collected for aviaries must be used immediately and not stored for any length of time
d) Concrete can be used in areas that require cleaning often, however it is not to be used in more than 50% of the enclosure
e) All enclosures must include a double entrance "airlock" to prevent the birds from escaping when husbandry staff enter
f) Enclosures should not only be sited to take into account thermoregulation requirements but also be positioned where possible to take into account height to maximise the birds' outlook. Enclosure should be sited in an area to maximise natural environmental (sun, shade, wind, temperature gradients) and landscape factors (topography, vegetation, water sources). If these are not available, design of an enclosure which takes the kakas natural environmental conditions into account to maximise expression of normal behaviours should be developed
g) Areas must be provided in the enclosure where display birds can retreat totally from public display, if they so desire. These can be provided using either artificial shelters/screening (ply or other solid materials) of natural screening (browse or logs)
h) Fresh water must be provided at all times in a way which enables all birds to access freely. A main water source of minimum dimensions $1m^2$ x 200 mm deep (to allow bathing behaviours). In the event of only one confined water source being accessible to multiple birds, an additional water bowl must be provided at all times at another location in the enclosure to ensure subordinate birds have access to water at all times (a stream system which provides water across an extended area is adequate on its own).
Enclosures must meet the requirements set out in the Code of Welfare for zoo animals (Code no. 5, 2007).

5.1.5 Furnishings and vegetation

General

Kākā are an inventive and playful species, therefore natural enrichment is recommended as a priority. Natural environments allow the birds to express exploring and innovative behaviour by feeding on

natural foods and assembling nests with natural material. Large logs, fresh branches, decaying wood and appropriate vegetation may be used for either nesting, shelter, feeding and playful behaviour (such as the stripping of bark and wood and hanging from branches). Fresh branches usually flower and fruit and will stimulate the natural foraging behaviour of kākā. Rotten logs and decaying wood can function as nesting sites or material. These types of furnishing are frequently used in kākā enclosures (A. Richardson, personal communication, August 6, 2012; J. Simister, personal communication, August 12, 2012; R. Empson, personal communication, August 20, 2012).

Kākā are known for their inquisitive nature and will show play behaviour with any object (Alley, 2002). Large stones and rocks are used for general enrichment of the enclosure and may add to the natural look of the enclosures. Their exploring behaviour will be stimulated by a varied and stimulating environment (J. Simister, personal communication, August 12, 2012).

Perches

Perches in enclosures are important for kākā in captivity to stimulate flight and to enable resting. Parrots should be able to move and turn around on a perch without touching the walls or floor (Kalmar et al., 2010). In the various facilities, perching is mostly constructed using logs and trees.

Appropriate non-slippery textures on the perches are needed for the birds to be comfortable and safe. Using wooden perches may result in replacing the perches regularly, as kākā tend to be destructive birds. Rope may be used as an anti-slip texture; however, the destruction of this may result in unsafe threads for the birds to get tangled in or ingested (King & Wilkinson, 2006). These need to be monitored closely and replaced when needed.

The flights and shelters should have a variety of perches at different heights and diameters, although perches should not be placed directly underneath each other, and some consideration should be given to flight paths within the aviary. For example, perches might be installed in the shelter and at either end of the flight to provide a maximum flight path for the captive birds. 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 30mm in diameter but much larger branches (up to 100mm) are perfectly 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.

Vegetation

The timing of reproduction of kākā is thought to be closely correlated to mast production of seeds and fruits in the environment (Greene, Powlesland, Dilks & Moran, 2004). For captive breeding, it is therefore important to adjust plant species and food availability according to their reproductive cycle to maximize breeding potential.

Between seasons, the wild kākā will feed on a variety of foods. For example, the fruits of kahikatea (*Dacrycarpus dacrydioides*), rimu (*Dacrydium cupressinum*), matai (*Prumnopitys taxifolia*) and miro (*Prumnopitys ferruginea*) are consumed by kākā all year round (Greene *et al*., 2004). These tree species are important for nesting, breeding, feeding and shelter (Greene *et al.*, 2004; Powlesland *et al*., 2009). Kākā will appreciate most native browse, however Table 3 shows the vegetation types that may be used for kākā enclosures and emphasizes the importance of mountain beech in the lifestyle of kākā.

Table 3 Possible vegetation for kākā enclosures, scientific names, maximum heights of the vegetation (in metres) and nutritious value for kākā.

Vegetation	Scientific name	Max. height	Nutritious value for kākā
Black beech	*Nothofagus solandri*	27	Aphids & Coccidae (honeydew)
Fuchsia	*Fuchsia excorticata*	5	Flowers / fruits
Kahikatea	*Dacrycarpus dacrydioides*	60	Pine / aril
Hinau	*Elaeocarpus dentatus*	20	Berry
Kamahi	*Weinmannia racemosa*	8	Nectar / honey
Kapuka	*Griselinia littoralis*	6	Sap feeding
Kauri	*Agathis australis*	40	Seeds
Matai	*Prumnopitys taxifolia*	30	Berry
Miro	*Prumnopitys ferruginae*	25	Berry
Mountain beech	*N. solandri ciffortiodes*	20	Larvae of kanuka longhorn beetle Aphids and Coccidae (honeydew) Sap feeding
Orihou	*Pseudopanax colensoi*	3	Sap feeding
Rimu	*Dacrydium cupressinum*	50	Sap feeding

Other browse species successfully used in kākā aviaries include flax, tarata/pittosporum species, coprosma species, makomako/wineberry, houhere/lacebark, horoeka/lancewood, kaikomako, kowhai, mahoe/whiteywood, porokaiwhiri/pigeonwood, rewarewa/honeysuckle.

Honeydew from scale insects (Coccidae, for instance: *Ultracoelostoma assimile*) and aphids (Aphidae) is an important feature for breeding in wild kākā (Gaze & Clout, 1983; Collar, 2000). These invertebrates are found mainly in beech forests and are most commonly found on black beech (*Nothofagus solandri*) and mountain beech (*N. solandri var. cliffortioides*) (Beggs & Wilson, 1991).

Kākā are specialized feeders. In addition to honeydew and fruits, they tend to feed on the larvae of small arboreal insects, such as Kanuka Longhorn beetles (*Ochrocydus huttoni*), often found on mountain beech (Beggs & Wilson, 1987), and are known to feed on tree sap (O'Donnell & Dilks, 1989; Diamond & Bond, 2004).

A particular play behaviour known in kākā involves hanging from tree branches or ferns and picking fronds or leaves from the vegetation and dropping them on the floor (Diamond & Bond, 2004). Besides play behaviour, ferns and trees are important vegetation types for the kākā to be able to perform other natural behaviour, such as foraging and may be used as nesting material. Species such as kamahi, orihou and kapuka are used by kākā for sap feeding and are appropriate vegetation types in outdoor enclosures (O'Donnell & Dilks, 1989; Diamond & Bond, 2004).

5.1.6 Lighting

Kākā require a circadian light-dark schedule and they need to be able to sleep without interruptions (Kalmar *et al*., 2010). An outside aviary or enclosure would be preferable. If the kākā are kept indoors, the light should resemble their natural circadian rhythm, with a gradual flow from light into dark, and vice versa (Kalmar *et al*., 2010). Outdoor enclosures not only allow for light-dark to be appropriate, they also provide fresh air, natural ventilation and natural photosynthesis for the vegetation.

Nonetheless, there is an increased risk of the transfer of diseases through open air (zoonoses) to other species and is riskier when it comes to theft or escape. However, birds that are held in captivity for long periods, or permanently, should have exposure to natural light.

Minimum Standard 4.

Furnishings and Vegetation

a) A variety of substrate types must be included in the enclosure including: Ground vegetation (one of which is grass/ground covers to encourage foraging), Trees/shrubs (to encourage foraging, provide perches (a minimum of 2 per bird of varying diameters) and or visual barriers), furniture (one of which is rotten logs to encourage foraging) in addition to basic enclosure furniture (nest cavity/box, perches, water source etc)
b) Kākā require a circadian light-dark schedule and mush be able to sleep without interruptions.

5.2 Health Care Standards

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. Alternatively, some sites have footwear (gumboots) at specific aviaries that staff can change into before entering the aviary, especially during quarantine.

5.2.1 Environmental hygiene and cleaning

Apart from providing a healthy diet to the captive kākā, it is also important to render them a clean captive environment for optimum health and production. This can be ensured only by a daily maintenance of the enclosure, thus preventing the built up of any debris.

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 rinsing 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). Some sites only sterilise feed and water dishes once a week or after heavy soiling. All food preparation equipment (e.g. dishes, utensils, knives and cutting boards) and surfaces should also be cleaned daily. Ideally, all utensils will be only being 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 ahead of feeding. Pellet foods should be kept in sealed containers in a cool dry place to prevent insect, mould or fungal damage.

Sites with concrete floors usually sweep them daily and wash them 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, at Boundary Stream leaf litter is removed after holding birds and the ground is left fallow until the next use.

Minimum Standard 5.

Cleaning.

a) All water dishes must be cleaned and re-filled with fresh potable water daily.
b) All food dishes must be cleaned daily.
c) As far as is practicable, all food scraps and leftover food must be removed from enclosures daily.
d) Roosting areas/nest boxes should be cleaned if faecal material has accumulated within the box (unless this is likely to interfere with breeding).
e) All areas used for the preparation of diets must be kept clean.
f) Any items cleaned with Milton Trigene or Sterigene must be completely rinsed and dried before placing back with the kākā

5.2.2 Known health problems

Health management

Kākā are generally long-lived in captivity. The longest surviving captive kākā was ~47 years old.

A change in day to day activity or behaviour is the first indication that captive birds might be unwell. This change might be behavioural, e.g. due to harassment from aviary mates, or physiological following contraction of disease-causing pathogens or parasites.
Birds are prone to hiding signs of ill health and by the time symptoms of illness or disease become apparent it is often too late to provide assistance.

Close monitoring of the health of individual birds should detect disease problems early. During daily feeding, their food intake should be monitored, and their general appearance noted. It is difficult to observe weight loss in birds, often the first sign of illness. They may be fluffed up, lethargic, their faeces become abnormal and the vent may become soiled. Becoming familiar with the normal behaviour of individual birds will allow quicker diagnosis of any problems that may occur.

Most infections are the result of underlying stresses and so this needs to be managed through good husbandry. These stresses include:

Social factors:

- Housing with aggressive birds
- Isolation from mates
- Overcrowding

Nutritional problems:

- Inadequate diet
- Poor food consumption

Environmental stress:

- Inclement weather
- Transfer to a new environment

Physiological stress:

- Moulting
- Breeding
- An inability to be able to retreat and/ hide from the public

Keeping these factors in mind can help to minimise this. Help should be sought from experienced holders or veterinarians if any doubt exists about the bird's health.

In addition, kākā must be weighed every time they are handled. This won't happen very often so as much detail as possible should be gathered and this should include a physical health check by an experienced keeper or veterinarian. This involves checking;

- Bill – scarring, wearing, staining
- Eyes – clear, good pupil reaction
- Ears – clear and open
- Inside mouth – normal pink membranes
- Feathers – no external parasites, stress bars, stage of moult
- Breast – check muscle condition
- Wings – good movement and extension
- Abdomen – not lumpy or taut
- Cloaca – clean and free from dried matter
- Legs and feet – good range of movement, no scarring or injuries

Some of these checks can be done during daily observation and do not involve capturing the bird.

Several diseases have been recorded in kākā, including:

Psittacine beak and feather disease (PBFD) – this viral disease can cause feather deformities and immunosuppression in most parrot species, although kākā have yet to be diagnosed with it. Testing for PBFD is especially important if the kākā have been in aviaries near exotic parrot species and in

particular, budgerigars, lovebirds or lorikeets that can have a high incidence of infection with minimal clinical signs. Testing can be carried out on a plucked feather by the Massey Equine Parentage and Genetics Service [EPAGS].

Avian chlamydiosis – this respiratory disease is common in parrot and pigeon aviaries and can spread to people (zoonosis). Birds that have survived infection may shed the organisms without clinical signs. Testing can be carried out on a swab of the conjunctiva or choana by EPAGS.

Salmonella and Yersinia – these bacterial diseases can be spread by wild birds and rodents and can cause intestinal disease, septicaemia and death. Captive kākā have died due to *Salmonella typhimurium* spread by sparrows in New Zealand. Testing is carried out on a cloacal swab and can be done by any veterinary diagnostic laboratory.

Endoparasites – kākā are susceptible to nematodes, cestodes and coccidia that live in the intestinal tract and can cause severe damage or death in heavy infestations. Testing is carried out on fresh faeces and can done by any veterinary diagnostic laboratory. Alternatively, the birds can be drenched as part of the transfer and quarantine protocol.

However, diagnoses can only be made by an experienced veterinarian, often following laboratory analyses.

Minimum Standard 5.

Health Management.

All staff must be aware of the following:

- What constitutes behaviour indicative of ill health in kākā
- The procedures to follow in the event of a sick kākā
- Any staff that come into contact with wild parrots must follow proper hygiene protocol to prevent cross contamination
- Any staff that come into contact with pet parrots at home must follow proper hygiene protocols

The following diseases/health problems are a potential threat to parrots and as such the signs and symptoms of each must be known by the kākā husbandry staff:

- Beak and feather (PBFD)
- Toxic response
- Respiratory infection

Any instances of ill health must be reported to DOC's National Wildlife Database Project at http://www.doc.govt.nz/wildlifehealth

5.2.3 Preventative procedures (health monitoring)

It is also necessary to keep the enclosure vermin and predator free; it should be checked daily by the assigned zookeeper for any sign of invasion (Orr-Walker, 2010). Hygienic daily management of the kākā enclosures and a balanced diet can help in combating many infectious or nutrition related diseases. Monitoring the behaviour, food consumption, general health and movement of kākā and their interaction with con-specifics, should be part of daily husbandry practices. Any change in these behaviours should be noted (Kara Goddard, pers.comm.2012)

Weight of kākā should be recorded at least once a month, which can be made easier by a basic conditioning or training programme.

