KEA (*Nestor notabilis*) HUSBANDRY MANUAL 2024

Photo Credit: Brian Cairns/Auckland Zoo

Tamsin Orr-Walker (Kea Conservation Trust) and Todd Jenkinson (ZAA)

VERSION 3 (updated and revised in 2024)

Department of Conservation
Te Papa Atawhai

KEA CONSERVATION TRUST

Zoo and Aquarium Association Australasia

Contents

Iwi Statement of Acknowledgement

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

1. PREFACE

This reviewed husbandry manual reflects the collective experience of many individuals and organisations that have held kea in captivity nationally and internationally. It seeks to document current best practice in husbandry of captive kea and to establish clear minimum standards for holding kea. The standards are designed to ensure the best welfare outcomes for captive kea in New Zealand and abroad.

This Husbandry Manual is one document to set the direction of the captive kea population, and establish standards for the care of the birds in this population. As such it will be used to promote best practice and consistency in management direction. This document will be used by DOC to develop consistent Authority conditions, and for auditing purposes if required.

It is not the intention of this manual to reproduce material which has been published elsewhere. As such this manual should not be considered in isolation, but as part of a series of resources that lay out why and how we care for kea in captivity. All resources may be found on the Kea Conservation Trusts website here and ZAA website here.

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

Kea are an important taonga to South Island Maori. Although often referred to as a 'mountain parrot', kea occupy a broad altitudinal distribution ranging up to c. 2100 m asl along the slopes of the Southern Alps and associated ranges, down to sea level (Weston et al, 2023).

In captivity, the life expectancy of kea is 40+ years with the oldest known kea in New Zealand reaching 50 years. Because of their longevity, intelligence, playful and social nature, kea require considerable mental stimulation and therefore require the highest standards of husbandry, the ongoing commitment of qualified husbandry staff and improved infrastructure (large stimulating habitats) to be maintained in a healthy state.

Kea may only be held in New Zealand under a permit from the Department of Conservation for the purposes of advocacy, education and research to support kea in the wild.

Taxonomy

Kingdom:	Animalia
Phylum:	Chordata
Class:	Aves
Order:	Psittaciformes
Superfamily:	Strigopoidea
Family:	Psittacidae
Genera:	*Nestor*
Species:	*Nestor notabilis*
Other Names:	*Mountain Parrot, New Zealand Mountain Parrot*

2.2 Conservation Status

Department of Conservation Classification: Nationally Endangered (Criteria C1/1. Qualifiers RR)

IUCN Status: Endangered A2be+4be (BirdLife International 2017. *Nestor notabilis*. *The IUCN Red List of Threatened Species).*

2.3 Captive Management Co-ordinator and Husbandry Advisor

Todd Jenkinson
Zoo Aquarium Association
email: todd@zooaquarium.org.au
Phone: +64 22 322 9622

Catherine Roughton
Orana Wildlife Park
email: catherine@oranawildlifepark.co.nz
Phone: +64 27 305 1863

2.4 Timeframe of the plan

The Kea Conservation Trust (KCT), the Zoo and Aquarium Association (ZAA), the Kea Recovery Group (KRG), and the Department of Conservation (DOC) have supported the production of this husbandry manual. Changes to this document require appropriate consultation with all stakeholders, including the author, KCT, ZAA, KRG, and DOC.

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

3. IDENTIFICATION METHOD

3.1 Individual Identification

External forms of visual identification are required to ensure correct identification of individuals in captivity.

Reliable, safe and permanent individual identification of all kea involved in the captive management programme is essential for the maintenance of the programme. Individual identification is used to track parentage of new individuals and, to enable the identification of genetically appropriate pairings. It is also crucial for tracking information such as medical treatment and behavioural data on individual birds.

Banding

Metal leg bands with individual identification numbers can be placed on captive kea (metal bands are available from the DOC Banding Office).

Common band sizes used for kea are V bands (12mm internal diameter). Previously, LN bands (11mm internal diameter) or 27 series bands on larger birds (Kemp, pers. comm., 2008) were used. To minimise the potential for leg problems, only one metal band should be used per leg.

Some holders have reported that stainless bands wear to sharp edges after several years and have found the frequency of changing means plastic ID bands, as used on wild kea, are easier to deal with as these do not need a level 3 DOC bander to apply, are easier to identify birds and last approximately

Kea with metal and plastic colour bands (Brian Cairns/Auckland Zoo)

the same time. Holders of kea with bands should regularly check bands for any wear or sharp edges and replace bands before they become a potential hazard to the bird (e.g. at least every 10 years).

Radio Frequency Identification (RFID) bands are being trialled for use on wild kea (Dearlove pers comm 2023). This is a non-invasive remote method of ID-ing birds with an electronic tag inserted into a plastic leg band fitted to the bird.

More information about the banding office can be found here.

Micro-chipping

Microchips are another method that can be used. 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.

See example in **Appendix 1**

Best Practice 1.

Identification.

All kea held in captivity must be individually identified by:

a) An approved band within three months of hatch (metal band numbers are to be sent to the DOC banding office and to the kea captive coordinator), or within three months of being transferred into captivity (for wild caught birds).
b) or the implantation of a recommended brand of microchip/transponder (e.g. Trovan/Allfex).

3.2 Sexing Methods

3.2.1 Sexing

DNA analysis

Kea do not exhibit obvious sexual dimorphism although males are generally larger and heavier than females and have a longer upper mandible and skull. The only reliable way of sexing birds is by "feather sexing" (DNA/molecular testing). All chicks that hatch in captivity as part of the management programme must be sexed in this way, as the sex of captive kea often determines where they are placed within the captive population. This should be done as soon as possible in a bird's life, preferably before birds are transferred for the first time.

Wild caught birds that are brought into captivity and are incorporated into the captive management programme (e.g. suitable injured birds that cannot be released after treatment or new founders) must be sexed within 4 months and the captive coordinator notified of details.

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

Once the results are received, the captive coordinator must be informed so the studbook information can be updated.

Best Practice 2.

Sexing.

a) All kea hatched in captivity must be sexed using molecular techniques (DNA feather sexing) within four months of hatching.
b) All kea that 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) within four months of their transfer into captivity.
c) ID records and sexing records (including method used) are to be entered into a relevant records programme (ZIMS or other where applicable) and specimen reports.
d) Captive Coordinator to be informed of results.

4. NATURAL HISTORY

4.1 Distribution and habitat

Kea (*Nestor notabilis),* , iconic mountain and forest parrot of Te Wai Pounamu, Aotearoa/New Zealand, are sparsely distributed across approximately 3.5 million hectares from Farewell Spit in the Northern South Island through to Southern Fiordland in the South and including the Kaikoura ranges to the east (Robertson et al., 2007; Weston et al. 2023).

They can be found from coastal dunes to high alpine peaks but are most common in montane forests and adjacent subalpine and alpine zones. They are absent from the Marlborough Sounds, Catlins, Blue Mountains and both the North Island and Stewart Island (Robertson et al. 2007). Sub fossils at several North Island sites indicate a previously wider range (Weston et al. 2023).

Kea mainly nest within native forest although nests have also been recorded in exotic plantation forestry (Orr-Walker, pers comm). Their foraging habitat includes all types of native forest, sub-alpine scrub, tussock and herb-field and exotic plantation forestry.

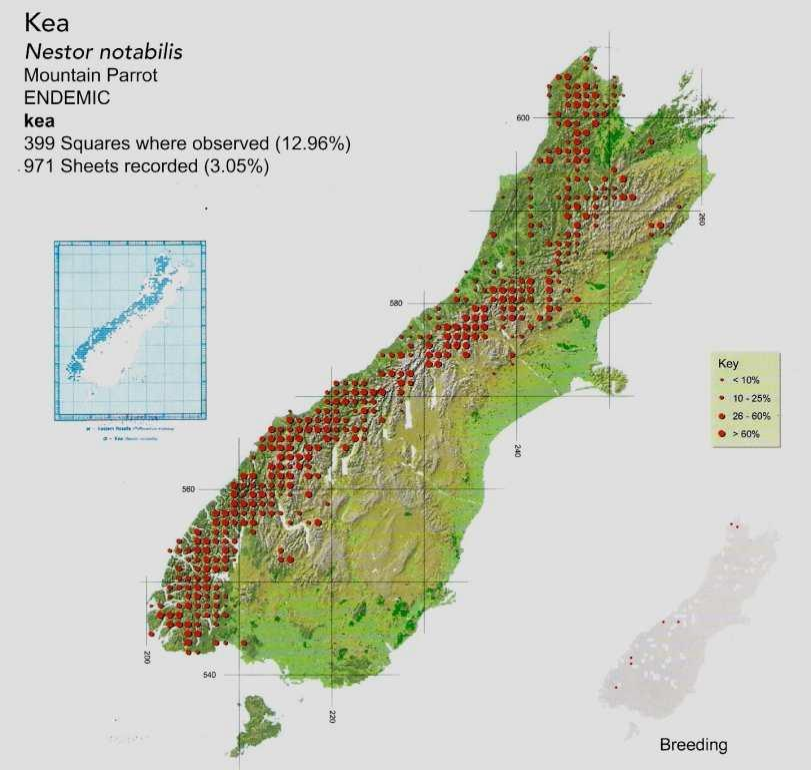

Figure 1. Present distribution of kea in the South Island of New Zealand (Robertson et al, 2007)

Population Estimates

Numbers of kea pre-European settlement, although not known, are likely to be higher than present day. Kea numbers were substantially reduced during a government bounty (1860s-1970s) which saw an estimated 150,000 birds culled. This was due to reports of kea attacking snowbound sheep for their fat on European settler high country stations. Kea only gained full protection in the 1980s as a result of lobbying by Forest & Bird.