Faecal samples are recommended to be taken twice yearly, ideally pre- and post- breeding season (March and September). The common helminth and protozoan parasites in kākā are (Alley, 2002; Heath, 2010):

Nematode: *Capillaria* sp.
Microtetrameres nestoris
Oxyspirura sp.

Protozoa: *Coccidia* sp.
Giardia sp
Toxoplasma gondii

Aviary: Toxicological studies should be done for water and watering systems in the aviary and associated areas to assess for lead or pesticide residues. The disinfectants used in the aviary should also be tested for any harmful residues that may affect kākā.

Minimum Standard 6.

Health Monitoring.

a) All adult captive kākā must be weighed at least twice annually and have their weights recorded in the individual specimen record.
b) Faecal sampling for parasites must be undertaken on each kākā held at least once every six months. Samples must be checked for signs of infections (as above) by a veterinarian or suitably trained laboratory technician.

Monitoring must be conducted as follows:

a) Observations: Daily distance observations (recorded in ZIMS and or a daily diary)
b) recording changes in behaviour
c) Weights: Weights attained through training programme to be recorded on a monthly basis
d) Daily enclosure and perimeter checks for foreign materials, introduction of pest species and toxic plants or enclosure breach

5.2.4 Treatments and Veterinary Procedures

All kākā captive sites should establish a working relationship with an experienced avian veterinarian to facilitate optimum health in captive birds. In case of any sickness, the kākā should be quarantined and given proper veterinary treatment. It is the duty of the staff to prevent cross contamination between the different bird enclosures, by following some strict hygienic measures, as follows:

- All clothes, field gear and equipment must be disinfected with Trigene.
- Boots must be cleaned of gross dirt or debris and then soaked in 1:20 dilution for 10 minutes and then thoroughly rinsed (Orr-Walker, 2010). Additionally, it is better to keep separate boots for the sick kākā enclosure or the quarantined birds (Kara Goddard, pers. Comm.2012)
- Clothing and footwear worn in contact with wild or pet parrots must be separate from the one worn at work (Orr-Walker, 2010).
- Towels used for handling purpose should be washed to reduce the exposure of disease to other birds (Chitty, 2011).

Minimum Standard 7.

Treatments and Veterinary Procedures.

All kākā captive sites must establish a working relationship with an experienced avian veterinarian to facilitate optimum health in captive birds.

5.2.5 Procedure if kākā die

Dead specimens

It is the requirement of the Department of Conservation (Wildlife Health Standard Operating Procedure) that all dead native wildlife should undergo necropsy (post mortem examination) to attempt to determine the cause of death and to provide useful information for better understanding of the species.

Any dead kākā must be submitted directly to Massey University or, after consultation with the captive coordinator to a suitably experienced veterinarian for a necropsy. The procedure for preservation is as follows:

1. Do not freeze the carcass, as it damages the tissues and makes it difficult for a complete investigation. It is to be put in freezer only when it is unable to be delivered within 36 hours of discovery. Otherwise, the carcass is wet thoroughly in clean water in order to reduce its temperature quickly and then refrigerated as soon as possible.
2. Complete a Huia Database Wildlife Submission Form (see **Appendix 3**). The purpose of the form is to identify the specimen, list any background information that can help to identify the cause of death, state any special information the submitter is seeking about the sample, aside from cause of death and to record any special instructions regarding the disposal of the

carcass following necropsy (e.g. returned to submitter, given to iwi, offered as teaching resource).

3. Place the labelled (tag around leg) carcass in multiple puncture and tear resistant plastic bag or a plastic container with a secure and tight-fitting lid. Put a paper towel or other absorbent material in the bag or container to absorb any fluid that may seep out. Put the bag/container in a robust container (either a small polystyrene chilli bin or a strong cardboard box) together with a non-leak freezer pack (or frozen, half-filled, soft drink bottle) and packaging (e.g. screwed-up paper, bubble-wrap) to ensure the contents do not move around in transit. Label the package **urgent**, **perishable** and/or **keep cool**, **do not freeze** and to courier to:
   Attention: Stuart Hunter/Brett Gartrell
   Room 5.06, Vet Tower, Massey University, Palmerston North

A copy of the necropsy report must be sent to their respective Captive Management Coordinator.

Minimum Standard 8.

Procedures if kākā die in captivity.

All captive kākā that die must be sent to Massey University to undergo necropsy or alternatively after discussion with the captive co-ordinator an alternative suitably experienced veterinarian may be used

The kākā Captive Management Coordinator must be informed about the kākā death as soon as possible, and a copy of the necropsy report (prepared by the veterinarian performing the necropsy) must be forwarded to the Captive Coordinator by the institution where the kākā was last held (i.e. the institution that submitted the kākā for necropsy). The sex of the dead kākā should be recorded (if unsexed at death).

5.2.6 Quarantine procedures

Pre- or post-transfer quarantine is undertaken to minimise the risk of transferring diseases between the institutions or between an institution and the wild.
A full quarantine period must be undertaken by either the receiving or sending institution (generally the sending institution, but sometimes both). The two institutions involved in the transfer should discuss quarantine options for the birds in quarantine and the pre-transfer screening required (recommended - clinical exam, 3-day bulk faecal sample for parasitology & Salmonella/Yersinia, CCC swab for Chlamydia PCR, feathers for PBFD PCR).
Results from laboratory analyses for internal parasites should be available from the laboratory providing the analysis 24 hours after they received the sample. Enteric screen results are normally available after 48 hours, but further time is often needed to identify specific strains. If the receiving institution is doing the quarantine the sending institution still must ensure that the bird is fit for travel by getting an experienced veterinarian to examine the bird prior to transfer.

A complete copy of a bird's individual records must be sent by the holding institution to the receiving institution including any records from pre-transfer quarantine and vet checks. An information sheet with a summary of the individual's specimen record should accompany the bird being transferred. A current diet sheet and a list of observed personal behavioural traits can be included with the animals' information to help ensure ease of transition to a new facility (Orr-Walker, 2010).

Apart from the tests and detection of obvious signs of trauma or infectious diseases, it is essential for the staff to be attentive to more subtle indications of impaired health such as abnormal plumage, bone dimorphism, emaciation, clinical signs of metabolic disease resulting from impaired immunological function before any transfer from quarantine (Kalmar *et al*., 2010).

Minimum Standard 9.

Quarantine Procedure.

All kākā being sent to or received from another captive facility, or from the wild, must, as a minimum, undergo the following quarantine procedure either immediately before or after the transfer.

a) Birds should be isolated in quarantine for a minimum of 14 days after arrival or before being transferred (depending on whether the quarantine is being undertaken by the sending or the receiving institution). If birds that have been/are about to be transferred are held in an enclosure with other birds then ALL birds in the enclosure must undergo the quarantine, including all medical checks and faecal and blood sampling and analysis.
b) Enclosures containing birds undergoing post-transfer quarantine must be serviced **after** other enclosures containing kākā. Enclosures containing birds undergoing pre-transfer quarantine must be serviced **before** other enclosures containing kākā.
c) The bird(s) must undergo a thorough physical examination by a vet at the start and end of the quarantine period.
d) The birds must be weighed at the start and end of the quarantine period (and the weights recorded).
e) A faecal sample from each bird undergoing quarantine (or a pooled sample for birds sharing an enclosure) must be collected and analysed by a veterinarian or suitably trained laboratory technician at the start **and again** on day seven-nine of the quarantine period
f) A blood sample must be collected from each bird in quarantine at the start of the quarantine period to check for haemoparasites and to check that blood chemistry is within the normal range for kākā.
g) A complete copy of the bird's individual record must be sent by the sending institution to the receiving institution.

5.3 Behavioural Notes

5.3.1 Common captive behavioural needs

As a social species kākā must not be housed on their own unless undergoing medical or quarantine procedures (Orr-Walker, 2010). Groupings should be appropriate for the age and breeding status of the kākā and mimicking natural sex-ratios is ideal. Breeding individuals should be housed separately but with some form of optional communication with con-specifics. The minimum number of birds should be 3-4 and the maximum should be appropriate to the size of enclosure and follow natural flock sizes to avoid overcrowding and associated aggression. Monitoring of social interactions is necessary to ensure aggression is minimised and to resolve any social issues within the flock that may arise.

Social Grouping

Solitary housing should be avoided, as parrots are social individuals (Kalmar et al., 2010). However, clumped social housing may lead to aggression. Social housing is thought to be an effective tool for birds to acquire the social skills necessary before release (Moore, Bell & Linkater, 2008). Kākā chicks that are raised in social groups show normal social development and may have higher survival success in the wild than individuals that need to be introduced to groups.

Kākā are known to be playful birds, especially juvenile birds. They tend to play in small groups (usually in pairs) and this behaviour is mainly seen in the evenings (Diamond & Bond, 2004). The ability to socialize with others at night seems important in kākā behaviour, therefore public display and interaction should be avoided during late afternoon and evening hours.

It is important to encourage social behaviours, and this can be achieved both via social grouping and social enrichment (Orr-Walker, 2010). Both physiological and psychological welfare are affected by social groupings and, provided they are appropriate, this form of social enrichment can enhance welfare and be one of the most effective forms of enrichment (Garner, Meehan & Mench, 2003; Orr-Walker, 2010). It involves not only consideration of interactions with con-specifics, but also interaction with neighbouring aviaries and humans (Field & Thomas, 2000).

The kākā is a flock bird and often more active and sociable in the evening and early morning. During the day they are less sociable and forage as individuals (Otorohanga Zoological Society, n.d.). During the breeding season, wild parrots tend to reduce to small groups, however outside the breeding seasons large groups are common (Garner *et al*., 2003). Recreating natural social groupings if possible is the best practice for social parrots such as kākā however, large aggregations are not often feasible due to resource constraints but also because of potential for adverse effects of captivity such as stress or injury due to aggression (Garner *et al*., 2003). Overcrowding may also lead to distress, fighting and aggression because of competition for food and water (National Animal Welfare Advisory Committee [NAWAC], 2005). Observation is necessary to monitor any dynamic social changes which may lead to a welfare compromise regarding social groups.

Minimum Standard 10.

Social Housing.

Kākā must not be held singly unless the following applies:

- Where birds have been held singly for the entirety of their lives and are proven to be unable to be integrated with other kākā (evidence required)
- Undergoing medical treatment
- Undergoing quarantine

Life stages and gender requirements

- Adult females: are housed in mixed sex exhibits with equal male/female ratio or more males than females represented where possible. Adult males: may be held in single sex groups
- Juveniles: should be housed together where possible in mixed sex flocking situation, until sexual maturity at 3-4 years. Juveniles may also be housed with other adults
- Current non-reproductive pairs: Unless a particular bird is required for important pairing at another facility, current pairs engaged in normal pair behaviours should not be separated

Development of new social groupings

- Integration of new birds must be undertaken in appropriate facilities by experienced personnel
- Birds must be monitored during this period utilising standardised protocol by competent personnel
  Daily records of integration process must be maintained

Monitoring

- Daily on-going monitoring of social groupings needs to occur so any issues with group dynamics e.g. aggression/stress can be picked up early and appropriate changes made quickly

5.3.2 Behavioural enrichment activities

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 and development. 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.

Animal Welfare

Zoos and wildlife parks can provide a powerful opportunity to engage the public and promote wildlife. This must not come at the expense of animal welfare however as the animals' needs must always be prioritised above public perception. That doesn't mean that animal welfare and public experience of

the animals can't both be positive and coexist (King, 1999). While the animals' natural environments are very difficult to mirror in captivity, captive institutions should endeavour to ensure that both the behavioural and physiological needs of the animal are met, and that the natural environment is reproduced in their enclosures as best as possible (World Association of Zoos & Aquariums [WAZA], 2005; Ministry of Agriculture & Forestry, 1999). The New Zealand Animal Welfare Act of 1999 uses the five freedoms in its legislation; these are adequate provision of food and water; sufficient shelter; the opportunity to display normal behaviour patterns; appropriate physical handling; and adequate treatment of injury and disease. Animal welfare can be broken into five domains; nutrition, health, behaviour, environment and mental welfare (Gregory & Mellor, 2011) all of which must be considered when planning enrichment and training programmes. These domains are however often difficult to measure in some cases and so the accepted indicator of poor husbandry and captive animal welfare is the expression of maladaptive behaviours such as stereotypies and abnormal repetitive behaviours (King, 1999; Clubb, Latham, Mason & Vickery, 2007).

Enrichment

Introduction

Animal welfare is paramount when keeping birds in captivity. Consequences of a captive environment that is inadequate for the birds' needs include stereotypic behaviours and abnormal repetitive behaviours (ARBs). These are defined as repetitive actions which appear to lack purpose, and which are maladaptive or self-injurious (Clubb *et al*., 2007; Garner, Meehan & Mench, 2007 cited in Janssens, Kalmar & Moons, 2007, p.420). Janssens, Kalmar & Moons (2007) cite Meehan and Mench (2006) who categorise stereotypies into; locomotor (repetitive movements without purpose such as pacing, path-tracing), oral (spot pecking, bar-chewing, feather-plucking) and object directed (repetitive, goal-less manipulation of objects) and, in extreme cases, vocal (repetitive screaming). A common source of these behaviours is the frustration and boredom that results from the restriction from expressing fundamental behaviours. Stereotypies may, however, continue after the cause has been removed, ceased or even improved (Janssens *et al*., 2007) and are therefore difficult to resolve, indicating the importance of regular observation and record keeping of behaviour. Known triggers of stereotypies in Psittacines include impaired opportunities to engage in foraging, locomotion, and socialisation with con-specifics (Garner *et al*., 2003). The most common way of reducing and preventing problems such as stereotypies and ARBs is environmental enrichment (Clubb *et al*., 2007).

Behavioural Needs

While there has been minimal direct study of kākā behaviour in captivity relating to stereotypies, there have been studies of the closely related Kea (*Nestor notabilis*) which has been shown to benefit greatly from enrichment (Orr-Walker, 2010). As two highly intelligent parrots, both species will benefit from enrichment in captivity; however, techniques and enrichments used may have subtle differences between species due to the difference in life history and neophobia of kākā (Bond & Diamond, 2004).

The natural behaviours of kākā resemble those of most wild parrots and include flying, feeding, foraging, drinking, preening, bathing, perching, nesting, roosting, shelter/retreat, play, exploration, social interaction and breeding. Defining the behavioural needs of the captive population is institute-specific and is not solely dependent on the life history and natural behaviours of the animals. With regard to the importance of encouraging and stimulating the expression of different natural behaviours, the objectives of keeping the animals in captivity must first be defined. A captive institute

which has no intention of breeding and releasing their captive animals will have different enrichment priorities of behaviours to encourage than one which aims to breed their population with the goal of release. While it may be ideal to aim to encourage the animals to express as many natural behaviours as possible, it may not be practical or feasible to encourage all-natural behaviours as some behaviours are not relevant to a long-term captive situation. An example of this is encouraging flight behaviour in response to danger or predatory threat if there is no intention to reintroduce them to the wild. This will influence the type of enrichment items and activities which are integrated into a programme depending on the specific situation of the animals in each captive institute.

Enrichment Programmes

Enrichment should aim to stimulate natural behaviour including play, foraging, nesting, roosting and social interaction. It is defined as "an animal husbandry principle that seeks to enhance the quality of captive animal care by identifying and providing the environmental stimuli necessary for optimal psychological and physiological well-being" (WAZA, 2005, pp. 63; Shepherdson et al. 1998 cited in Janssens *et al*., 2007). The New Zealand Animal Welfare (Zoos) Code of Welfare adds that enrichment aims to provide "cognitive challenges, allow opportunities for appropriate social interaction and exploration, give animals some control over their environment, and meet species-specific behavioural needs, through the provision of shelter, and opportunities for hiding, foraging and exercise" (NAWAC, 2005, pp. 8). Enrichment does not have to be extraordinarily complex and can be implemented simply and at a low cost when it forms a fundamental part of the animals' husbandry regime, yet it is still the task which is most likely to be overlooked when a zoological park faces difficult times (Field & Thomas, 2000).

Enrichment has been shown to effectively decrease stereotypies when implicated for captive Psittacines and is effective in alleviating some of the causes of such maladaptive behaviours such as boredom and resulting frustration (Bauck, 1998; Field & Thomas, 2000; Clubb *et al*., 2007). Careful planning of an implementation strategy is necessary; however, it is often the simplest enrichment that is the most successful (Field & Thomas, 2000). Field and Thomas (2000) also recommend that enrichment should be factored in right from the design of the enclosure and husbandry regime and should not just constitute an occasional puzzle in the enclosure. Enrichment can be broken into five categories, nutritional, sensory, physical, occupational and social (Orr-Walker, 2010) which can then be grouped under inanimate enrichment for the first four and animate for the fifth because it involves interaction with con-specifics as well as humans (Janssens *et al*., 2007).

Occupational

Occupational enrichment involves the kākā investigating, interacting with and manipulating enrichment elements to stimulate them mentally and relieve boredom. Enrichment is important to provide captive birds with exercise for energy expenditure as whilst wild birds forage for extended periods and move between foraging sites, captive birds are less active and have little need to spend large amounts of time foraging (Elson & Marples, 2001; Orr-Walker, 2010). Toys and objects to investigate made from natural materials sourced from the forest such as flax, pine cones and logs make great enrichment for kākā (Berry, R. Pers comms. August 2012). Food hidden inside or attached to these toys increases time spent interacting with them. The concept of puzzle feeders here means that the extended foraging times in the wild can be mimicked to an extent by having to solve a puzzle

to gain food. Relating the enrichments to foraging is an integral part of kākā enrichment as a study by Bond & Diamond (2004) found that kākā rarely interact with objects not in a foraging context.

South Island kākā have been documented to spend over two hours, or over a third of their daily foraging time digging for Kanuka Longhorn beetle larvae of *Ochrocydus huttoni,* large Huhu-like grubs in mountain beech tree trunks (Beggs & Wilson, 1987). It is interesting to note that to copy this activity the researchers had to use hammer and chisel to recreate the kākā excavating the live wood to access the larvae. Both live and dead wood will provide enrichment for kākā to express natural foraging behaviour and combining this with either hidden food items or releasing commercially reared live invertebrates and larvae into the enclosure would have nutritional and environmental/physical enrichment benefits (Mills, pers comm, June 2012). Captive facilities use pine cones filled with nuts, dates and other food items with hooks screwed into the bases to hang around the enclosure. Food is also placed in a dish concealed under a lid which only opens when the kākā sit on the appropriate perch that allows access to the food via the bird's weight and a lever. This also ensures against rodents and wild birds which may enter the enclosure to feed on the captive birds' food. Elsewhere, woven flax balls as well as wire cages containing food are used as enrichment for native birds including kākā (Auckland Zoo, 2010).
Occupational enrichment involving food not only stimulates manipulation skills, it also increases food handling time to better mimic the activity budget in the wild (Field & Thomas, 2000). While puzzle feeders provide useful enrichment, it is also important to provide adequate nutrition in addition in case some birds miss out because of refusal, neophobia or dominance status (Field & Thomas, 2000).

Physical
Physical enrichment includes adding to the existing captive environment by planting native vegetation and using different substrates and furnishings (Orr-Walker, 2010). Particularly relevant to birds are perches, which should be natural but of varying size, shape, height, angle and distance apart and some should be suspended and mobile and others sturdy to encourage flight, exercise of balance, movement and exploration (Field & Thomas, 2000). Many keepers of kākā plant native vegetation in their enclosures and ensure that natural substrate such as rotten logs, branches, seasonal flowers, fruits and berries are introduced regularly (Berry, R. Pers. Comm. August 2012). Comfort behaviours can be facilitated by providing perches on which kākā can preen and water features, whether a stream or bath, for the kākā to bathe themselves or assist in thermoregulation in hot weather.

Novel objects should be introduced regularly into the enclosure to stimulate curiosity, investigation and interaction. Ensuring none of the objects are toxic, many seemingly mundane objects to humans can be enriching for parrots. Examples range from tops of pineapples with some fruit attached, cardboard boxes and tough material for them to chew and destroy (Field & Thomas, 2000). The only problem here for kākā is how natural the enclosure needs to be in the sense that some objects may appear out of place to the public or create a messy enclosure. As public awareness of animal welfare and perception of enrichment increases, pressure for all-natural enrichment elements which fit with the habitat increases (King, 1999). Thus, public perception of non-natural enrichment objects, irrespective of the benefit to the animal, may detract from the message – generally of conservation of nature – that the captive institute is trying to portray (King, 1999; Clubb et al., 2007).

Sensory

Stimulating the senses of animals can help alleviate boredom and encourage exploratory behaviours.

Olfactory (smell): Preliminary studies into the significance of olfaction in the ecology and life history of kākā have conclusively found it to be important (Brunton, Gsell & Hagelin, 2012). This gives scope for the use of scents such as spices, herbs, other animals' scents and perfume to add interest to their surroundings and to encourage investigation. It is important to note however that overly-strong odours may have a counter-productive effect as instinct will dictate caution and avoidance of potent, unfamiliar scents, as found in the study by Brunton *et al*. (2012).

Taste: In the same way as olfaction can be used as enrichment, so too can varying flavours by varying food items offered, and using extracts (lemon, vanilla, honey) to flavour water in order to add interest to food presented (Orr-Walker, 2010).

Visual: Providing visual stimulation via a mirror, objects in the enclosure, use of colour and lighting adds interest to the enclosure and may stimulate exploratory behaviour.

Auditory: Music and con-specific calls are suggested by Orr-Walker (2010) but also a recording of forest sounds can be used to provide enrichment using sound.

Tactile: Using different materials and objects of varying textures, in the enclosure to promote investigative and exploratory behaviours.

Nutritional

While the nutritional requirements of kākā have been covered in the nutrition and diet section, in addition to providing adequate nutrition, food is the most common environmental enrichment device used in zoos. Adult kākā, although having a foraging strategy specialised to the forest canopy, are opportunistic omnivores meaning that a range of foods can be used as enrichment including sugar water, jam and honey, fruit, vegetables, nuts, seeds, ice blocks, and mealworms and it is important to vary the type and presentation of food to stimulate foraging (Field & Thomas, 2000; Orr-Walker, 2010). Offering multiple feeding stations means that dominance of feeding stations will have less of an impact on less dominant kākā and has been shown to reduce aggression in other parrots (Field & Thomas, 2000).

Ideas for nutritional enrichment include but are not limited to:

- Fruit kebabs & strings of food items on thick string, rope or wire threading by drilling holes into nuts, fruit, vegetables.
- Use of treats or regular food in puzzle feeders
- Fruit frozen into ice blocks for hot weather
- Cages containing food items
- Commercially reared invertebrates released into enclosure
- Pinecones stuffed with treats such as dates, nuts and fruit, hung around enclosure

- Harder fruit and vegetables (cabbage, coconut) stuffed with other food items as a natural puzzle
- Feeder ball – a woven flax ball with one hole which must be rolled around for treats/food to be obtained or no holes which must be opened
- Hanging a sack (materials can vary – leather, hessian, hemp, paper) containing food
- Hammering nails in different locations in enclosure to spike fruit and vegetables onto
- Foraging trays whereby seeds, and nuts are hidden amongst bark and leaves in a metal tray to encourage foraging behaviour

(Auckland Zoo, 2010; Bauck, 1998; Field & Thomas, 2000; King & Wilkinson, 2006; Orr-Walker, 2010; Wellington Zoo Charitable Trust [WZCT], 2008; Goddard, pers comm. August 2012; Mills, pers comm. June 2012).

Social

Social enrichment involves elements which require cooperation of multiple birds. As social play is less prevalent in adult kākā, this strategy may work better in enclosures of juvenile and sub-adult kākā (Bond & Diamond, 2004). These enrichments involve kākā working together to receive a food reward in a puzzle which cannot be resolved by a single kākā. While these work for Kea (Orr-Walker, 2010) it is uncertain how useful they would be for adult kākā. The keeper can get involved directly in kākā enrichment in having the birds watch them burying an item or manipulating one to encourage investigation by the kākā and foster interaction between keeper and kākā (Orr-Walker, 2010). Certain enrichments however may be counter-productive in relation to breeding for release as encouraging interaction with humans will not benefit kākā post-release (Clubb *et al*., 2007). Walk-through enclosures are also an idea to add enrichment to an enclosure through interaction with visitors, provided there is ample space and shelter for the kākā to retreat if necessary to minimise stress and give the kākā a certain degree of control over the situation in the event that they need to be away from people (Orr-Walker, 2010). Vegetation can provide a visual barrier between both con-specifics and humans and kākā (King & Wilkinson, 2006).

Enrichment Considerations

While enrichment has the aim of satisfying the behavioural needs of the animal through stimulation of natural behaviours, enrichment requires careful consideration before implementation. The following are some considerations necessary for kākā enrichment.

The feeding enrichments may pose an overfeeding risk to the kākā if treats or high calorie foods are not removed from the base diet when used in the feeding enrichment (Field & Thomas, 2000). Depending on the activity level and energy expenditure of the birds in question this could lead to obesity if left unchecked (WZCT, 2008).

Durability and safety of materials regarding toxicity, potential for injury and destruction also need to be considered when designing enrichment items (Bauck, 1998). Enrichment objects must be of some interest value to the kākā if they are to be effective enrichment, as if they are not attractive they may be ignored and ineffective.

Conversely, neophobia is an issue that needs to be addressed in captive populations that may not have had much enrichment experience. Bond & Diamond (2004) report how wild kākā adults are highly neophobic meaning this is a necessary consideration when planning to introduce novel enrichment objects. Beginning regular enrichment when kākā are young may help alleviate this neophobia. Fear, if continuous, can result in injury through panic, physiological implications of stress, and inefficient energy use and can be caused not only by novelty but by changes in keepers and fluctuating visitor numbers (Meehan & Mench, 2003).

Cost to the kākā of enrichment during winter needs consideration. Depending on the microclimate of the captive institute, providing energy taxing enrichment when it is cold has potential to be detrimental if the birds are expending more energy than they consume or gain from the enrichment activity which could lead to thermoregulatory problems (Field & Thomas, 2000). It has been shown that parrots will show a preference to obtain food from an enrichment device over a tray of food and therefore could face energy imbalances in winter (Elson & Marples, 2001).

Information regarding enrichment programmes will be beneficial to the public's impression of the enclosure, animal welfare and the institute itself. Whether by a sign or by a presentation by the keepers, enrichment items should be explained to the visitors to enable them to understand the presence in the enclosure of objects which seem unnatural for the animals they are viewing if non-natural enrichment objects have been used. Education is very important to inform the public of the institute's priorities, whether it is a purely naturalistic habitat to promote the animals' natural behaviour in their wild habitat and promote its conservation, or to mix that with the priority of stimulating the animals' natural behaviours which entails the use of a foreign object.