Due to difficulties surveying, current modelling estimates of the kea population sit broadly between 1,000-5,000 individuals (Dussex and Robertson 2018; Kemp, pers comm).

4.2 Habits, movements and social structure

Although kea are considered to be diurnal they are generally more active in the early morning and late afternoon/evening.

They are a highly gregarious species which in the wild, form large flocks with non- linear hierarchies. Once adults reach breeding age they tend to leave the main flock and pair up for breeding. Studies of kea populations, movements and foods in Nelson Lakes National Park, showed very definite changes in group composition and location related to different times of the year. During August - September it was observed that kea formed flocks of 6 -8 birds which dispersed in October – December into smaller groups of 2 – 3. In January and February large flocks of up to 13 individuals again formed.

Studies in Arthur's Pass also observed large groups of around 20 first year birds during the summer period. These large flocks were then seen to disperse into groups of 2 -6 in autumn. Seasonal movement of groups was driven by food availability. Birds moved to higher altitudes in the warmer months and retreated to the beech forests during autumn and winter (Weston et al. 2023).

4.3 Feeding behaviour

Kea are opportunistic omnivores and consume a wide variety of foods in the wild. Behavioural, faecal and gut studies have shown that kea eat over 200+ different varieties of natural foods including a wide range of animal and vegetable matter. Foods include grasshoppers, beetles (adults and larvae), ant larvae, weta and cicada nymphs, other invertebrates and the roots, bulbs, leaves, flowers, shoots, seeds, nectar and fruit of native and exotic plant species (Brejaart, 1988; Clarke, 1970; Greer et al, 2015; Young et al, 2012, Aitken et al, 2023).

They have also been known to consume fat from the carcasses of hunted introduced mammal species such as Tahr, deer and Chamois (Schwing, 2010), and on occasion are also known to attack the fatty area around the kidneys of live sheep snowbound in high country areas during winter when resources are low (NHNZ, 2006).

Kea have also been observed feeding on the carcasses of rabbits and possums killed on roads (Walmsley, pers. comm., 2009).

Kea are one of the few species which have managed to take advantage of humans moving into their habitat. They use their beak, cognitive abilities and tenacity to access resources and investigate any potential uses of new objects. Rubbish dumps/bins, seasonal deer culls, farms, tourist sites and ski fields continue to provide sources of food (and toxins in some cases) for kea in times of hardship, however this poses a major risk to kea health due to ingestion of unsuitable or toxic foods and development of conflict situations with landowners.

4.4 Reproduction

Kea nest mainly below the tree line, on the ground in natural cavities such as a rock crevice, the hollow base of a large tree, a hollow under the roots of a tree, a hollow log or a dirt cavity under the lip of an old river terrace. There has been one recorded event of kea nesting in a tree at Okarito (Orr-Walker pers comm). One to four eggs are laid and incubated July to January (peak laying in August-October). Normally one clutch is laid per year. An individual female may nest in several successive years, but not all females nest every year.

Incubation takes 23-28 days. The female does all the incubation, brooding and feeding the young by regurgitation. The male brings food to the female, feeding her by regurgitation near the nest site.

Kea chicks have a long juvenile period and as such are dependent on their parents for the first 4-5 months of their lives.

Lifestage	**Timeframes**	**Time of Year**
Egg to hatching	28 days (23-26 days Woolcock, 2000)	July - October
Fledgling	13 weeks	December - February
Parental care period	Minimum 19 - 26 weeks invested in chick rearing (2-6 weeks of this after fledging)	June - March

Table 2: Life stages and time frames (adapted from Fijn, 2003)

4.5 Protected species' role in ecosystem

Kea, as a significant berry and seed eating species in alpine areas, are considered to be important in the dispersal of the seeds of native alpine plants (Brejaart, 1988; Clarke 1970; Young et al, 2012).

4.6 Threats in the wild

Like many other native birds, kea suffer from predation by introduced mammals. Kea are also impacted by human activity (Weston et al. 2023).

Introduced predators

Mustelids (stoats, ferrets and weasels), feral cats, possums and rats are all threats to kea. Stoats are considered the primary predators of kea across the keas range, while feral cats are a major threat on the eastern side of the main divide (Kemp et al, 2022), capable of taking foraging adult kea. Possums are known to kill kea chicks on the nest as well as disturb nesting pairs. Rats have also occasionally been observed taking kea eggs.

Impacts of human activity

Lead poisoning, conflict with humans, vehicle strike, electrocution, ingestion of unnatural food items and interfering with predator control activities (kill traps and poison baits) are all serious threats for kea. People feeding kea increases the risk of these occurring by encouraging kea to interact with humans and their belongings and decreasing the amount of time they spend foraging for natural foods.

Lead poisoning occurs right across the keas range, wherever they overlap with humans. Lead is malleable, easily manipulated and sweet, making it highly attractive to kea who ingest it is accessible to kea predominantly via lead nails and flashing on buildings built prior to 1990 and lead ammunition used in hunting. As a heavy metal, lead is not excreted from the body and can result in multiple organ failure and death if left untreated.

Despite being illegal, reports are received annually of kea being intentionally killed as a result of human conflict. The last permit to legally shoot kea was issued by DOC in 2009 (Weston et al. 2023)..

4.7 Summary of conservation actions

Several organisations work together to drive and support kea conservation actions in-situ. These include Department of Conservation (DOC), the Kea Conservation Trust (KCT), Te Rūnanga o Ngāi Tahu (TRONT) and local community conservation/trapping groups throughout the kea range.

The Kea Recovery Group, established in late 2022 and comprised of DOC, TRONT and KCT, has recently developed a 10-year Kea Recovery Strategy - Te Rautaki Whakaora Kea (Weston et al. 2024). This Strategy will guide and coordinate conservation actions for kea moving forward, and includes a priority around ensuring the captive population is optimally managed for the benefit of the wild kea population

Predator Control

Landscape predator control (aerial 1080) is overseen by DOC to control predators over large areas and in rough kea habitat. DOC works in partnership with groups such as Zero Invasive Predators (ZIP) and OSPRI in this space. Mitigation action to reduce the threat of aerial 1080 baits to kea is being

researched with input from the Kea Mitigation and Kea Recovery Groups (Weston et al. 2021; Young et al. 2022).

Ground based pest control is carried out by a variety of organisations including DOC and local conservation NGOs/trapping groups. A kea safe Ground-based Pest Control document, developed by the KCT and the Kea Safe Pest Control Working Group, aims to minimise the risk of ground-based methods to kea by reducing access to kill mechanisms and baits (www.keaconservation.co.nz/wp-content/uploads/2022/08/Safe-Pest-Control-in-Kea-Habitat_2022_FINAL-1.pdf).

Lead Poisoning

The KCT's Lead Removal programme (2016 – present) aims to identify lead poisoning hotspots by blood lead testing kea and identifying and removing sources of lead in these areas with community partners (particularly DOC and the Backcountry Trust). This programme builds on previous lead testing by DOC and university researchers carried out from 2006.

Conflict Response

The KCT's Conflict Transformation programme aims to provide a practical resource and on the ground support for people experiencing conflict with kea. The KCT works alongside local DOC to deliver this service.

Role of the Captive Population

The role of captive population is for advocacy, research and an insurance population if required in the future.

Holders are required to develop an advocacy plan if they display kea as both an expectation of the captive programme and as a requirement for the Department of Conservation permitting process.

5. CAPTIVE HUSBANDRY

It is impossible to fully mimic the expansive high country and forest habitats of wild kea in captivity. However, kea aviaries should be as natural as possible to ensure high welfare standards when in captivity.