Recommendations

The enrichment programme scope and complexity are going to be limited by the situation of the institute and therefore be largely institute-specific. Time and financial resources, expertise and management are limitations that will vary between facilities however minimum standards are important to ensure some form of basic enrichment is used. The minimum standard for enrichment should be sufficient to reduce (if present) and prevent stereotypies and ARBs and encourage a more natural and wider behavioural repertoire. At the very least, food items should be varied in both type and presentation and if varying feeding times is not possible this should happen twice a day. Enrichment objects should be introduced and changed in the enclosure at least twice a week and a new browsable plant or large log be introduced every month to minimise boredom and frustration but at the same time ensuring the safety of enrichment initiatives with careful planning and research. Positive interactions with keepers will be beneficial. Best practice would involve beginning enrichment early in life for captive kākā to ensure that neophobia is minimised. Previous sections offer information on enclosure design and nutritional requirements of kākā and variety of these food items and presentation is preferable including the use of suitable puzzle feeders and ways of making the kākā work for food. A food source should always be provided as back up to ensure adequate nutrition. The addition of natural materials such as logs, foliage and browse very regularly to enrich the enclosure without excessive change is preferable for kākā exhibiting neophobia towards enrichment objects. Ensuring enrichment objects are changed before closing time will allow for the highly active period in the evening of kākā would help occupy the hours when the zoo is closed. Keeping the enrichment

programme varied and unpredictable with use of enrichments from all five categories as enrichment is only limited by imagination (Field & Thomas, 2000).

Minimum Standard 11.

Enrichment.

Daily enrichment must be provided on a on a rotational unpredictable adlib basis with a minimum of 1 item from 3 different types of enrichment supplied per day (nutritional, occupational, physical/sensory or nutritional, social and occupational etc)

5.3.4 Handling/physical restraint

Capture and Handling

Kākā in aviaries can be captured in various ways, the most common of which is with a hand net. When using a net, the handler must be careful not to strike the birds with the solid part of the nets as these may cause serious injuries (Hoffmeister, 2011). Alternatively, nets may be padded to reduce the chance of injury to the birds. Multiple people may be required to corner the bird if it is too difficult to catch (N. Ackroyd, *pers. comm.,* 1-8-2012).

It is also possible to condition kākā to enter a crate (K. Goddard, *pers. comm.,* 3-8-2012), therefore avoiding potentially dangerous contact between the handler and the bird.

Feed Station trapping is also a method of capture for kākā in captivity. The feed station used has attachable back, side and bottom mesh panels and sliding trap door at the front of the station. The panels can be permanent or attached on the feed-station several days before the capture. A simple trigger system consists of a pin to keep the door open and tied to a piece of fishing line or thin string. This line can be pulled once the bird is in the trap. The pin falls and releases the door, which quickly slides shut. The bird is then removed immediately. Two people are required for this procedure. One person reaches into the trap to catch the bird, while the other person holds the towel or net around the door to prevent escape.

Cage trap set on feed-station (Auckland Zoo)

Care should be taken when both capturing and handling any birds, as their bones are hollow (pneumatised) and therefore fragile and easily broken (Hoffmeister, 2011; Melville, 2011). Kākā also have sharp talons and beaks that can cause serious injuries to handlers if appropriate precautionary measures are not taken. Handlers should also be aware of other potential risks to themselves such as pathogens in the faeces (Melville, 2011). Contact with the birds should be minimised to reduce potential risks to both the bird and the handler, and to reduce the amount of stress placed on the bird (Melville, 2011). When handling is absolutely necessary, the standard parrot holding technique can be used. Handlers should restrain the bird with an appropriate amount of force, the general rule being 'gently, but firmly' (Melville, 2011). One hand should restrain and support the bird's head, using the thumb and middle finger to hold either side of the mandible (Hoffmeister, 2011). Special care should be taken not to crush the eyes or crop while holding the head in this way (Hoffmeister, 2011). The other hand should be used to restrain the bird's legs. To avoid crushing their legs and to maximise restraint the handler's fingers should be placed between the legs (Hoffmeister, 2011). Therefore, a minimum of two people is needed when handling kākā. A clean towel or equivalent can also be used to wrap around the birds wings to increase security of restraint and also to cover the birds head to reduce stress. The surrounding environment should be kept as quiet as possible to further reduce the amount of stress placed on the bird while being handled. It is recommended that only someone fully trained in handling kākā should physically restrain the birds (Hoffmeister, 2011), however if this is not possible anyone with bird handling experience may be used.

When handling a bird to weigh, it is suggested that the bird is placed in a sturdy material bag (e.g a pillowcase) (N. Ackroyd, *pers. comm.,* 1-8-2012). The bird will be much calmer as it cannot see its

surroundings, and a more accurate measure of weight can be taken as the bird should not be moving around as much. Darker coloured bags are ideal, as they will put the birds into complete darkness, so stress will be minimised.

Minimum Standard 12.

Handling/physical restraint.

- No one should handle kākā without first having been trained and supervised by someone experienced with handling the species. Kākā require special care when being handled because they can seriously injure handlers with a bite from their beak.
- Restraint of birds must be for husbandry and/or research purposes
- Records must be maintained stating reasons for restraint, outcomes and techniques used

5.4 Feeding Standards

Food Hygiene

A high standard of food hygiene must be maintained to prevent food contamination, spoiling and possible transmission and proliferation of disease-causing organisms (Collen, 2010; Hoffmeister, 2011). Important hygiene measures include: providing fresh fruit and vegetables and storing them in a refrigerator along with other perishable food (MAF, 2005; Hoffmeister, 2011); storing seeds and dry food products (such as nuts and nutritional supplements) in airtight, rodent-proof containers; washing food and water bowls daily (King & Wilkinson, 2006); making sure that utensils and surfaces used for food preparation are clean at all times (MAF, 2005; Hoffmeister, 2011) (all washing and cleaning should be done using a non-toxic detergent, followed by thorough rinsing with water to wash off the detergent before drying) (Orr-Walker, 2010); having separate chopping boards and utensils for meat and fruit/vegetable preparation; cleaning feed stations and picking up dropped or discarded food to prevent a build-up of organic matter (Orr-Walker, 2010); and checking expiry dates of perishable food (Hoffmeister, 2011).

5.4.1 Diets and supplements

Diet

It is important to provide captive kākā with a diet that has a nutritional content as similar as possible to the wild kākā diet to avoid dietary-associated health problems due to nutritional deficiencies or excesses (MAF, 2005). The best way to achieve this would be to duplicate the wild diet, however this is not feasible in captive situations as many of the food items this diet consists of are not readily available or cultivated in large enough quantities to sustain captive populations of kākā (King & Wilkinson, 2006). Therefore, in captivity, artificial diets should be formulated that consist of dietary items that can be sourced in adequate quantities and that meet the nutritional requirements of

captive kākā (Orr-Walker, 2010); these requirements include appropriate proportions of vitamins, minerals, proteins, carbohydrates, fats and water throughout all life stages. Since wild kākā have broad diets (O'Donnell & Dilks, 1994; Moorhouse, 1997), the captive diet should be varying and flexible with different items added, removed or substituted based on seasonal availability; however, when doing so, it is important that the combination of food items provided still fulfils these nutritional requirements. It is also important to provide food similar to that eaten by wild kākā so that natural feeding behaviours can be expressed (MAF, 2005; Hoffmeister, 2011).

Recommended Diets

Captive kākā should be fed an artificial diet 1-2 times daily. This diet should consist of fruit, vegetables, seeds, invertebrates (or a protein supplement) and a nectar substitute (specific examples of captive kākā diets are shown in the **Appendix 4**). Enough food needs to be provided so that a small quantity is left behind after each feeding; the amount provided should vary seasonally and individually with monitoring undertaken so this quantity can be altered as required (MAF, 2005; Orr-Walker, 2010; Hoffmeister, 2011). The fruit and vegetable component of the diet should be chopped up into pieces large enough to be picked up and manipulated by the kākā with care taken to remove all labels off fruit (Hoffmeister, 2011). The nectar substitute should be provided ad libitum (as well as water) and can be formulated in a variety of ways as shown in Table 2 in **Appendix 4**. Treat items such as nuts (however, see below the caution on using nuts, especially when adults are feeding chicks) can be offered as rewards when undergoing training; these items however are high energy foods and therefore should only be offered in small quantities to prevent overindulgence and subsequent weight gain (Orr-Walker, 2010; Hoffmeister, 2011). The artificial diet should also be supplemented with natural browse and rotten logs to enable the expression of natural foraging behaviours (Berry, 1998; Hoffmeister, 2011).

In the past captive diets often contained cheese, corn and large quantities of nuts or peanuts. Cheese, along with 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**.

5.4.2 Presentation of food

Solid food should be presented in metal dishes (such as stainless steel) as they are durable and easily cleaned. Ideally one dish should be provided per bird and each dish should be placed at one of multiple feeding stations within the enclosure (Hoffmeister, 2011); this helps to reduce aggression between the birds whilst feeding by making sure that both dominant and subordinate birds have access to food (MAF, 2005; Hoffmeister, 2011). Feeding stations should be raised up off the ground at a height of approximately 1.5m (as in the wild kākā forage in the trees and rarely come to the ground) (O'Donnell & Dilks, 1994) and it is recommended that these stations are covered to prevent food becoming wet and mouldy. Like solid food, nectar can be presented in metal dishes; alternatively, nectar can be provided within water dispensers (such as those used for pet rabbits and rodents) (Berry, 1998). These dispensers act as a source of enrichment for the kākā by encouraging them to engage in an activity that provides some mental stimulation. Some kākā sites use "Grandpas Feeders" which are a metal feeder that is opened when a feeding bird stands on an attached treadle.

Additional sources of enrichment can be provided by: hiding food within objects such as pine cones, digging trays, woven flax balls, logs, treat balls, bamboo tubes, hanging cages and puzzle feeders; scattering food around the enclosure; providing fruit kebabs and "fruitsicles" (fruit frozen within blocks of ice); hanging corn cobs; and providing whole large fruit and vegetables (Bauck, 1998; Jenkinson, Friedman & Whybrow, 2004; Hoffmeister, 2011). In addition to these artificially created forms of enrichment, natural items can also be provided to stimulate the kākā. For example rotten logs enable kākā to forage for grubs, and planting the enclosure with vegetation eaten by wild kākā that produce berries and/or nectar (such as *Coprosma* species, flax (*Phormium tenax*), manuka (*Leptospermum scoparium*), supplejack (*Ripogonum scandens*) and kowhai (*Sophora microphylla*)) (Berry, 1998; O'Donnell & Dilks, 1994) enable the expression of natural foraging behaviours.

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*), tutu (*Coriaria arborea*), poroporo (*Solanum aviculare/S. laciniatum*) and karaka (*Corynocarpus laevigatus*).

5.4.3 Seasonal/breeding changes in feeding requirements

In institutes which breed kākā, it is recommended that before and during the breeding season the nutritional content of the diet is adapted to fulfil breeding requirements. For example, food items high in calcium should be offered to assist eggshell formation and the development of healthy embryos (Orr-Walker, 2010). Additionally, protein-rich foods, such as eggs, should be offered to fulfil increased energetic demands during this time (King & Wilkinson, 2006). These demands can also be met by increasing the amount of nectar offered to breeding pairs (in addition to providing protein-rich foods). Nectar provision is particularly important before the breeding season because in wild kākā reproductive success has been found to be directly related to the amount of honeydew consumed prior to breeding (Beggs & Wilson, 1991; Hoffmeister, 2011). Offering a nectar mix as a substitute for honeydew should therefore also aid captive reproductive success as like honeydew, nectar is a high energy carbohydrate (Beggs & Wilson, 1991).

In addition to these changes to the nutritional content of the diet, the frequency and amount of food provided to breeding pairs should also be increased (Orr-Walker, 2010). This predominantly benefits female kākā by making sure they are in good breeding condition and are thus able to produce and rear healthy chicks (King & Wilkinson, 2006). Examples of two breeding season diets provided by captive institutes that have had reproductive success with captive kākā are shown in Tables 3 and 4 in **Appendix 4**. These diets are provided to breeding pairs in addition to the regular diet.

Food Hygiene

A high standard of food hygiene must be maintained to prevent food contamination, spoiling and possible transmission and proliferation of disease-causing organisms (Collen, 2010; Hoffmeister, 2011). Important hygiene measures include: providing fresh fruit and vegetables and storing them in a refrigerator along with other perishable food (Hoffmeister, 2011; MAF, 2005); storing seeds and dry food products (such as nuts and nutritional supplements) in airtight, rodent-proof containers; making sure that utensils and surfaces used for food preparation are clean at all times (Hoffmeister, 2011; MAF, 2005); washing food and water bowls daily (King & Wilkinson, 2006); all washing and cleaning

should be done using a non-toxic detergent, followed by thorough rinsing with water to wash off the detergent before drying (Orr-Walker, 2010); having separate chopping boards and utensils for meat and fruit/vegetable preparation; cleaning feed stations and picking up dropped or discarded food to prevent a build-up of organic matter (Orr-Walker, 2010); and checking expiry dates of perishable food (Hoffmeister, 2011).

Diet

Diet is often the predominant factor which is manipulated to encourage breeding. The availability of liquids (jam water/Wombaroo mix) can be limited during the non-breeding months of the year, and then reintroduced daily when the breeding season starts. This reassurance that food is plentiful enough to feed chicks may encourage the kākā to breed (Pers. Comm. Raelene Berry, 2012).
In addition to these changes to the nutritional content of the diet, the frequency and amount of food provided to breeding pairs should also be increased (Orr-Walker, 2010).

Seasonal Changes

Dietary changes should also be made according to season. In the wild, kākā alter their diet according to seasonal availability of food items and nutritional requirements (Moorhouse, 1997; O'Donnell & Dilks, 1994); therefore, in captivity food variation should also be provided with seasonal fruits and vegetables offered in combinations that adequately fulfil these nutritional requirements (Hoffmeister, 2011). For example, in winter and early spring, the fat content of the diet should be increased by providing additional nuts (nuts must be reduced once adult are feeding chicks). Also, when natural browse is fruiting and/or flowering, if possible, branches should be acquired and incorporated into the kākā enclosure to simulate a natural environment and thus enable the expression of natural foraging and feeding behaviours (Berry, 1998). These dietary changes also ensure that captive kākā remain healthy as well as providing some mental stimulation for the birds by making life less predictable and routine (Orr-Walker, 2010).

Minimum Standard 13.

Feeding Standards.

Novel foods must be checked to ensure they are not toxic to kākā.

Quantity and types of food must be of an amount to allow for a complete and balanced diet and must provide the following daily:

- Enough food that a small amount is left over after feeding. This will vary seasonally and individually and should be monitored and adjusted accordingly.
- The following food groups should be represented daily in decreasing amounts: cereals and whole grains, fresh greens and vegetables, proteins, fresh fruits and seeds, treats (nuts). High energy foods such as nuts may also be used in limited quantities for training.
- Browse items

Presentation of food

- Food must be presented 1-2 daily (in addition to browse) in two different forms to encourage active foraging throughout the enclosure
- Food in the form of enrichment items and/or browse must be provided at the end of each day to illicit foraging at high activity times (dusk and dawn)

Seasonal/breeding changes in feeding requirements

- Additional nutrients must be provided for breeding pairs particularly during egg production and chick rearing
- Breeding females must be provisioned with additional calcium supplements prior to and during egg laying

Food hygiene

- All foods must be stored appropriately to ensure they remain fresh and free of pests
- All food preparation areas must be kept clean and hygienic

Routine weighing is to be undertaken as part of weekly training sessions and individual bird weights recorded to monitor food intake.

5.5 Breeding Requirements

While captive populations are established for many reasons, such as conservation, education and research, captive breeding also provides a means for conserving species that may not survive in the wild. Such programs aim to establish a healthy and stable captive population of the species in

question. One of the main aspects of establishing a species in captivity is breeding and rearing of young ones. Whether the offspring are raised for a captive future or wild releases, their growth stages and requirements along with how they are managed play an important role in their development into adults.

Kākā breed between the months of September and March (in the wild this is usually following a masting year or a period of high food productivity); this is generally about once every 4 years (Powlesland *et al*., 2009). In captivity they can be encouraged to breed more frequently than this, and are able to because food availability is more consistent. They reach sexual maturity at about 3-4 years of age; however, they sometimes breed younger at release sites where supplementary feeding is available (Pers. comm. Raelene Berry, 2012). Clutches of 2-4 eggs are usually produced, two clutches in a year can occur if food availability is high. The eggs are incubated by the female for about 28-30 days; during this period the male provides her with food. Brooding lasts for approximately 15 days, with fledging usually at around 65-75 days of age. When the chicks leave the nest, they cannot fly and are ground ridden for around the first week (Powlesland *et al*., 2009).

5.5.1 General behavioural notes; forming new pairs

Developing New Social Groupings

Caution and quarantine procedures should be taken when changing or introducing new individuals into social groups and observation is necessary to monitor the situation (King & Wilkinson, 2006) preferably in the morning to allow a whole day's observation (Orr-Walker, 2010).

Captive pairs sometimes take longer to breed as they are usually forced pairings. There has been talk of creating group flock situations where kākā can choose their own mates; however, this is subject to resource availability (Pers. Comm. Raelene Berry, 2012).

5.5.2 Nesting/breeding requirements

Nest boxes

Nest box design and construction has varied between sites with several designs and mounting methods. 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 (note: Te Anau constructed a PVC box with an internal diameter of 375mm and found it quite small for a clutch of 4, so this diameter is to be used as a guide). 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 an inspection door on the lower end of the nest box (to allow nest inspections, chick banding and cleaning). Pūkaha Mount Bruce, Zealandia and Cape Sanctuary have used PVC pipe for constructing nest boxes whereas at Orokonui boxes were constructed out of untreated timber (macrocarpa). PVC pipe nest boxes will likely last longer whereas timber boxes will be chewed, along with deteriorating over time due to weathering.

Kākā Nest Box Used at Pūkaha National Wildlife Centre

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.

Nesting sites

For captive breeding programmes to be successful, it is important to provide reliable nesting sites and roosting assemblages in the captive environment. Kākā should be enabled to breed in quiet and appropriate nest sites, without access, disturbance or viewing by the public. Nest boxes and specifically allocated breeding sites are preferred and should be fenced off (Bell & Merton, 2002). Keepers need to be able to reach nest sites and the enclosure, with minimal disturbance to the animals.

In many captive facilities that hold kākā, old and rotting logs are in place which the birds use for nesting in (J. Simister, personal communication, August 12, 2012). The majority of facilities primarily use multiple artificial nest boxes as a type of nesting cavity (A. Richardson, personal communication, August 6, 2012). To maintain wild behaviour, natural cavities would be advantageous; however, in off-display enclosures, artificial nest boxes may prove to be more hygienically and practically functional than natural nest sites.

Nest Boxes/Set up:

In the wild kākā would make nests in hollow trees (Powlesland *et al*., 2009). In a captive setting, nest boxes should be provided for this purpose with an appropriate substrate covering the bottom e.g. wood shavings (the wood shavings used in nestboxes need to be from natural/untreated timber source as female and chicks may ingest them). If the chicks are being bred for release and nest boxes are going to be provided at the release site, these nest boxes should be the same style as those they were reared in. This will encourage them to recognise the release site as a good place to establish themselves and nest (Pers. Comm. Raelene Berry, 2012).

Hand rearing should be avoided to avoid imprinting and approval must be given by the species coordinator. If hand rearing is required, strict procedures should be followed.

Monitoring during breeding/rearing:
Food intake needs to be monitored while the chicks are being reared; it is suggested that an additional feed is added once the chicks are hatched (Pers. Comm. Raelene Berry, 2012). It is important to keep track of the dates when eggs are laid, so that an expected hatch date can be prepared for. Hatch dates also need to be recorded so that age is accurate, growth and progress can be monitored and a fledge date can be estimated (Pers. Comm. Raelene Berry, 2012).
Nest box baskets should be changed regularly to keep sanitary; weighing and general health checks should be done at this time to minimise disturbance.

5.5.3 Requirements of young

Development of young
Developmental requirements differ from species to species. For example, kiwi chicks are unusually mature and feeding on their own since the time they hatch, and leave the nest at 2-4 weeks of age (Fraser, 2011). Kākā fledglings on the other hand are dependent on parents for food for almost half a year (Moorhouse & Greene, 1995). Moorhouse (1995) classified kākā into four age groups; fledglings, these are less than five months and are completely dependent on adults for food, juveniles which are five months to a year old and mostly independent of adults, sub adults which are one to four years of age, independent and sexually immature, and lastly adults over four years old. Providing the right care for young chicks in captivity can be challenging.

South Island Kākā Chicks. Image: **Natureland**

Nestlings are mostly fed by females by regurgitating food, and the young exhibit a begging response consisting of high pitched calls that are interspersed with guttural coughing or choking sounds. During this time, the females are fed by the males. Food type for the chicks rely mostly upon what is available to the parents, even though it is important to provide a balanced diet to not just the chicks but parents also (Moorhouse, 1997). The chicks fledge at almost 10 weeks of age and will spend their first few days on the ground, mostly hidden in trees or shrubs. Thus, it is essential to provide enough hiding space and habitat for the chicks in the enclosure. Care also needs to be taken when walking around the aviary at this time, so fledglings don't accidentally get stood on (they can blend in with vegetation). They usually begin to fly 3-8 days after leaving the nest. Fledglings are then able to be fed by both parents. The young are dependent on the parents for food for about a month after fledging (Moorhouse & Greene, 1995). Around 4-5 months later, when the young are at the juvenile stage, they will investigate and consume food provided to adults. The parents will make sure to feed a right mixture of food and water to the chicks in correct quantities and intervals, thus ensuring good development (Koutsos, Matson, & Klasing, 2001).

5.5.4 Methods of hatching/rearing/manipulation

Captive kākā breeding is controlled by a national captive breeding co-ordinator who is normally associated with an established captive facility or organisation (e.g. Pūkaha Mount Bruce or the NZ Zoo and Aquarium Association). This is necessary to ensure that all captive kākā are managed as a single flock thereby ensuring maximum genetic diversity within the captive population and avoiding inappropriate breeding. The captive kākā programme is being reviewed (as of 2016) and it is currently unclear if breeding pairs will be available to sites wanting to establish kākā populations. Breeding kākā on site also requires additional skills and resources compared to just holding captive birds for release. 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.

5.5.5 Methods of controlling breeding

Breeding Control

The Animal Welfare for Zoos Code of Welfare states that as the minimum legal standard, breeding needs to be controlled to prevent overpopulation or overcrowding (MAF, 2005). When breeding is required to be controlled, dummy eggs are often used to replace viable ones (Pers. Comm. Raelene Berry, 2012). However, breeding is not often required to be controlled, and techniques to encourage breeding are often used.

Further discussion is required to whether diet can be used to control reproductive preparedness. In the wild when there is no protein kākā don't breed; this could be applied in the captive situation to either create breeding or to supress it naturally.

Minimum Standard 14.

Breeding Requirements.

Breeding must only be carried out by a facility who has obtained a breeding recommendation from the Captive Coordinator.

Maintaining or forming new breeding pairs

- The formation of new breeding pairs must be undertaken and monitored by competent, confident personnel following appropriate protocol
- Records of protocol, observations and outcomes must be maintained during the introduction process

Nesting/breeding requirements

- Each year all birds (whether recommended to breed or not) must be provided with appropriate nesting areas and dry, clean nesting materials to allow expression of natural behaviours
- All birds (whether recommended to breed or not) must be provided with additional nourishment to ensure health during the breeding period
- Nesting pairs must be provided with a nest area which is undisturbed by the public (particularly important in public access enclosures) to ensure aggression and stress does not result.

Kākā chicks must be parent raised (unless otherwise approved by the Captive Coordinator)

Methods of controlling breeding

Reproduction must be controlled by one of the following methods (depending on social grouping):

- Removal of eggs from non – recommended breeding pairs and replacement with artificial eggs
- Maintenance of single sex groups (please note that holding of multiple females together will require standardised monitoring to be undertaken, due to increased risk of stress and aggression).
- Rendering eggs infertile by shaking, pricking or freezing. These eggs must be candled within 1-2 weeks to ensure they are not viable

5.6 Incubation/rearing young

All attempts should be made to have the chick's parent reared. However, in some cases where parents are unavailable (e.g. have died) cross-fostering or hand rearing can be used only if permission has been received from the Department of Conservation and/or the Species Coordinator. No kākā chick should be hand reared individually. During rearing kākā chicks must have a nest mate to avoid imprinting on humans.
See Incubation in **Appendix 5**

5.7 Transport Requirements
Transportation

When transporting kākā between captive institutions within New Zealand, a permit must be obtained from and sent to the Department of Conservation (DOC) or as a recommendation from the ZAA captive coordinator.

Kākā are a large powerful bird and can inflict serious injury on inexperienced handlers or be injured themselves. Therefore, if birds are captured as a component of the transfer then 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 transporting birds between capture and release sites, which is one of the riskiest stages of any translocation.
Under the Animal Welfare Act (1999) both the Animal Welfare (Zoos) Code of Welfare 2005 (MAF, 2005), and the Animal Welfare (Transport within New Zealand) Code of Welfare 2011 (MAF, 2011) must be followed when transporting any animals. The Animal Welfare (Zoos) Code of Welfare states that at a minimum the keepers or other relevant person must firstly inspect the animals to ensure that the animal is fit enough for transportation. It also states that the person in charge of the animal's safety and welfare during transportation must be identified and ensure that the security, health and welfare requirements of the animal is met. Finally, it states that where appropriate the IATA (International Air Transport Association) Live Animal regulations 2011 must be followed. Keepers in charge of transporting animals should also make sure that they comply and are familiar with all aspects of the Animal Welfare (Transport within New Zealand) Code of Welfare (MAF, 2011), as this document gives details on the minimum requirements for all aspects of transportation within New Zealand.

For the transportation of kākā, in particular it is recommended that a strong carry crate (e.g. wooden) is used for both international and national travel (K. Goddard, *pers. comm.,* 3-8-2012). Pet packs or bags (e.g. those used for weighing) can be used for shorter distances between enclosures (N. Ackroyd, *pers. comm.,* 1-8-2012; K. Goddard, *pers. comm.,* 3-8-2012), but are not recommended for long periods of time as they are not very secure. If a bird is already in some form of transportation device, it is recommended that it remains in here for transport if possible, to reduce the stress of transfer to another device.

North Island Kākā in Transport Box Prior to Release. Image: **Todd Jenkinson**

All transport containers must be fully labelled with the appropriate information of both the sender and recipient of the animal, including name, address and phone number (Hoffmeister, 2011). It is also important that a complete set of the bird's records including ZIMS/ARKS are kept with the bird, as well as any vet checks or other relevant health information (Hoffmeister, 2011).

Minimum Standard 15.

Transport Requirements.

Ensure appropriate transport containers are used. Over short distances kākā can be transferred in a solid carry cage with the following:

- Non-slip floor surface (newspaper/towelling/mat of a type not able to be ingested)
- Ventilation which does not allow the kākā beak access outside the cage
- Water supply with refilling capabilities on the outside of cage or suitable moist food available.

Ensure compliance with IATA container requirements where relevant. Air transport containers must comply with the principles specified for the relevant International Air Transport Association (IATA) container requirements

Ensure appropriate hygiene protocol during transfer. All transport boxes should be wiped down with disinfectant (e.g. Trigene) after use

6. RECORD KEEPING

6.1 Individual records

Animal records should be maintained electronically to make it easier to maintain a backup copy of all records and to facilitate their transfer to other holders and the Captive Coordinator. Ideally the software provided by the International Species Information System [ISIS] should be used. This is currently the Zoological Information Management System [ZIMS].

End of breeding season/studbook data reports

The success of the kākā captive management programme depends to a large extent on effective communication among holders and between holders and the Captive Coordinator. Holders must inform the Captive Coordinator as soon as practicable about any significant developments in the kākā programme at their institution (e.g. deaths, hatches, plans to increase or decrease the number of kākā enclosures etc).