Kea thrive on new experiences; they have evolved to investigate new objects in new situations and are, as a result, insatiably curious. Kea are one of our most robust avian species, reacting more positively to stimulus than to inaction in their environment. Therefore, providing a stimulating, complex environment is a basic husbandry requirement for this species.

5.1 Stereotypies

Stereotypies - repetitive behaviours which appear to have no obvious goal or function (Mason, 1990) - have long been used as welfare indicators, and as they are not seen to be exhibited within wild animal populations, their development has been linked to suboptimal captive environments which discourage expression of natural species specific behaviours (ibid). Historically, kea in New Zealand facilities have exhibited high levels of stereotypies (Orr-Walker, 2005).

Research on the development of locomotor stereotypies (route tracing) in parrots has been identified as related to lack of space and physical complexity while development of oral stereotypies (i.e. feather

plucking) to lack of opportunity to perform foraging behaviour. Both stereotypy types are seen to be related to lack of social interaction (Sargent & Keiper 1967; Keiper 1969; Meehan *et al.,* 2003a, 2004; Meehan *et al.,* 2003b cited in Engebretson, 2006). Changes in the captive environment including **enclosure size, enrichment, and socialisation** have been shown to improve the welfare of captive parrots (Engebretson, 2006).

All stereotypies involved some form of locomotor activity (flying, running, hopping or rocking from one leg to the other) and anecdotally were linked to pre-feed times. Carlstead (1998) maintains that the form in which stereotypies are expressed often indicates which wild behaviour is being frustrated.

Therefore, stereotypic locomotor activities may indicate a need to forage for food, search for mates or fly long distance - all high energy activities in the wild. Stereotypies that are linked to a food motivation may be observed to increase prior to feeding episodes (Carlstead, 1998). This has been observed in species which expend much time and/or energy in procurement of their food source and may be reduced by varying temporal feeding patterns and providing in a form which more closely replicates the natural situation (ibid). This was found to be evident in New Zealand captive kea as provision of additional feeds during the day (as a form of nutritional enrichment) in 3 of the 13 facilities observed, significantly increased foraging, investigative and manipulative behaviours across all groups and correspondingly decreased body maintenance behaviours such as self-preening. Enrichment, both frequent and varied is essential for kea in captivity (Orr-Walker, 2005).

An increase in enrichment, and number of feeds per day, has been shown to significantly decrease stereotypic behaviours. The role of enclosure size and social structure is less clear although as larger enclosures tended to correspond with enclosure complexity, size may be an important factor in reducing stereotypies by providing more areas for exploration, space between animals and more opportunity with larger group size for socialisation.

5.2 Housing/Environment Standards

This section covers the following topics;

- Enclosure types (and their pros and cons)
- Enclosure size and social dynamics
- Safety considerations
- Enclosure siting
- Shelter and screening
- Water
- Furnishings and vegetation

Enclosure complexity and design is crucial for maintenance of an animal's physical and psychological wellbeing. Kea are considered a highly intelligent and complex social species with many of the attributes that support a high level of cognition (Gadjon, 2005). They are opportunistic feeders with an almost complete lack of neophobia (fear of new things) and as such, fit into Kreger and Mench's respective models of a high-priority species requiring high levels of novelty and variability in their captive environment (Mench *et al.,* 1998). Additionally, kea in the wild cover an extensive range and variety of ecotones (Diamond & Bond, 1999).

Enclosure design is also extremely important for advocacy purposes – a poor enclosure can send the wrong message to the public and reflect badly on the facility. Enclosure design should seek to increase the expression of natural behaviours in the kea of a normal duration (i.e. which decreases the incidence of stereotypic behaviours) and send a clear conservation message to the public, providing a meaningful link for the public to species issues in the wild.

Enclosures must enable kea to perform basic locomotor behaviours (flight) to avoid atrophy of flight muscle groups as well as the manifestation of stereotypies. Kiepers (1969) documented stereotypic pacing in wild birds which was extinguished when birds were introduced to larger aviaries that allowed appropriate levels of flight. However, larger enclosures on their own are not necessarily better, as space within that area may not be physically or psychologically useable by the species concerned. Enclosure design should therefore be species specific and take into account variation in topography, substrate types (as defined by Eisenberg, 1981 as cited in Young, 2003, p 122) and include a range of useable space and levels.

The behavioural repertoire of captive kea in New Zealand facilities has been observed to be significantly affected by provision and complexity of enrichment and enclosure complexity (Orr-Walker, 2005). High enclosure standards are considered a basic requirement for this species.

5.2.1 Enclosure types

There are three main types of enclosures currently housing kea in New Zealand: public walkthrough enclosures, limited-access enclosures, and traditional aviaries. Each has its place in housing kea and can provide vastly different experiences for kea and the public alike.

Walkthrough enclosures are excellent for immersion and provide positive and exciting experiences for the public. Assuming that there are ample off display areas that are inaccessible to the public, and enclosures are of a size to accommodate public presence, they are also extremely effective for ongoing kea enrichment.

If the design of walkthrough enclosure is carefully thought out, all life and reproductive stages can be housed successfully and safely. Additionally due to the larger size typical of these enclosures, a greater number of birds can be housed together, providing for an increased potential for complex social interactions.

Pros:

- Excellent advocacy and public interactive immersion experiences
- Excellent enrichment opportunities for kea
- Excellent social opportunities for kea
- Excellent advertisement for the facility
- Benefits for training and conditioning to be included in encounter

Cons:

- Costly
- Public access may need to be monitored throughout the day to ensure public are not feeding birds, offering dangerous items or entering kea only areas
- Care must be taken to meet individual kea requirements; some birds may not be suitable in public access enclosures
- Potential issues relating to territorial behaviours (e.g. aggression towards people or each other). This should be assessed on an individual basis
- Potential transfer/introduction of disease (e.g. transmittable avian pathogens on footwear)

Limited access enclosures are useful for holding of kea where birds are less able to cope with direct human presence in their enclosure. This may be particularly true of older wild sourced birds, or non-breeding pair-bonds.

Limited access enclosures allow for unobstructed views of the enclosure while containing public access to one area of the enclosure by use of a solid barrier system. Birds get the benefit of the extra space the public viewing offers when the public are absent (particularly at night when kea are active).

Pros:

- Allows public easy viewing with no mesh between public and birds
- Cost effective method of public immersion
- Provides increased space for the kea
- Safe for birds which may be less tolerant of public presence
- Easy to construct on existing enclosures with minimal disturbance to birds
- Allows for great encounters with the public (e.g. An alternative to free flight)

Cons:

- Public access may need to be monitored as with walk through enclosures (i.e. maximum numbers of visitors)
- Potential issues relating to territorial behaviour. This should be assessed on an individual basis
- Potential transfer/introduction of disease

Traditional aviaries are those which do not allow any public access into enclosures. Traditional aviaries do not generally enable an interactive exhibit for the public unless kea are provided with good enrichment opportunities and are now considered undesirable for kea that are held for advocacy.

Pros:

- Assuming best practice standards are followed, these aviary types are appropriate for valuable breeding pairs which may also be territorial during the reproductive season

Cons:

- Difficult to provide an interactive experience for the public
- Advocacy potential substantially lowered
- Enrichment potential for birds substantially lowered

5.2.2 Enclosure size and social dynamics

In the wild kea are strong flyers covering great distances both horizontally and vertically (altitudinal) in any one day. Satellite tracking of juveniles and observations of adult kea at Nelson Lakes (unpub. KCT, 2009) has shown birds to fly several kilometres in a matter of minutes and over 40kms in normal dispersal behaviour over a 2-month period. Kea territorial range for a breeding pair in the wild is estimated at 4km^2 (Bond & Diamond, 1992).

For a highly intelligent, social and mobile parrot species living in a complex alpine environment, flight, social interactions and exploration are fundamental. Some captive environments allow only limited expression of these behaviours (Engebretson, 2006), denial of which can result in physical (Graham 1998) and behavioural abnormalities (van Hoek & ten Cate 1998; Garner *et al.,* 2003b; Meehan *et al.,* 2003a, 2004; Meehan *et al.,* 2003b cited in Engebretson, 2006).

A measure of adequate housing for kea is difficult to define as a smaller but more complex enclosure may be preferable to a large empty one. Stating minimum enclosure sizes for captive kea is

problematic***. However, a combination of enclosure size, complexity and enrichment helps prevent stereotypies and encourages the expression of natural behaviours in kea.*** The development of overt stereotypic behaviours are a clear indication of insufficient space and/or enrichment

As such, the current accepted minimum enclosure size for kea is:
1 kea - 108 m³ (e.g. 6Wx6Lx3m H) (justification for holding a single bird must be documented and available)
2 kea - 180m³ (e.g. 10x6x3m)
3 kea - 312m³ (e.g. 13x8x3m)
4 kea - 528m³ (e.g. 16mx11mx3m)
5 kea - 798m³ (e.g. 19mx14mx3m).
6 kea - 1122m³ (e.g. 22mx17mx3m)*
Each additional kea – $3m^3$

All enclosures built or remodelled after 2020 (after the release of this updated husbandry manual) must comply with these size requirements. Enclosure complexity and enrichment must be provided at levels sufficient to prevent the development of stereotypies. This is highly dependent on individual birds and group dynamics and requires vigilant oversight by holders.