At the end of the breeding season a summary of information collected by the holder during the season is submitted to the Captive Coordinator in the form of an end of breeding season/studbook data report (a template is sent out to all kākā holders by email by the Captive Coordinator). For those holders using ZIMS, a ZIMS taxon report for the requested timespan covers this requirement.

Minimum Standard 16.

Records.

An individual record must be maintained for every kākā ever held at an institution. This record must include the following information:

- Individual identifiers (e.g. band numbers, transponder numbers)
- Sex (if known)
- Sexing method (if known)
- Identity of Parents (if known)
- Origin (if wild caught or birth/transfer facility)
- Hatch date (if known)
- Arrival date at your institution
- Departure date from your institution (if applicable)
- Death date (if applicable)
- Cause of death (if applicable and known)
- Weights
- Notes on when faecal (or other) samples were taken and the results.
- Notes on health problems and treatments offered (if applicable)
- Important behavioural notes

An end of season report must be submitted to the Captive Coordinators for kākā each year, detailing developments. A template will be provided by the species coordinator for this purpose.

Information required:

- Records of kākā hatches, deaths and transfers at your institution
- Numbers of eggs produced by each breeding pair and the fate of those eggs
- Confirmation that the transfers, releases and breeding recommendations made in the previous year's Annual Report and Recommendations (ARR) were achieved (or at least attempted)
- Information on planned holdings and requests for more (or less) birds

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- Taxonomy, conservation status, wild population estimates, distribution, habitat and home range and genetic diversity in the wild. **Author: Amanda Fisher**
- Threatening processes in the wild and summary of wild mortality (Huia database summary), summary of conservation actions. **Author: Nicki van Zyl**
- Life history and social structure. **Author: Lena Olley**
- Reproduction in the wild. **Author: Kathryn Strang**
- Wild nutrition and feeding behaviour. **Author: Emily Craig**
- Captive nutrition including recommended diets and supplements, presentation of food, seasonal/breeding changes in feeding requirements and food hygiene. **Author: Karin Sievwright**
- Captive Enclosure Types including recommendations for size, materials for housing, shelter/screening/barriers, water, furnishings, vegetation and substrates, enclosure site and security. Author: **Carlijn Bouwman**
- Behavioural needs, enrichment programmes and training, management of social groupings. **Author: Alexandra Brighten**
- Health Care Standards including: environmental hygiene and cleaning, summary of captive mortality (Huia), preventative health measures, management of sick birds, dead specimens, quarantine procedures. **Author: Carolyn Rajan.**
- Capture, handling and transport recommendations. Identification methods. Sexing. **Author: Alaine Holdom**
- Facilitating breeding in captivity, including forming new breeding pairs, nesting/breeding requirements, controlling breeding. **Author: Tylee Reddy**
- Requirements and development of parent-reared young and hand-rearing guidelines, including preventing imprinting. **Author: Natasha Bansal**

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8. REFERENCES

Alley, M.R. (2002). Avian wildlife diseases in New Zealand: current issues and achievements. *New Zealand Veterinary Journal, 50*(3), 118-120.

Alley, M.R. & Berry, R. (2002). Twinning and embryonic mortality in a free-living kaka (*Nestor meridionalis*). *New Zealand Veterinary Journal, 50*(1), 39-39.

Auckland Zoo. (2010). *New Zealand native bird enrichment*. Retrieved from: http://www.aucklandzoo.co.nz/explore-the-zoo/enrichment/examples-of-enrichment-we-use-at-auckland-zoo/new-zealand-native-bird-enrichment.aspx

Bauck, L. (1998). Psittacine diets and behavioural enrichment. *Seminars in Avian and Exotic Pet Medicine, 7*, 135-140.

Beggs, J. (2001). The ecological consequences of social wasps (Vespula spp.) invading on ecosystems that have an abundant carbohydrate resource. *Biological Conservation, 99*, 17-28.

Beggs, J.R. & Wilson, P. R. (1987). Energetics of South Island kaka *(Nestor meridionalis meridionalis)* feeding on the larvae of Kanuka longhorn beetles *(Ochrocydus huttoni). New Zealand Journal of Ecology, 11*: 143-147.

Beggs, J. R., & Wilson, P. R. (1991). The kaka (*Nestor meridionalis),* a New Zealand parrot endangered by introduced wasps and mammals. *Biological Conservation, 56*, 23-38.

Bell, B.D. & Merton, D.V. (2002). Critically endangered bird populations and their management. In K. Norris & D.J. Pain (Eds.), *Conserving Bird Biodiversity: General Principles and Their Application* (pp. 105-138). Cambridge, United Kingdom: University Press.

Berry, R., (1998). Reintroduction of kaka (Nestor meridionalis septentrionalis) to Mount Bruce Reserve, Wairarapa, New Zealand. *Science for Conservation 89*, 1173-2946. Wellington, New Zealand: Department of Conservation.

BirdLife International. (2012). *The IUCN Red List of Threatened Species: Nestor meridionalis.* Retrieved 31 August 2012 from http://www.iucnredlist.org/details/106001412/0

Brunton, D. H., Gsell, A. C. & Hagelin, J. C. (2012). Olfactory sensitivity in Kea and Kaka. *Emu*, *112*, 60-66.

Cahill, J. (n.d). *Information on the avian DNA tests*. Retrieved 09 August 2012 from http://www.massey.ac.nz/massey/learning/departments/institute-veterinary-animal-biomedical-sciences/research/epagsc/epagsc_home.cfm

Chitty, J. (2011). Hospitalization of Birds and Reptiles. *Journal of Exotic Pet Medicine, 20*(2), 98-106.

Clubb, R., Mason, G., Latham, N. & Vickery, S. (2007). Why and how should we use environmental enrichment to tackle stereotypic behaviour? *Applied Animal Behaviour Science, 102,* 163–188.

Collar, N.J. (2000). Globally threatened parrots: criteria, characteristics and cures. *International Zoo Yearbook, 37*, 21-35.

Collen, R. (2010). *South Island Kaka Captive Management Plan 2010-2020*. Department of Conservation: Wellington, New Zealand.

Department of Conservation. (2009). *North Island Kaka.* Retrieved from: https://www.doc.govt.nz/nature/native-animals/birds/birds-a-z/kaka/

Department of Conservation. (2012). *Kaka: Current situation*. Retrieved 31 August, 2012 from http://www.mfe.govt.nz/environmental-reporting/biodiversity/indicator-species/kaka/

Department of Conservation. (n.d.). *The Project Kaka.* Retrieved from: https://www.doc.govt.nz/our-work/project-kaka/

Diamond, J. & Bond, A. B. (2004). Social Play in kaka (*Nestor meridionalis*) with comparisons to kea (*Nestor notabilis*). *Behaviour, 141*(7), 777-798.

Elson, H. L. G & Marples, N. M. (2001). How captive parrots react to foraging enrichments. *Proceedings of the 3rd Annual Symposium on Zoo Research,* 1-8. The North of England Zoological Society: Chester, England.

Field, D. A. & Thomas, R. (2000). Environmental enrichment for Psittacines at Edinburgh Zoo. *Int. Zoo Yb.* 37: 232-237

Garner, J. P., Meehan, C.L. & Mench, J. A. (2003). Isosexual pair housing improves the welfare of young Amazon parrots. *Appl Anim Behav Sci,* 81,73-88

Gaze, P.D. & Clout, M.N. (1983). Honeydew and its importance to birds in beech forests of South Island, New Zealand. *New Zealand Journal of Ecology, 6,* 33-37.

Greene, T. C. & Fraser, J. R. (1998). Sex ratio of North Island kaka (*Nestor meridionalis septentrionalis*), Waihaha Ecological Area, Pureora Forest Park. *New Zealand Journal of Ecology 22*(1)*,* 11-16

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 Journal of Ecology, 27*(2), 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 178*. Wellington, New Zealand: DOC Science Publishing.

Gregory, N.G. and Mellor, D. J. (2011). 194.343 *Applied Physiology and Animal Welfare: course material. Section 1; dimensions of animal welfare.* Institute of Food, Nutrition and Health, Massey University, Palmerston North, New Zealand.

Heath A.C.G. (2010). Checklist of ectoparasites of birds in New Zealand: additions and corrections. *Surveillance, 37*(1)*,* 12-16

Heather, B. and Robertson, H. (2015). *The Field Guide to the Birds of New Zealand.* Penguin Group NZ, Auckland.

Hess, E. H. (1964). Imprinting in birds. *Science, 146*(3648), 1128.

Higgins, P. J. (Ed.). (1999). *Handbook of Australian, New Zealand and Antarctic Birds. Volume 4. Parrots to Dollarbird* (pp. 623-632). Oxford University Press, Melbourne.

Hoffmeister, J. (2011). *Husbandry Protocol: North Island Kaka-Nestor meridionalis septentrionalis.* Unpublished Husbandry Manual: Wellington Zoo, New Zealand.

Holland, G. (2007). *Encyclopaedia of Aviculture*. Parrots, Chapter 14, Psittaciformes.

Jackson, J.R. (1963). Studies at a kaka's nest. *Notornis, 10*(4), 168-170.

Janssens, G. P. J., Kalmar, I. D. & Moons, C. P. H. (2010). Guidelines and ethical considerations for housing and management of *Psittacine* birds used in research. *ILAR Journal, 51*(4), 409-423.

Jenkinson, T., Friedman, M., & Whybrow, M. (2004). *Auckland Zoo Kea (Nestor notabilis) behavioural enrichment manual.* Retrieved August 30, 2010 from http://www.keaconservation.co.nz/pdfs/kea_be_manual_aucklandzoo_example.pdf

Kalmar, I.D., Janssens, G.P.J., & Moons, C.P.H. (2010). Guidelines and ethical considerations for housing and management of psittacine birds used in research. *ILAR Journal, 51*(4), 409-423.

King, C.E. (1999). Environmental enrichment and bird welfare. In: Adams, N.J. & Slotow, R.H. (eds) *Proc. 22 Int.Ornithol. Congr., Durban*: 886-895. Johannesburg: BirdLife South Africa

King, C., & Wilkinson, R. (2006). *Palm Cockatoo EEP Husbandry Manual.* The North of England Zoological Society: England.

Koutsos, E. A., Matson, K. D., & Klasing, K. C. (2001). Nutrition of birds in the order Psittaciformes: a review. *Journal of Avian Medicine and Surgery, 15*(4), 257-275.

Meehan C. L. & Mench, J. A. (2003) Environmental enrichment affects fear and exploratory responses to novelty of young Amazon parrots. *Applied Animal Behaviour Science. 79*: 75-88.

Melville, D. S. (2011). *New Zealand National Bird Banding Scheme bird bander's manual*. Department of Conservation, Wellington, New Zealand.

Ministry of Agriculture and Fisheries. (2005). *Animal Welfare (Zoos) Code of Welfare, 2005.* Retrieved from: http://www.biosecurity.govt.nz/files/regs/animalwelfare/req/codes/zoo-code.pdf

Ministry of Agriculture and Fisheries. (2011). *Animal Welfare (Transport within New Zealand) Code of Welfare, 2011*. Retrieved 07 August 2012 from http://www.biosecurity.govt.nz/animal-welfare/codes/transport-within-nz

Ministry of Agriculture and Forestry. (1999). *Guide to the Animal Welfare Act 1999; Policy Information Paper No. 27.* Ministry of Agriculture and Forestry. Wellington, New Zealand.

Miskelly, C.M., Dowding, J.E., Elliott, G.P., Hitchmough, R.A., Powlesland, R.G., Robertson, H.A., Sagar, P.M., Scofield, R.P., & Taylor, G.A. (2008). Conservation status of New Zealand birds. *Notornis, 55*(3), 117-135.

Miskelly, C. M. & Powlesland, R. G. (2013). Conservation translocations of New Zealand birds, 1863-2012. *Notornis, 60*, 3-28.

Moorhouse, R. (1997). The diet of the North Island kaka (*Nestor meridionalis septentrionalis*) on Kapiti Island. *New Zealand Journal of Ecology, 21*(2), 141-152.

Moorhouse, R. J. (2013) [updated 2017]. Kaka. In C. M. Miskelly (ed.) *New Zealand birds online*. www.nzbirdsonline.org.nz

Moorhouse,R., & Greene, T.C. (1989). *Research plan for Kaka (Nestor meridionalis) 1996-2002*, Department of Conservation.

Moorhouse, R., & Greene, T. (1995). Identification of fledgling and juvenile kaka (*Nestor meridionalis*). *Notornis, 42*(3), 187-202.

Moorhouse, R., Greene, T., Dilks, P., Powlesland, R., Moran, L., Taylor, G., Jones, A., Knegtmans, J., Wills, D., Pryde, M., Fraser, I., August, A. & August, C. (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., 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.

National Animal Welfare Advisory Committee. (2005). Animal Welfare (Zoos) Code of Welfare. MAF. Wellington, New Zealand.

O'Donnell, C. F. J. & Dilks, P. J. (1989). Sap feeding by kaka (*Nestor meridionalis)* in South Westland, New Zealand. *Notornis, 36*, 65-71.

O'Donnell, C. F. J. & Dilks, P. J. (1994). Foods and foraging of forest birds in temperate rainforest, South Westland, New Zealand. *New Zealand Journal of Ecology, 18*(2*),* 87-107.

O'Donnell, C.F.J. & Rasch, G. (1991). *Conservation of kaka in New Zealand: a review of status, threats, priorities for research and implications for management*. Department of Conservation: Wellington, New Zealand.

Olliver, N. (2011). *Kaka*. Retrieved 21 July 2012 from http://www.nzbirds.com/birds/kaka.html.

Ornithological Society of New Zealand. (n.d.). *NZ National Banding Scheme*. Retrieved 21 August 2012 from http://osnz.org.nz/book/export/html/97

Orr-Walker, T. (2010). Kea (*Nestor notabilis*) husbandry manual. Kea Conservation Trust.

Otorohanga Zoological Society Inc. (n.d.). *Species fact sheet n.o. 10; North Island Kaka*. Retrieved from: http://www.kiwihouse.org.nz/pdf/species-fact-sheets/SFS10-NI-Kaka.pdf

Powlesland, R.G., Greene, T.C., Dilks, P.J., Moorhouse, R.J., Moran, L.R., Taylor, G., Jones, A., Wills, D.E., August, C.K. & August, A.C.L. (2009). Breeding biology of the New Zealand kākā (*Nestor meridionalis*) (Psittacidae, Nestorinae). *Notornis,56,* 11-33.

Sainsbury, J.P., Greene, T.C., Moorhouse, R.J., Daugherty, C.H. & Chambers, G.K. (2006). Microsatellite analysis reveals substantial levels of genetic variation but low levels of genetic divergence among isolated populations of kaka (*Nestor meridionalis*), *Emu*, *106*, 329–338.

Smuts-Kennedy, C. & Parker, K. A. (2013). Reconstructing biodiversity on Maungatautari. *Notornis, 60*, 93-106.

Van Horik, J., Bell, B. & Burns, K. C. (2007). Vocal Ethology of the North Island kaka *(Nestor meridionalis septentrionalis). New Zealand Journal of Zoology, 34*, 337-345.

Wellington Zoo Charitable Trust. (2008). *Kaka*. Retrieved from: http://www.wellingtonzoo.com/net/explore/animals.aspx?id=49

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*(2), 175-185.

World Association of Zoos and Aquariums. (2005). Building a Future for Wildlife: The World Zoo and Aquarium Conservation Strategy. Retrieved from:

http://www.waza.org/files/webcontent/1.public_site/5.conservation/conservation_strategies/buildig_a_future_for_wildlife/wzacs-en.pdf

Young, A.M., Hobson, E.A., Bingaman Lackey, L. & Wright, T.F. (2011). Survival on the ark: life-history trends in captive parrots. *Animal Conservation, 15,* 28-43.

Appendices

Appendix 1 "Protocol for Implanting Transponders (Kea Example)"

Reason

For permanent identification of Kea in captivity and to complement leg banding as a method of accurately identifying individuals.

Microchipping protocol

1. Scan the Kea to make sure there isn't already a microchip implanted.
2. Microchips in parrots are implanted under general anaesthesia in the left pectoral muscle, in the cranial third of the muscle.
3. The anesthetized bird is positioned in dorsal recumbency.
4. The area around the entry site is cleaned with aqueous chlorhexidine
5. Scan the microchip to be implanted to confirm that it can be read and to confirm its number matches the number stated in its packaging.
6. The implant needle is inserted at a 45 degree angle dorsally and caudally to an appropriate depth, relatively shallow but depending on the size of the bird, and then the plunger is depressed implanting the microchip.
7. As the needle is retracted, a gauze swab is placed over the entry site and direct pressure applied for 30 seconds or longer to control any bleeding. If no bleeding occurs, then the skin hole is sealed with skin glue.
8. If muscle bleeding occurs and won't stop with digital pressure, then additional pressure may be applied by closing the muscle using a simple interrupted pattern and 4-0 monofilament suture, followed by closure of the skin in a similar manner.
9. Before recovery from anaesthesia, the bird is scanned to verify that the chip has been implanted and can be read.

Recommendation

Kea in captivity should be opportunistically microchipped when undergoing a health check or procedure for any reason. Microchipping should only be performed under general anaesthesia and by a ZAA member facility approved veterinarian.

Baukje Lenting, Principle Veterinary Advisor, NZ Fauna Veterinary Advisory Group (Baukje.lenting@wellingtonzoo.com)

Lisa Argilla, Wildlife Hospital Dunedin (lisa@wildlifehospitaldunedin.org.nz)

Appendix 2 "Specialised Products and Suppliers mentioned in the text"

Capture Nets

Specialised bird nets can be purchased from Rusler
https://www.rusler.co.nz/shop/product/209404/Jungle-Capture-Net-Series--Custom-Made/

Mesh
Zoo Mesh can be purchased from Fabric Structure http://www.fabricstructure.co.nz/

Trovan transponders and scanners are available from:
Advanced Identification Ltd. 'Nano' trovans (used at Wellington Zoo) are available
PO Box 48087 from:
Blockhouse Bay Microchips Australia Pty. Ltd.
Auckland 22 Fiveways Boulevard
Phone (09) 820 7543 Keysborough, Victoria 3173
Or 09 820 0009; 09 8283410 Tel +61 3 9706 3165
trovan@xtra.co.nz www.microchips.com.au

Allflex transponders and scanners are available from:
Allflex New Zealand Limited
17 El Prado Drive
Private Bag 11003
Palmerston North
Phone (06) 356 7199
Fax (06) 355 3421
Transponders and scanners can also often be purchased through your local veterinary practice.

Wombaroo nectivore mix
Contact: Karen Wiley
Native Bird Rescue Trust, Wellington
Phone/fax (04) 479 2936
Email: Karin@nbrwt.org.nz

Live invertebrates
Biosuppliers
Birkenhead
Auckland
Phone/Fax 09 418 2352
Email: bugs@bio.pl.net
http://www.ak.planet.gen.nz/~bio/

Cat carry boxes are available from veterinary practices and pet shops nationwide.

ZIMS animal records software is available from **Species360**. Visit their website https://www.species360.org/ for details.

Disinfectant
Virkon™ is often available from your local vet. Can also be purchased from NRM (phone 0800 800 380 to order or for local agents).
Trigene™ is also available often available from your local vet or from:
Animates Botany Downs
371 Ti Rakau Drive
Botany Downs
Auckland
Phone: 09 272 7510

Artificial eggs
Can be obtained for US$38 + postage from:
Boneclones – Osteological Reproductions
21416 Chase Street #1
Canoga Park
California 91304
USA
www.boneclones.com

Appendix 3 "Massey University (Huia) Wildlife Submission Form"

SPECIMEN DETAILS (Complete the reverse side of this form with the case details and this side for each animal associated with the case)

Animal Details

Species/Common Name: _____

Animal ID: _____

Identification Type: _____

(Leg Band, Microchip Implant, Wing Tag, Tattoo Toe Clip etc.) _____

Individual Name: _____

Sex: Male ☐ Female ☐ Unknown ☐

Age Classification: Adult ☐ Subadult ☐ Juvenile ☐

Neonate ☐ Foetus ☐ Embryo ☐ Egg ☐

Date of Birth/Lay/Mating: / /

Age/Incubation/Gestation: Period / Period

Years	Months	Weeks	Days

Where Born / Hatched: Wild ☐ Captivity ☐

Weight: _____ gm / kg

Laboratory Use Only Specimen No: _____

Tests Required Minimum Tests to Obtain Diagnosis ☐

Mortality Date Animal Died: / /

Death Circumstances:

Found Dead ☐ Infertile ☐

Found Alive and Died ☐ Euthanased ☐

Treated and Died ☐ ByCatch ☐

Capture or Release ☐

Specimen Quality:

Freshly Dead ☐

Mild Decomposition - Organs Intact ☐

Moderate Decomposition - Organs Intact ☐

Advanced Decomposition - Organs Not Intact ☐

Animal History (Please attach additional sheets if more space is required for animal history)

Information Specific to the Individual Animal Including: Previous Health History; Clinical Signs; External Examination; Individual Treatments; Abnormal Behaviours (feeding, reproductive, agonistic); Breeding History; Diet with any Changes; Exposure to Toxins; Translocation Details; Previous Clinical Pathology (attach relevant reports)

Samples Submitted (Tick Boxes)

	Fresh	Fixed	Frozen
Carcase			
Egg			
Tissue			
Viscera			
Muscle			
Blood			
Serum			
Faeces			
Urine			
Other (Specify)			

Appendix 4 "Kaka Diets"

Pūkaha Mount Bruce National Wildlife Centre Kākā Diet

Daily Base Diet (individual servings based on previous consumptions)

- All measurements/weights are of fruit with skin *on* unless specified
- Weigh out the day before and place in the fridge. ***DO NOT CHOP UP UNTIL THE FOLLOWING MORNING***.

200g **PEAS** – weigh out from bags in freezer

200g **CORN KERNELS** – weigh out from bags in freezer

35g **BEAN MIX** – pre-weighed into containers in freezer

85g **SPINACH AND/OR SILVERBEET** – coarsely chopped

230g **APPLE** – chopped

150g **ORANGE** – remove skin before chopping

260g **BANANA** - remove skin before chopping

200g **PEARS** – chopped

125g **KIWI FRUIT**

NB: if you can't find pawpaw or mango, it may be in the insect room to help ripen it. Check the shelf above the cricket bins

170g **PAWPAW – substitute with melon (no skin) if there is no pawpaw**

70g **CARROT** – chopped

60g **GRAPES** - halved/quartered depending on size

Daily variations:

For Monday add:	**For Tuesday add:**	**For Wednesday add:**
1 **CORN COB** – remove from freezer to defrost	7 **BEANS** 70g **COOKED PUMPKIN** - pre-weighed in small containers in freezer	1/2 of a head of **BROCCOLI**
70g (raw) **BEETROOT**		

For Thursday add:	**For Friday add**	**For Saturday add:**
1 **CORN COB** – remove from freezer to defrost 70g **COOKED POTATO** – weight is cooked weight, not raw	70g **COOKED KUMARA** – weight is cooked weight, not raw 7 **BEANS**	100g **PINEAPPLE / MELON** - weight is with skin removed

For Sunday add:

1/2 **MANGO**

Wellington Zoo Kākā base diet:

Kākā Diet (per individual / day)

Mazuri Parrot maintenance pellet	15g
Mazuri Lorikeet nectar	150ml (30g of powder)
Selection of fruit	100g

- Banana
- Orange
- Melon
- Apple
- Pear
- Kiwi fruit
- Papaya

Auckland Zoo basic daily captive diet

(individual servings based on previous consumptions)

1.5 IC **SPROUTED LEGUMES**

1 IC **PEAS**

1 IC **CORN KERNELS**

150g **BEAN MIX**

200g **GREENS MIX** – coarsely shredded

3 **APPLE** – 2 chopped, 1 grated

3 **PEARS**- 2 chopped, 1 grated

2 **ORANGE**

3 **BANANA**

2 **KIWI FRUIT**

200g **CARROT** – grated + chopped

100g **GRAPES**

1 Large (~ 200g) Potato (Cook on Mon, Wed, Fri, Sun) or Kumara (Cook on Tues, Thurs, Sat)

Supplement: 40g **Calcium carbonate**

For Monday add:

5 **CORN COB**

200g **BEETROOT**

For Tuesday add:

20 **BEANS**

100g **COOKED PUMPKIN**

For Wednesday add:

Half a **Cucumber**

For Thursday add:

2 **CORN COB**

1 **Capsicum**

For Friday add:

200g **COOKED KUMARA**

20 beans

For Saturday add:

200g **PINEAPPLE / MELON**

For Sunday add:

1 **MANGO**

Note: All ingredients are to be cut into pieces no larger than 5mm cubes, otherwise the parrots will kick the food onto the ground, providing feeding opportunities for vermin.

Flexibility: Adjust dietary ingredient amounts on a daily basis as required ie: appetite, seasonal variation, births, deaths, food availability etc.

Table 1. Ingredients of the regular (non-breeding season) artificial diets fed to kākā in six captive institutes in New Zealand (these institutes are listed below). A combination of these items is provided daily depending on seasonal availability.

1=Otorohanga Kiwi House (E. Fox, personal communication, July 27, 2012).
2=Mount Bruce National Wildlife Centre (R. Berry, personal communication, August 12, 2012).
3= Willowbank Wildlife Reserve (N. Ackroyd, personal communication, August 7, 2012).
4= Rainbow Springs Kiwi Wildlife Park (M. Paterson, personal communication, July 24, 2012).
5=Staglands Wildlife Reserve (J. Waterhouse, personal communication, July 24, 2012).
6=Wellington Zoo (Hoffmeister, 2011).

	Captive Facility						
Ingredient	1	2	3	4	5	6	**Number of Facilities Providing this Ingredient**
Carrot	■	■	■	■	■	■	6
Orange		■		■	■	■	4
Banana		■	■	■	■		4
Grapes	■	■	■	■		■	5
Pear	■	■	■	■	■	■	6
Apple	■	■	■	■	■	■	6
Corn	■	■	■	■		■	5
Dates	■	■			■	■	4
Cheese	■			■			2
Seed mix	■	■	■	■	■	■	6
Nectar substitute	■	■	■	■	■	■	6
Peas	■		■	■		■	4
Sultanas	■		■	■		■	4
Plums		■					1
Kiwifruit		■	■		■		3
Native Puha		■					1
Silverbeet		■	■		■	■	4
Melon			■	■			2
Spinach			■		■		2
Broccoli			■				1
Dock			■				1
Plantain			■				1
Bread	■		■	■		■	4

Tofu	■					■	2
Figs	■					■	2
Yoghurt	■					■	2
Wombaroo Insectivore Mix	■	■	■			■	4
Ornithon Supplement			■				1
Coconut				■			1
Honey				■			1
Nuts	■	■		■	■	■	5
Science Diet cat biscuits			■				1
Harrisons parrot pellets				■			1
Avian Multivitamin Powder				■			1
Honey Sandwich					■		1
Banana Chips					■		1
Dried Apricot					■		1
Dried Mango					■		1
Prunes					■		1
Mealworm Scatter			■				1
Total	17	17	22	19	17	18	

Table 2. Formulation of the nectar substitute provided to kākā at three different captive institutes in New Zealand.

[1] (M. Paterson, personal communication, July 24, 1012)
[2] (R. Berry, personal communication, August 12, 2012)
[3] (Jennifer Waterhouse, personal communication, July 24, 2012)

Captive Institute:	**Ingredients:**
Rainbow Springs Kiwi Wildlife Park	Farex baby food, jam, plain complan, warm water [1]
Mount Bruce National Wildlife Centre	apple and raspberry jam, water [2]
Staglands Wildlife Reserve	sugar, glucose, complan, milk powder, brewer's yeast [3]

Table 3. Breeding season diet provided to breeding pairs of captive kākā at Mount Bruce National Wildlife Centre (R. Berry, personal communication, August 12, 2012).