It is the expectation of the captive programme that holders wanting to hold kea long term plan to build or remodel enclosures to hold a minimum of four birds on display (with provisions to for off-display holding to manage any medical or social issues. See below – Exceptions to housing standards).

However, higher stocking densities are likely to increase conflict issues, particularly in the case of pairings. Groupings of 6+ kea must be closely monitored to ensure that subordinate birds do not become aggressed by dominant birds or breeding pairs. Although kea can form large flocks in the wild, these tend to be fluid groupings of juveniles and sub adult birds moving over an extensive area prior to pairs forming and establishing breeding territories (Clarke, 1970).

Height of the enclosure must be a minimum of 3 metres. All other proportions are up to the holder assuming that the minimum area is surpassed.

The dimensions above are subject to review as holding requirements are affected by group makeup (i.e. a breeding pair may be intolerant of other females in their environment whereas flocking juveniles/sub-adults may be more comfortable in larger groups).

<u>Exceptions to housing standards:</u>
Kea less than three months old or undergoing medical treatment or quarantine can be held in any enclosure suitable for housing an individual of that life stage and/or medical condition temporarily (e.g. brooders, small enclosures, if required to limit movement of injured birds).

Although kea should never be housed singly long-term, birds that have not been properly socialised (i.e., are hand-reared and unable to be integrated with other kea) may require a separate enclosure. This enclosure must have a minimum volume of 108m3 (6x6x3m). The number of birds unable to be integrated will decrease over time as current practice ensures birds are appropriately socialised.

5.2.3 Containment safety

Entrance safety
For safety purposes, a “double door” enclosure entrance is required to ensure birds do not escape as

a keeper, or member of 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.

Enclosure Security

All reasonable steps must be taken to ensure that kea on public display are secure from theft, physical disturbance and injury. This is particularly important where kea are housed in public walk through or limited access enclosures. The following steps should be implemented to ensure security of kea areas:

- Materials must be of a strength to prevent unauthorised access to enclosures and prevent a containment breach by larger animal species such as dogs.
- Enclosure barriers to extend below the surface of the ground to ensure no pest incursions in, or kea escapes.
- Appropriate locks and latches are to be used to ensure no unauthorised access.
- No entry signs should be displayed in non-public access areas.
- Areas containing the kea enclosure should have an external perimeter fence which cannot be accessed by the public after hours when staff are offsite. This is also preferable for those facilities which do not fall under MPI regulations (i.e. that do not hold new organisms and are therefore not subject to the HSNO Act, 1996).

Regular inspection of any external vegetation is required to ensure branches have not grown through the mesh and to review if any overhanging limps threaten to damage the mesh if they drop on the aviary in the event of high winds or heavy rainfall/snow.

Non-toxic materials

Kea 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. Lead should not be used for any part of an aviary construction. If an exposed timber frame is used, the timber should be untreated as kea will likely chew on it. They can do considerable damage in a short space of time, so the aviary should either be constructed to allow easy replacement of damaged timber or, ideally, the framing should be covered to prevent damage. Tanalised timber can be used for framing but only if it is completely covered to prevent birds chewing it and ingesting toxic material. Steel pipe framing can also be used for aviary construction.

In most cases, wire mesh is used for the walls and ceiling. “Zoo Mesh” is the preferred material. Sharp edges of mesh must be avoided in any case to prevent the possibility of the birds getting stuck or tangled into loose pieces of mesh wire.

5.2.4 Enclosure siting

Wild birds can tolerate a range of climatic conditions, but they do this by moving in response to changing weather, something which captive birds are restricted in doing.

As such, any enclosure must be sited in such a way to ensure it is sheltered and allows for correct thermoregulation and humidity taking into account the following:

Sunlight: The natural environment of kea is exposed to high levels of solar radiation. Research has identified that kea prefer areas of high solar radiation (although areas with very high solar radiation

are preferred less than low solar radiation areas). Sunlight is very important for manufacture of vitamin D in all species (important for bone mineralization); a deficiency can result in bone softening diseases (Grant, 2005). Access to adequate sunlight (minimum 2-3 hours per day) within the captive environment is considered vital for maintenance of health in kea.
Kea require a circadian light-dark schedule and they need to be able to sleep without interruptions (Kalmar *et al*., 2010). If kea are kept indoors (e.g. during recovery from illness or a medical procedure), 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. Birds that are held in captivity for long periods, or permanently, must have exposure to natural light.

Shade: The kea is a stocky bird which has evolved to survive in low temperatures. They are essentially an alpine forest dwelling species and may therefore be prone to heat stroke. Access to shaded areas throughout the day, particularly during the middle of the day when they generally rest, is necessary. Multiple shade areas ensure that subordinate birds are not displaced by dominant individuals. In public access areas, these should be away from direct human access points.

Airflow: Adequate airflow is important to ensure an environment does not become persistently damp as this may encourage the development of pathogens.

Moisture: Kea tolerate higher rather than lower precipitation rates (Freudenberger *et al.,* 2009) with known wild nest sites located in areas of higher humidity.

Ambient Air Temperature: Kea live in alpine regions where temperatures can drop below -4℃ in winter (Nelson Lakes, Freudenberger *et al.,* 2009). This may be the high end of the scale with kea habitats further south routinely exceeding this. They have evolved to tolerate cooler, wetter conditions. In warmer areas kea have been observed 'swimming' when a larger body of water is provided. This may be an important requirement for thermoregulation in more northern facilities.

Topography: Kea live and nest on steep and often unstable mountain terrain. They spend much time walking on uneven ground foraging, digging and investigating. Enclosure design should therefore incorporate variations in topography. This can be achieved by the addition of rock walls, scree slopes and building up of soil mounds.

Public interaction

Public interaction within public access enclosures must be carefully directed and restricted to ensure kea are not unduly stressed. 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 from the public.

5.2.5 Shelter/screening

Shelter and screening can be temporary or permanent depending on the reason for use (i.e. additional temporary screening may be required on introduction of new birds) and may be made from naturalistic or man-made materials. Rock walls or overhangs, timber structures (e.g. tramper's huts or roofs), live vegetation or browse are examples of shelter/screening type. Public barriers in walkthrough or limited access enclosures should be obvious to visitors and of a design that discourages breaching.

Undercover area – multiple undercover areas should be made available to kea to ensure that subordinate birds are not excluded by more dominant individuals. If only one area is available, it

should be of a size that is able to accommodate all birds easily and must have sight barriers and multiple access/exit points. Each bird should have a 1m² area which is undercover to access. Separate naturalistic shelter areas can be achieved by provision of rock ledges, large fallen logs etc.

Visual barriers between birds – each bird should have access to at least two areas that allow visual separation from other kea. This can be in the form of vegetation, rocks or solid screens/walls.

Visual barriers to public – vegetation, rocks and barriers should be used to ensure that the public are not allowed constant visual and/or physical access to all areas of the enclosure which may cause stress to the birds. This is particularly important in the case of public access enclosures (where physical barriers to restrict access are also required).

5.2.6 Water

Kea in the wild have access to fast running alpine streams and high-altitude tarns at all times. Bathing in these areas is a part of daily maintenance. Kea are also sensitive to heat (Freudenberger *et al.,* 2009) and need to be able to cool off in warmer temperatures.

Fresh water must be provided at all times in enclosures. If using containers, the main water container must be large and deep enough to allow birds to bathe (approx 1m² x 200 mm deep). A second water receptacle should be located elsewhere in the enclosure to ensure a subordinate bird is not kept from drinking water at any time.

Running water – Ideally, running water features and pools should be used in enclosures, but care must be taken to ensure that birds can easily exit the pool should they fall in. Water presented in appropriate-sized containers will likely be used for bathing. In walk-through enclosures, appropriate siting of the water source must be considered (i.e. water should be available away from public access to ensure birds are not restricted in their use of water throughout the day).

A water feature (natural waterfall or flowing water through/spigot system) can be easily set up with a circulating pump system. Water and receptacle area in a closed system will need changing and cleaning on a regular basis (twice weekly) to prevent buildup of pathogens and algae. Kea also have a tendency to dip their food into water during feeding, so it is important to ensure that food remnants are removed on a daily basis.

5.2.7 Furnishings and vegetation

Kea in the wild, spend a large proportion of their time foraging on the ground in alpine herb fields or on the forest floor. They dig up the roots of plants and search for invertebrate species. It is, therefore, very important to provide them with diverse vegetation, substrates and enclosure furniture (such as rotting logs) that can be manipulated by the birds on a daily basis.

Captive kea are predominantly held at low altitudes across the length and breadth of New Zealand. These environmental conditions may not support the growth of vegetation native to their natural habitat. Local or introduced plant species will likely be more practical to grow. However, care must be taken to ensure they are non-toxic (refer to the list below).

Enclosures should also contain shrubs/trees. Vegetation may provide some food if appropriate species are planted. Plant cover will also generate leaf litter.

Examples of furnishings, substrates, and vegetation

Ground vegetation: kea have been observed in captivity foraging on the young shoots of grass or picking up scattered food in carex grasses. A grass area to simulate an alpine herb field in the enclosure to encourage expression of normal foraging behaviours is desirable.

Substrates: Social play and engagement is often initiated by kea on the ground (Diamond & Bond, 2004). As such a variety of substrates are very important to encourage social interactions as well as encourage foraging and digging. Substrate materials should include leaf litter, bark mulch, soil, grass, wood shavings, different sizes of stones/rocks, and snow where possible. Different substrates can also be used to vary the topography in the enclosure and encourage natural behaviours such as climbing on moving scree slopes etc. Research into kea nest site preference indicates mainly coarse and very coarse gravel is preferred followed by gravel, and sand. Areas with silt and clay as well as areas with boulders received very low probabilities of presence (Fredenberger *et al.,*2009).

New substrate should be checked prior to introduction for foreign objects and spores and be screened for seeds etc. Any leaf litter collected should not be stored in bag any longer than 24 hours – ideally leaf litter should be placed in the enclosure the day it is collected. Existing soil in enclosures should be turned over each year to ensure soil health and decrease anaerobic organisms or be replaced. Be especially vigilant after extensive enclosure renovations or construction of new enclosures. A metal detector **(see Appendix 2 - Specialised Products and Suppliers mentioned in the text**') and magnet should be used following any construction work in or significant renovation of an enclosure.

Where concrete is present, it should not make up more than 50% of the floor area and be regularly cleaned with an appropriate disinfectant that is non-toxic to birds. Concrete is often perceived as being easier to clean, however pathogens and parasites can build up on rough surfaces. Concrete floors have also been responsible for bumblefoot in other species.

Trees and shrubs: Kea spend much of their time within alpine beech forests foraging for food. Enclosures should be able to support the growth of nontoxic native/exotic trees and shrubs which will provide shelter, shade, perching areas and encourage natural behaviours. Vegetation may need supplementing with browse to support investigative behaviour and decrease damage to live vegetation.

In general, native plant species are considered appropriate, however if the safety of a plant species is not known, then do not introduce into the enclosure until confirmed safe.

The following toxic plant species **must not be used in any enclosures** as they are either known, or thought to be toxic. Note: this is not a complete list:

- Onion Weed – *Asphodelus fistulosis*
- Black Nightshade- *Solanum nigrum*
- Bittersweet Nightshade – *Solanum dulcamara*
- Jerusalem Cherry – *Solanum pseudocapsicum*
- Karaka – *Corynocarpus laevigatus*

Furniture: Semi permanent items such as large logs, tree trunks, ponga logs, live trees, and multiple perches will increase the enclosures useable area and encourage flight behaviour between areas.

Human objects: Human objects can demonstrate a link for the public, and if presented appropriately, can provide opportunities to send useful advocacy messages to those intending to visit the South Island (e.g. don't feed the kea, ensure your equipment is stowed safely in kea habitat). Objects may also provide a diversity of enrichment for the kea (e.g. swandri, camping/tramping gear, ski equipment, farm equipment, DOC/tramping huts) which can readily and frequently be changed. ***Care must be taken to ensure that introduced items are safe, non-toxic and do not have parts which can be ingested.***

Perches: Perches in enclosures are important 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). Appropriate non-slip surfaces on perches are needed for the birds to be comfortable and safe. Natural branches with the bark intact should be used for perches as they are easy for birds to settle on. Using wooden perches, including branches, logs and trees, will require regular replacing, as kea will likely chew. Rope may be used, however regular inspection is required to ensure any loose threads don't endanger the birds (through tangling or ingestion (King & Wilkinson, 2006)).
A variety of perches set at different heights and diameters should be considered, although perches should not be placed directly underneath each other. 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. Perches should be fixed securely in place, whether fixed or swinging.

Best Practice 3.

Enclosures.

a) All kea must be held in facilities that provide an adequate mix of space, complexity and enrichment to prevent the development of stereotypies and to encourage natural behaviours.

Enclosures should therefore have the following dimensions (height to be a minimum of 3 metres):
1 kea - 108 m^3 (e.g. 6Wx6Lx3m H) *(justification for holding a single bird must be documented and available)*
2 kea - 180m^3 (e.g. 10x6x3m)
3 kea - 312m^3 (e.g. 13x8x3m)
4 kea - 528m^3 (e.g. 16mx11mx3m)
5 kea - 798m^3 (e.g. 19mx14mx3m).
6 kea – 1122m^3 (e.g. 22mx17mx3m)
Each kea after this must be provided with an additional 3 cubic metres of space (*because of territorial behaviour, more kea will require more space*).

b) Security: double door entrances required. Materials of a strength to prevent breaches. Latches and locks to prevent unauthorized access. Perimeter fencing to exclude public after hours. Enclosure to extend below ground to prevent pest incursions or kea escape.
c) The material used for enclosures needs to be strong, safe and non-toxic. "Zoo Mesh" is the preferred wire mesh for enclosures. Tanalised timber must be covered.
d) 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 keas natural environmental conditions into account to maximise expression of normal behaviours should be developed.
e) 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).
f) 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 receptacle 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).
g) Furnishings and vegetation must be non-toxic. Floor substrate must include soil, leaf litter, bark mulch, grass or wood shavings and be checked for foreign objects, pathogens and spore load prior to introduction. Substrate replacement should be 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.
h) Concrete can be used in areas that require cleaning often, however it is not to be used in more than 50% of the enclosure.

Enclosures must meet the requirements set out in the Code of Welfare for zoo animals (Code no. 5, 2007).

5.3 Health Care Standards

This section deals with the following:

- Enclosure hygiene and cleaning
- Health problems
- Preventative health care
- Treatments and veterinary procedures
- Quarantine procedures
- Handling and physical restraint
- Procedure if kea die.

5.3.1 Enclosure hygiene and cleaning

Strict quarantine and daily hygiene protocols are essential for maintaining good health in captive kea.

Daily maintenance to ensure a clean, pathogen-free environment is important for the optimum health of any captive animal. However, in the case of kea, a clean enclosure should not be confused with a tidy enclosure. Tidy enclosures may equate to an unstimulating environment which may ensure physical health, but not mental health. A complex "untidy" enclosure must, however, still maintain acceptable physical health standards.

Apart from providing a healthy diet to the captive kea, it is also important to provide a clean environment for optimum health and production. This can only be achieved through daily maintenance of the enclosure and food preparation areas, thus preventing the built-up of any debris as follows:

- All old food, obvious concentrations of gross matter and mouldy vegetation should be removed from aviaries daily and all feeding dishes, water dishes, bottles, buckets and trays cleaned. To clean equipment, use a hot wash in a non-toxic detergent for the initial clean followed by rinsing in clean water before drying.
- 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 kea and those used for waste food will be kept separate from those used for fresh food. Sterilising feed and water dishes with products such as Milton, Trigene or Sterigene (note, dishes should be carefully rinsed after washing in products such as Trigene) should be done once a week or after heavy soiling. All perishable kea 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 should be swept daily and washed down at least 1-2 times a week, depending on soiling. Either water or a non-toxic detergent can be used for cleaning floors. Sites with earth floors should periodically replace flooring materials. For example, at Boundary

Stream leaf litter is removed after holding birds and the ground is left fallow until next use.

Best Practice 4.

Hygiene and 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 gross 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 kea.
g) In larger environments, the issues of hygiene and cleaning should be kept to a minimum. Kea enclosures should not be unnaturally tidy as this will limit complexity for the birds.

5.3.2 Health problems

Kea are not known to have any disease or health problems that are specific to the species (other than a wild flea), however they are susceptible to common parrot diseases and health problems.