Captive Institute: Mount Bruce National Wildlife Centre	
Breeding Diet:	**Quantity Given:**
Brown bread blended to crumbs in a food processor	One slice
Finely chopped boiled egg	Half
Insectivore Wombaroo	8.5g
Calcium	1/2g
Cooked brown rice	20g

Table 4. Breeding season diet provided to breeding pairs of captive kākā at Willowbank Wildlife Reserve (J. Waterhouse, personal communication, July 24, 2012).

Captive Institute: Willowbank Wildlife Reserve	
Breeding diet:	**Quantity Given:**
Nuts	10
Mashed boiled egg	2 tablespoons
Raw mince	1 tablespoon
Scattered mealworms	Small handful

Appendix 5 "Incubation"

Incubator Room Set-up

Incubator rooms and equipment should be kept simple and hygienic. The room itself should be heated (or air conditioned) to maintain an ambient temperature of around 20°C. A dehumidifier may be necessary to keep relative humidity in the room at a low level.
All windows need to be blacked out to prevent direct sunlight affecting the temperature of the room or individual incubators. Complete darkness is the ideal condition for egg incubation and candling.
A high level of hygiene is important for successful artificial incubation. Shoes should be removed before entering the incubator room and shoes dedicated to the room should be used. Hands are washed with an anti-bacterial soap before handling any eggs or chicks, as well as between different clutches or between eggs and chicks.

All equipment is sterilised pre-breeding season with Trigene then rinsed clean. In addition, incubators and hatchers must be sterilised between clutches.

Equipment and furnishings in the incubator and brooder room are kept to a minimum to allow effective hygiene management.

Hygiene Standards

- Hygiene is extremely important in the incubation and brooder rooms.
- Only dedicated footwear is worn in the incubation and brooder rooms. Normal footwear is to be removed at the door and incubation footwear is to be worn – this is not to leave the incubation/brooder room.
- Lab coats are worn when working with the eggs so that dirty work clothes do not rub against incubators, benches, eggs etc.
- Thoroughly wash and dry hands on entry and before each egg is handled.
- Keep hair tied back if necessary and refrain from touching hair or face etc after your hands are sterilised.
- All equipment that you use in the incubation room – scales, pens, candlers, bench surfaces etc are to be kept clean and sterile by being sprayed down weekly with Incusan solution.
- Ensure any rubbish is immediately removed from the rooms.
- At the start of the season all incubators and equipment should be thoroughly cleaned with Trigene.

Cleaning Products

Trigene – Fresh dilution used for cleaning incubators/wiping down benches/washing floors etc.

Incusan – Solution used for egg washing. Can also be used from spray bottle for cleaning surfaces, instruments etc.

Egg Hygiene

Kākā eggs are not generally cleaned before they are incubated, however if they are particularly dirty a 1% Incusan solution (slightly heated to avoid cooling the egg) can be sprayed onto the egg. They should not be scrubbed or wiped, as this will force dirt and bacteria through the shell membrane causing bacterial infections and death of the embryo.

Some Key Facts

- When collected most eggs are already part way through incubation by parents and any penetration of the shell by bacteria is already likely to have occurred.
- At this stage keeping eggs dry and warm is more important than cleaning them.
- It is important not to add to the bacterial burden of the egg. The eggshell is porous and should be kept from contamination when in your care.
- The most contaminated surface your egg is likely to be in contact with is your hand.
- The fastest way for bacteria to penetrate the shell is to drop the egg temperature.
- Egg handling with unwashed hands is easily the most dangerous activity likely to happen to the egg - this is the risky combination of contamination with temperature drop.

Golden rules for egg care

- Start with a thoroughly clean and fumigated incubator (including the fan and heating mechanism) at the beginning of each new incubation.
- All ledges and surfaces in the incubator room should be cleaned and disinfected.
- Handle eggs as infrequently as possible, and for as short a period as possible.
- Before handling eggs wash hands with disinfectant (eg. Antec instant hand sanitiser, or Hibiclens) and thoroughly dry or use disposable gloves.
- Eggs should only be in contact with sterile, dry surfaces.
- Re-glove or re-sterilise between different incubators or eggs of different species.
- Do not allow egg temperatures to drop significantly.
- Handle eggs gently and slowly - sudden movements or holding blunt end of egg down can cause strains on membrane between albumin and air cell thus damaging the embryo.
- Prolonged candling can also damage the embryo.
- Separate hatching eggs from the others as these eggs do not need to be turned in the last few days and, in hatching, release a lot of bacteria. All empty shells should be removed from incubator and incubation room.
- For eggs that are exceptionally dirty, or you suspect infection; gently clean eggs by lightly scraping off large pieces of muck with a knife. Take care - if you damage the cuticle you are changing the porosity of the shell and so increase temperature conductivity and moisture loss.
- Dip egg in disinfectant (eg. Techsan – TC – Qual Tech PO Box 4182 Hamilton East or Antec Superhatch Chickguard, NRM, Private Bag 99927, Newmarket), which is warmer than the egg. (eg. 43-44 °C) for no more than 5 seconds. Carefully change grip so the whole surface is in contact with the solution. This draws bacteria out.
- If there is a known infection - dip eggs in antibiotic solution, eg. Baytril, at lower temperature than egg, eg. 4-11°C this draws antibiotics in.

Before placing eggs in the incubator:

1. Candle egg to determine fertility.
2. Examine egg thoroughly for cracks.
3. Clean egg if necessary.
4. Weigh egg
5. Place on a clean flat surface and allow egg to find its centre of gravity then draw a pencil line down the eggs length indicating top centre.

All eggs lose weight during the course of incubation, generally between 13 and 17% of their fresh weight. Larger eggs tend to lose more weight (16%) than smaller eggs (12%).

Incubation

Incubators that turn the eggs automatically can be set to turn as often as required, generally every 60 minutes. Turning is done to prevent the embryo sticking to the eggshell. Eggs should not be turned more than 90° in one direction as this will cause the coils (Chalazae) supporting the yolk to become damaged or break.

Candling is done daily to monitor embryo development and weights are taken every morning to monitor weight and density loss. Candling should not take too long as it can overheat the embryo. Air cell development should be noted, as the air cell gets larger during incubation then "draws down" just before internal pip. The beak can be seen inside the air cell after internal pip and the chick can often be heard vocalising through the shell.

Incubation temperature: 37.2°C - 37.5°C

Humidity: 55% RH

Turning: 45° x 5 times a day (turning the egg an uneven number of times per day will prevent the embryo settling in the same area of the egg each night).

- Weigh the egg daily and plot the weight on a graph
- Calculate density loss.
- Candle the egg once per day to check the embryo development and status.
- Stop turning once the egg internally pips.
- At external pip, increase humidity to 70 – 75%. Use sponges not water dishes to achieve this humidity to prevent drowning. At full hatch, reduce the humidity to 40 – 50%.

There doesn't have to be an equal amount of weight lost each day. There must however be careful attention paid to the weight loss of an egg over a period of days and regular assessment of whether this weight loss is right.

Egg losing too much weight? Increase humidity by increasing the surface area of water in the trays or decrease the level of ventilation. Ventilation should never be completely blocked.

Egg not losing enough weight? Decrease humidity by reducing the surface area of water in the trays or increase the level of ventilation.

Embryo death can happen any time during development. Signs can be:

- No observable growth/development of veins and embryo over a 7-day period.
- Visible breakdown of veins/embryo
- Contents of egg sloppy and move around a lot when the egg is moved
- Distinct edge of aircell breaks down and becomes very 'fuzzy'
- Egg begins to smell

Dead eggs should be removed from the incubator to prevent bacteria affecting other eggs. At incubation temperature a dead egg will break down relatively quickly – and within days you should see definite signs.

Hatching

- Temperature set at 36.5°C
- Humidity should be maintained or increased to 70-75% when the chick has externally pipped and broken through the shell.
- Ensure the hatching egg is in an incubator by itself ie with no other eggs.
- Ensure the grey brooder matting ("Miracle Grip" or similar) covers the entire base tray of the incubator. This will provide traction to both the egg and chick once hatched
- The egg should be stabilised using wads of cotton wool, providing the chick resistance and preventing the egg from rocking around too much.
- Record good notes throughout the hatching process.

Brooder

Once hatched, leave the chicks in the incubator for 4 - 5 hours before moving to a "TLC" Brooder that should be set at 35.5 °C with a humidity of approximately 55%.

The brooder temperature should be reduced by approximately ¾°C per day, starting at day two and continuing until an ambient temperature of 24 - 25 °C is reached. It is however important at this time to monitor the chicks body language which will signal if temperatures are too hot (sprawled out and fast breathing) or too cold (huddled/shivering) – both extremes will be accompanied by a lack of appetite. Initially the chicks should be housed in polar fleece lined plastic ice-cream tubs placed in TLC Brooder.

All food must be prepared fresh each feed and feeding utensils cleaned and sterilised between feeds. Hygiene is critical during the hand-rearing process, particularly during the early part of it.

Feeding and Nutrition

Nutritional requirements vary with age and are highest at the hatchling stage. Balanced dietary protein, amino acids and calcium is required for tissue growth, bone calcification and maintenance (Koutsos et al., 2001).

Thus, one of the main considerations during hand rearing needs to be given to the nutritional requirement of the chicks. Commercial parrot hand rearing formulae are available (Table 1).

Table 1. Commercial hand-rearing formula for parrots that have been used to hand-rear kākā successfully.

Harrisons Juvenile Hand-feeding formula	Age	Formula: Water	Water at 37^0 C should be used. In most cases, 1 tbsp. per 150-200gms body weight should be fed.
	Day 1	1:6 parts	
	2-6 days	1:3 parts	
	From day 7	1:2 parts	
Kaytee Exact Hand-Feeding formula	Age	Formula: Water	Sterile water should be used at 38^0C
	Hatch- 2 days	1:6 parts	
	2-5 days	1:2-3 parts	
	5 days- weaning	$1:1^{1/3}$- 2 parts	

Some other well-known formulae for parrots are Roudybush Optimum Hand feeding Formula, ZuPreem Embrace hand feeding formula and Pretty Bird 19/8 hand rearing formula. Most of these

formulae contain minimum crude protein in the 18-22% range, 10-12% moisture and most essential minerals and vitamins. However, Harrison's formula relies on mostly organic ingredients to provide the required nutrition and is commonly used. Pretty Bird has successfully been used since 1996 to feed young birds from 7 days of age (Woolcock, 2000).

Table 2. Recommended feeding frequency for young parrots (Holland 2007)

Age in days	Feeds/day
1	10
2-4	9
5-7	8
8-12	6
13-26	5
27-40	4
41-50	3
51-85	2
85-100	1

The food should be warmed to 38^0C and temperature checked with the help of a thermometer. Food that is too hot will cause crop burn. From hatching to day 4, 7% solids and 93% water is optimum, thereafter 30% solids is needed. Consistency is important since thick food may cause compaction and crop stasis and thin food gets digested too quickly. Insufficient water during the first few days after hatch results in high mortality, whereas insufficient solids later on results in slow growth rates (Koutsos et al., 2001).

For orphaned chicks it is important to offer an oral rehydrating formula to all orphans before introducing them to a new diet, even if they do not exhibit signs of dehydration. Rehydrating solutions include "Pedialyte" and "Biolyte" (Anonymous, 2010).

Some precautions need to be taken to ensure safe and hygienic feeding. Formula prepared should never be microwaved as it causes "hot spots" and may lead to crop burns (Worell, 2012). The water can be heated in a microwave before adding to the powdered mix. Food can be dispersed slowly with the help of syringes or feeding tubes directly into crop. As the birds grow older, they can also be stick fed. A routine should be followed to allow crop to empty between feedings. Food once prepared should not be re used. It is important to monitor how quickly the crop fills to prevent excess food filling. Also regurgitation of food is usually an indication that the crop is full and feeding should be stopped to prevent aspiration.

Weaning

Chicks will self-feed within 14-21 days of fledging if food (mainly seed and fruit) is provided to them (Woolcock, 2000). Introducing juveniles into enclosure with an adult will help them to learn foraging and other social behaviours.

Imprinting

Imprinting is when a young bird forms an emotional bond with the parents soon after hatching. This is dependent on the parent's being the first moving object that they see (Lorenz, 1935). This "critical period" during which imprinting occurs is very crucial to the future reproductive capability and

development of social behaviours in adult birds (Hess, 1964). Sexual imprinting is a major problem in hand raised wild birds throughout the world. The main dos and don'ts that need to be followed in order to avoid imprinting on humans are given in the table below.

Table 3. Guidelines for avoiding imprinting when hand-rearing young parrots.

DO'S	DON'T'S
• Handle orphans only at feeding times, minimizing human contact. • During feeding, wear a mask or put a cloth over self to distort image. Using kaka puppets to feed fledglings is also helpful. • Keep an adult near the brooder box so the chicks get imprinted on its own species. • Use surrogates if possible.	• Do not treat these animals as pets. • Do not display or exhibit these animals to humans. • Do not allow untrained people to feed the chicks.

Habituation

Ultimately, all captive kākā should be discouraged from interacting with people, especially birds that to be released into wild sites. 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 servicing should be restricted to feeding, cleaning and essential health checks, with birds otherwise left alone.

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 the 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 toxin used to be delivered via ice cream containers for mouse control. 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 in Wellington following the consumption of toxin. At Orokonui kākā have pulled tracking cards out from tracking tunnels and have also been seen inside kiwi feeding boxes within the Orokonui kiwi creche.

At Pūkaha Mount Bruce, birds regularly visit the café and steal food from the visitors that has the potential to affect their health.