Health problems or diseases which have been known to affect kea or are significant parrot diseases which require monitoring include:

- Psittacine Beak and Feather Disease (PBFD)
- Aspergillosis
- Avian Malaria
- West Nile Virus
- Psittacosis
- Ingestion of foreign bodies
- External and internal parasites

Psittacine Beak and Feather Disease (PBFD) (Also known as Psitticine circovirus PCV)
Beak and Feather is a serious disease which causes high juvenile mortality and chronic lowered suppression in parrots and has been found in wild populations of parrots in New Zealand (DOC, 2004).
Although this disease has not yet been identified in kea, there is no reason to suppose that kea cannot contract this disease (Potter, pers. comm.). The virus is extremely infectious and as well as affecting the beak and feathers of infected birds, can also affect the liver, brain, and immune system causing diminished resistance to infections. Consequently, premature death usually occurs from these secondary bacterial, fungal, parasitic, or viral infections.

Signs and Symptoms (Information from Avian Biotech).
Symptoms include irreversible loss of feathers, shedding of developing feathers, development of abnormal feathers, new pinched feathers, and loss of powder down. Other possible symptoms include overgrown or abnormal beak, symmetrical lesions on the beak and occasionally nails.

Immunosuppression, rapid weight loss, and depression are also possible in later stages of the disease.

Secondary viral, fungal, bacterial or parasitic infections often occur as a result of diminished immunity.

NB cases of PBFD have been found in Antipodes Island Parakeets where no common physical symptoms have been observed (i.e. beak or feather issues).

Transmission

Transmission of the virus between birds is primarily through direct contact, inhalation or ingestion of aerosols, crop-feeding, infected fecal material and feather dust. Most chicks are infected in the nest from a carrier parent. The virus can also be transmitted via contaminated surfaces such as bird carriers, feeding formula, utensils, food dishes, clothing, and nesting materials. The viral particles can remain viable in the environment for months.

Lovebirds and budgies are common carriers of the virus. Kea should be tested prior to transfer if held in facilities that also house these species.

Prevention and Treatment

There is no known treatment for this disease, so prevention is the key to stopping the spread between birds. Strict quarantine should be practised if beak and feather are suspected, and testing of all parrot species in the facility should be conducted to rule out latent infection in individuals.

Testing

If an outbreak of Beak and Feather is suspected, it should be confirmed by PCR (polymerase chain reaction) testing from a blood sample together with one or two feathers (especially abnormal or suspicious-looking feathers). Strict quarantine should be practised, and the bird should be re-tested after 4-6 weeks. If the bird tests negative the second time, a third test after 4-6 weeks is recommended. Birds showing positive after the third test should be euthanised.

In the event of a dead bird, seek advice from DOC and your vet.

Aspergillosis (Information from Avian Biotech)

Aspergillus species of fungus are common in the environment and in most cases do not cause ill health. This opportunistic pathogen is common among domesticated and cage birds and is known to affect kea.

If spore endotoxins occur, this is rare. More commonly, if a bird is exposed to large numbers of spores and/or its immune system is compromised (e.g. through stress) so that it cannot mount an appropriate defence against a spore load, this can result in the inhaled spores developing into a fungal infection. This usually starts as a fungal infection in the respiratory tract but can rapidly progress to severe disease and systemic disease. Aspergillosis (infection caused by an *Aspergillus* fungus) can also result in fungal infections that are very slowly progressing.

Signs and Symptoms

Symptoms range from respiratory distress, gasping, accelerated breathing, voice changes, abnormal droppings, emaciation, regurgitation, poor appetite, diarrhoea, anorexia, gout, increased thirst, nasal discharge, conjunctivitis, dyspnoea, neuromuscular disease, and somnolence, lesions (yellow or grey nodules and/or plaques in the lungs, air sacs, or trachea; less often in the peritoneal cavity, liver or other sites).

Infected eggs may develop a slightly greenish tint when candled. Well-developed lesions may appear on infected embryos after they hatch.

Transmission
Spores can be inhaled from contaminated feed, faecal material, and soil and develop in the respiratory system, lungs, eyes, and ears. Young and old birds, birds on antibiotics, and those birds whose immune systems are suppressed by surgery, reproduction, environmental changes, capture, shipping, or age are frequently infected.

Aspergillus can also infect the developing embryo by penetrating the egg while the embryo is developing.

Prevention
To reduce the number of spores in the environment, damp and contaminated hay, straw, leaf litter, or similar material must be avoided inside bird enclosures. All such material must be stored in a dry area. If a bird is suspected of having aspergillosis, aggressive veterinary treatment should begin immediately. Long courses of antifungal treatment, such as Amphoteracin and itraconazole, may be given, as well as immunostimulants. Surgery may be required with certain localised aspergillomas.
Feed should be stored in a dry environment to prevent fungal growth. Enclosure placement and design are also important in preventing this disease.

Testing
Tentative diagnosis can be made with clinical signs, blood tests (showing a very high white cell count), x-rays and is sometimes confirmed by culture. Unfortunately, this disease is most often confirmed after death.

Avian Malaria
Avian Malaria has been implicated in deaths of captive birds here in New Zealand. The actual symptoms depend very much on the species, as many species carry the parasite but remain clinically unaffected**.** Technically, there are many known species of blood parasite that cause "avian malaria" in native and introduced New Zealand birds – ie not just one species of blood parasite causes "avian malaria". To date, avian malaria caused by any of these species has not been detected in kea.

Signs and symptoms
Weakness, lethargy, anaemia and death if severely affected.

Transmission
Mosquitos are just one of many insect vectors that are involved in the life cycles of various blood parasites. Sandflies are another known vector. There are potentially more vectors also.

Prevention and Treatment
Mosquito control is the best way to prevent spread of the parasite.
Seek veterinary advice for possible treatments if the clinical signs of this disease are seen.

Testing
Can sometimes be confirmed by the presence of the parasite in blood smears.
Recently it has also become possible to test for the disease using molecular tests such as PCR. Vets and testing laboratories should know more about what tests they can perform and what samples are needed for this, and testing may vary depending on the laboratory.

Psittacosis
Psittacosis (also known as parrot disease or parrot fever) is a common infection in parrots species caused by *Chlamydia psittaci*, a specific type of bacteria.

Signs and symptoms

Infected birds don't necessarily show symptoms. They can also carry the bacteria for months before any outward signs appear. Just because a bird does not look or act sick does not mean that it's not infected. Infected birds may shiver or have difficulty breathing. Other symptoms include:

- discharge from the eyes or nose
- diarrhoea
- discoloured droppings (urine or faeces) in various shades of green
- weight loss
- lethargy and sleepiness

A sick bird may eat less or even stop eating completely.

Transmission

A bird does not have to have contact with another bird that has been infected with one of the types of bacterium that causes psittacosis in order to get it, but this is an easy way for them to get it. They can also come in contact with a person or item that has been in contact with an infected bird. Fomites, an object that can transmit infectious agents such as food and water bowls, airborne particles, feathers, faeces, and other items that have been in contact with a bird with psittacosis, can all infect healthy birds.

Prevention and Treatment

The traditional treatment of this bacterium is the use of doxycycline that the *C. psittaci* organism can hide out in the macrophage — a type of white blood cell in the bloodstream. Unfortunately, doxycycline cannot reach the organism in the macrophage when it is in its non-replicative cycle. But during its cellular division, which occurs at least two times during a 45-day treatment period, the organisms are released from the macrophage, which provides a time that the doxycycline can kill them. For this reason, the bird or birds must be retested after the end of the treatment period to make sure that the birds are free from disease and are not clinical carriers.

Several forms of the drug can be administered, so options should be discussed with your veterinarian. Doxycycline can be administered in the water, and the dose depends on the species of bird. It can also be coated on specified seeds with oil or administered directly by mouth. The doses vary based on the species of bird.

Testing

The quickest and preferred method of detecting the *Chlamydia* organism is a PCR, test. This reliable, sensitive test does not rely on the organism being viable, as with a culture. *Chlamydia* is very difficult to grow. There are some serologic tests of the blood available, but those tests can have more interpretive problems.

Ingestion of Foreign Bodies and Heavy Metal Poisoning

Ingestion of foreign bodies and heavy metal poisoning may also pose a significant risk for captive kea, particularly in the case of young or sick birds. Care must be taken when new objects are placed in the kea's enclosure. They are non-toxic or easily ingested, and signs of damage to plastic/hard rubber objects must be recorded, and removal considered if it is suspected material has been ingested.

Lead and zinc toxicity is seen reasonably commonly in parrots in human care, so birds should never come in contact with items containing these metals.

Signs and symptoms of ingestion of foreign bodies and heavy metal poisoning

- diarrhoea
- discoloured droppings (urine or faeces) in various shades of green
- weight loss
- lethargy and sleepiness

- loss of appetite

Parasites (external and internal)

External and internal parasites can impact on general health over time by placing pressure on the bird's immune system. External parasites may be identified visually either through presence of the parasite itself (this may be achieved through conditioning/training routines), or through visible damage caused to feathers through excessive preening or poor skin/feather health.

Identifying the presence of internal parasites is more difficult and routine testing of faecal samples is required as part of normal husbandry practices.

Internal parasites

Faecal screening must be carried out in spring and autumn. Birds should be treated when parasites are present as testing on birds shows presence/absence only.

External parasites

External parasites might be very small, and while some might be able to be seen during training sessions, other species might need an examination in the hand +/- microscopic examination of feathers +/- other samples in order to confirm.

Best Practice 5.

Health Management.

All staff must be aware of the following:

a) What constitutes behaviour indicative of ill health in kea.
b) The procedures to follow in the event of a sick kea.
c) Any staff that come into contact with wild parrots must follow proper hygiene protocol to prevent cross contamination.
d) 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 kea husbandry staff:

a) Psittacine Beak and Feather Disease (PBFD).
b) Aspergillosis.
c) Avian Malaria.
d) Psittacosis.
e) Ingestion of foreign bodies.
f) External and internal parasites.

Faecal screening must be carried out in spring and autumn.

5.3.3 Preventative health care

Sensible aviary design, hygienic practices, a balanced diet, and preventative health care (e.g. daily monitoring and faecal screening) should reduce incidence of disease.

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

Close monitoring of the health of individual birds should detect disease problems early.
Monitoring (inclusive of distance examinations) must be conducted as part of daily husbandry practices. Any behavioural or physical changes must be recorded in a daily diary as these may indicate a chronic or acute condition.

Faecal samples

It is recommended that faecal samples be taken once in spring, summer and autumn for internal parasite examination at a laboratory.
Daily cleaning of the bird's environment to remove gross matter, particularly from feeding utensils and areas, will help prevent buildup of parasites. Internal parasites are usually treated with ivermectin or fenbendazole (panacur) and external parasites with Frontline. Veterinary advice must be sought regarding dose rates as these will differ depending on the parasite.

Enclosure checks

Enclosure checks must be made on a daily basis as part of the normal husbandry routine to check that the environment has not been compromised in anyway. Daily inspections should check perimeter integrity, presence of any introduced foreign objects, evidence of pest species invasion (toxic plants, animals) etc.

Staff

All staff must be aware of procedure in the event of a sick kea. This must include knowledge of veterinary contact details, isolation/quarantine protocols, information records and additional contact requirements.

Any staff in contact with other parrots (wild or pets at home) must follow proper hygiene protocol to prevent cross contamination:

- Disinfect all clothes/field gear/equipment using Trigene disinfectant. Trigene can be added to a normal warm or cold wash in the washing machine (instead of laundry detergent) at 50mL per 4.5kg load.
- Boots must be cleaned of gross dirt or debris and then soaked in 1:20 dilution for 10 minutes and then rinsed thoroughly (McInnes, pers. comm. 2009).
- Alternatively, clothing and footwear used at work must remain separate from that worn while with wild or pet parrots

Weights

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 behaviours of individual birds will allow quicker diagnosis of any problems that may occur. Weights from kea should be recorded at least once per month; this can be achieved through instigation of a basic conditioning/training programme. Weight ranges for males and females (fledglings through to adults) are as follows:

Gender	Weight
Male	850-1000g
Female	750-950g

In addition, kea 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.

Keeping all 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.

5.3.4 Treatments and Veterinary Procedures

All kea captive sites should establish a working relationship with an experienced avian veterinarian to facilitate optimum health in captive birds. Contact name and details must be easily accessible to staff in the event of an emergency. In case of any sickness, the kea should be quarantined and given proper veterinary treatment.

Useful reference material can be found in **Clinical Avian Medicine** by **Harrison and Lightfoot** (2006).

Best Practice 6

Preventative Healthcare.

a) Identify and remove any chronic stressors.
b) Monitoring – regular schedule for faecal, blood works and weights. Daily distance and enclosure examinations.
c) All kea captive sites must establish a working relationship with an experienced avian veterinarian to facilitate optimum health in captive birds.
d) Contact name and details must be easily accessible to staff in the event of an emergency.
e) In case of any sickness, the kea should be quarantined and given proper veterinary treatment.

5.3.5 Quarantine procedures

Details of quarantine procedures should be readily available to staff. A full quarantine period must be undertaken for a minimum of 30 days after arrival. The two institutions involved in the transfer should discuss the pre-transfer screening required (**recommended** - clinical exam, 3-day bulk faecal sample for parasitology & Salmonella/Yersinia, CCC swab for Chlamydia PCR, testing for *Chlamydia psittaci* and 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. Facilities using ZIMS software can use a modified specimen report. In addition, 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.

Best Practice 7.

Quarantine Procedures.

All kea 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 30 days after arrival. 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 kea. Enclosures containing birds undergoing pre-transfer quarantine must be serviced **before** other enclosures containing kea.
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 kea.
g) A complete copy of the bird's individual record must be sent by the sending institution to the receiving institution.

5.3.6 Handling/physical restraint

Capture and Handling

No one should handle kea without first having been trained and supervised by someone experienced with handling the species. Although kea are a robust species which do not stress easily, physical restraint of any bird species should be done with care. Avian bones are hollow (pneumatised) and therefore fragile and easily broken (Hoffmeister, 2011; Melville, 2011).

There are three main capture techniques. It is important that proper technique be learned from an experienced handler. DOC, KCT and staff of Zoos/Birdparks are a good resource for learning how to properly work with kea. Contact the species coordinator for further information.

Kea 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 kea 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 kea 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.

Kea 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 kea. 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 kea should physically restrain the birds (Hoffmeister, 2011), however if this is not possible anyone with bird handling experience may be used.

Best Practice 8.

Handling/physical restraint.

a) No one should handle kea without first having been trained and supervised by someone experienced with handling the species to reduce incidence of harm to either bird or handler.
b) Restraint of birds must be for health, husbandry and/or research purposes only.
c) Records must be maintained stating reasons for restraint, outcomes and techniques used.

5.3.7 Procedure if kea die

Dead specimens

Authorities issued by DOC under the Wildlife act requires that all dead native wildlife undergo necropsy (post-mortem (PM) examination) to attempt to determine the cause of death and to provide information that might contribute to our understanding of the species.

Any dead kea 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 (form can be downloaded here). 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 and the Department of Conservation.

Best Practice 9.

Procedures if Kea Die.

a) All captive kea 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.
b) The kea Captive Management Coordinator must be informed about the kea 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 kea was last held (i.e. the institution that submitted the kea for necropsy). The sex of the dead kea should be recorded (if unsexed at death).
c) If the necropsy identifies any causes of injury or death that could be prevented through changes to enclosures or procedures, these changes must be made as soon as possible.

5.4 Behavioural needs

This section covers the following subject matter:

- Daily Activity
- Social grouping
- Multi-species exhibits

5.4.1 Daily activity

Wild kea spend over half of their day inactive (over 54%) with the remainder spread fairly evenly between foraging, locomotor and body maintenance activities (Brejaart, 1988; 1994). Stereotypic behaviour has not been recorded in the wild.

Although no comprehensive daily activity budget studies of kea in captivity have been undertaken, initial behavioural studies do suggest a higher proportion of motor activities expressed (Orr-Walker, *et al.,* 2005). It must be remembered however that wild activities such as flying between ridges and digging up the roots of plants in a cold environment are likely to be much more resource expensive than in captivity. Holders should therefore seek to increase the energy expenditure of their kea over the course of the day by encouraging natural foraging activities and flight opportunities. This can be achieved with additional perches, increased flight area and by giving birds reasons to fly between areas such as enrichment and/or food placement.

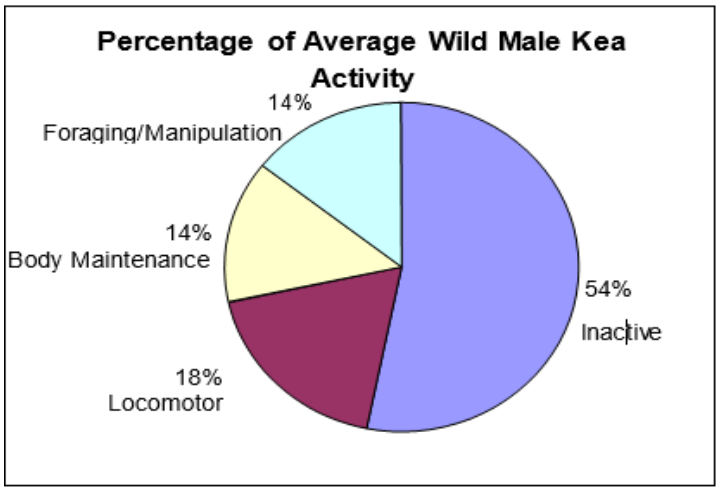

Fig 4. Although wild kea spend over half their day inactive, activity expenditure is high at all other times involving resource expensive activities such as foraging, exploration and flying.

Kea behavioural needs in captivity may more closely be satisfied through the provision of:

- Complex enclosures (inclusive of walkthroughs)
- Larger flight areas with multiple perches to encourage flight between areas
- Complex enclosure furniture which encourages manipulation
- Variable diet and multiple feeds throughout the day
- Frequent introduction of new furniture and substrates
- Appropriate and complex social interactions (inclusive of multispecies exhibits)
- Positive keeper interactions – training/conditioning

- Daily (unpredictable) enrichment

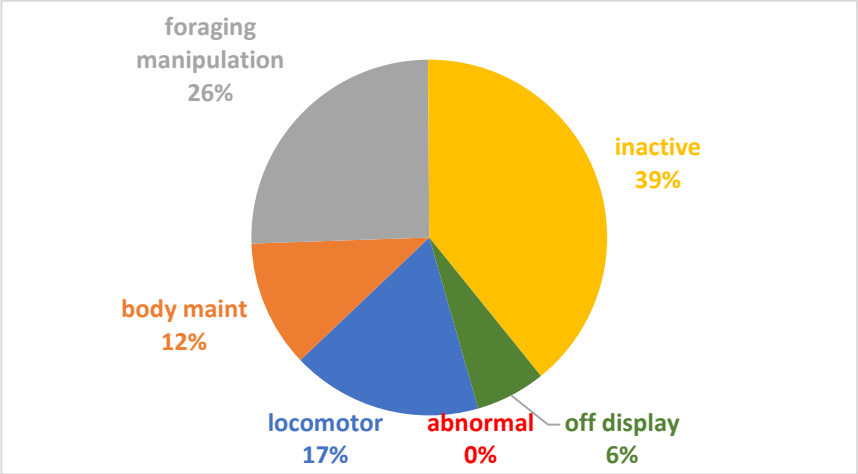

Fig 4. Example of activity for kea with a stimulating environment (Willowbank Wildlife Reserve)

5.4.2 Social grouping

Social enrichment of species is considered to be crucial for the maintenance of normal species-specific behaviours (Kreger *et al.,* 1998). It is generally acknowledged that group housing of any social species is necessary for psychological health of individuals and as a form of enrichment is one of the most complex and effective, assuming group structures are appropriate (Young, 2003). Inappropriate group makeup and size can negatively impact on reproductive success of some species. However, research has concluded that the benefits of social enrichment far outweighed the benefits of any other forms of enrichment, hence its importance in captive management (Schapiro *et al.,* 1996).

Kea as a social species must be held with other con specifics (Pullar, 1996). They are highly mobile, forming and dissolving flock groupings depending on age of individuals and season (Jackson, 1960; Clarke, 1970). Although changing social groupings seasonally is not logistically possible or necessarily in the best interests of the birds in captivity, holding kea in age and reproductive-appropriate groups is important to ensure optimal psychological and physiological well-being. As such, kea must not be housed on their own unless undergoing medical or quarantine procedures. Groupings should be appropriate for the age and breeding status of the kea and mimicking natural sex-ratios to avoid overcrowding and associated aggression. Breeding individuals can be housed separately, but with some form of optional contact with con specifics. Monitoring of social interactions is necessary to ensure aggression is minimised and to resolve any social issues that may arise.

Life stages and gender requirements:

- Females: There is some indication that holding single sex female groups is stressful with high stereotypies and aggressive behaviours (at times resulting in death) observed in research to date (unpubl, Orr-Walker, 2005). It is therefore preferable that females be grouped with males in multi sex enclosures. If females pair bond with males, they should be allowed to go through reproductive process, inclusive of nest building and laying of eggs. Those pairs not recommended to breed must

have their eggs pricked, shaken or replaced with dummy eggs to ensure that the female does not continue to lay eggs (which may cause health problems). If female-only groups are held, and until additional research is carried out to ensure that welfare is not compromised, females will require standardised monitoring to be undertaken in facilities with appropriate expertise due to a potential increased risk of stress and aggression.

- Males held in single-sex groups have been observed to pair and demonstrate mating and regurgitative behaviours during breeding season. All male groups have been successfully held. However, it is important to watch for changing group dynamics (e.g. overtly dominant/submissive behaviour that may result in welfare issues).
- Ideally, Juveniles should be held together to allow appropriate flocking behaviour for the first 3-4 years. After this time, they should be placed in either bachelor or mixed adult groups or pairs for future breeding. However, it is recognised that the constraints of captive management may not always allow for this.
- Present adult pairs should be allowed to remain in existing pair-bonds where possible. Kea mate for life, and it may be unnecessarily stressful for females, in particular, to be removed from the pair bond. Parrots are also notorious for being picky with mates and may not bond with a new mate (even if genetically a perfect match).

Development of new social groupings:

When establishing new social groupings or introducing new birds into an existing group, care must be taken to ensure that aggressive interactions are minimised.

There have been cases when new kea introduced into an existing social unit have been badly injured or killed. The introduction process must be carried out by staff with a sound knowledge of kea behaviour and over a period of time.

Integration should be carried out as follows:

- Introductions should be made early on in the day to ensure behavioural observations can be carried out

Release area must:

- be of a size which allows birds space to get away from each other.
- have appropriate sight barriers in place to ensure birds can move out of eyesight
- have multiple food and water receptacles to ensure all birds are not restricted from basic nutrition
- have access to multiple shelter areas to ensure basic shelter requirements are met
- be enriched to ensure environmental distraction

Integration duration is dependent on individual birds so it is important to be flexible with procedure. If overt aggression is evident, birds should be separated when not under observation (e.g. overnight). Newly introduced birds must be monitored at all times utilising standardised protocol to ensure unwanted behaviours do not develop.

5.4.3 Multi-species Exhibits

Kea in the wild interact with many introduced and endemic species. Native species include kaka, kakariki, bellbird, NZ robin, tomtit, blue duck and kiwi in the lowland and montane forest areas; falcon,

takahe, rock wren and alpine reptile species in the higher alpine areas. This list is by no means exhaustive.

DOC Guidelines for holding protected wildlife for advocacy purposes (DOC,2007), states that exotic and protected native species cannot be held together.

The majority of native species listed below would not be recommended to hold with kea unless in a very large enclosure which allowed for adequate territory sizes. Kea can become very territorial so any species held with kea must be either non-threatening to the kea, occupy quite different niches and/or be equally as robust. Kea are particularly aggressive during the reproductive season and breeding pairs may not tolerate another species in their local environment. Seasonal rotation can mitigate this. Individual kea may also react quite differently to the presence of other species; therefore, integration should be observed closely to ensure animals do not become stressed, injured or killed. There must also be provision of adequate space and visual barriers (vegetation, topography, rocks, enclosure furniture). It is important to ensure that no corners exist where an individual animal can become trapped.

Native species to be considered

Weka (*Gallirallus australis*). Weka are a robust flightless species and have been successfully held with kea in New Zealand. Inclusion of this species in an enclosure has the added benefit of controlling pest species such as rats, mice and sparrows. Observations of a mixed enclosure over a three-week period showed a complete lack of pest presence (including faecal matter) and infrequent and non-injurious territorial displays by the kea to counter weka incursions into kea 'territory' (a delineated area at the front of the enclosure designated by the kea). A lack of pest species was also noted throughout the year by staff (Fortis, pers. comm., 2009) Care must be taken however as fighting between kea and weka has occurred in other holdings.

Pukeko (*Porphyrio porphyrio melanotus*) Pukeko are a common native ground swamp dwelling species which may be used as an analogue species for the threatened Takahe. Pukeko have a very strong beak and may be territorial so care should be taken when first introducing this species to ensure that no injuries result.

Duck species Kea inhabit areas where threatened Blue Duck (*Hymenolaimus malacorhynchos*) are present. Other more common less territorial native duck species such as Scaup may potentially be integrated into a multi species exhibit. Scaup and Grey duck are presently held successfully in multispecies exhibits with pukeko and weka. Their different niches should ensure they have limited and non- territorial contact with kea. Water margin areas should be designed to be less accessible to the kea to ensure duck species are afforded safe areas to escape easily to water.

Best Practice 10.

Behavioural needs

Daily Activity

Aim to increase kea activity by encouraging foraging, social interactions and locomotor opportunities through daily husbandry and enclosure layout.

Social Grouping.

All life stages and gender requirements should be fully met with natural social groupings maintained at all times. Juvenile flocking should be undertaken for 3-4 years and pairings (non-breeding and breeding) developed after this period. Non breeding pairs should be maintained as single pairs or housed in groups with appropriate contraceptive methods in place to ensure no unwanted breeding occurs. Important breeding birds may be held as pairs only but should be held within audible and/or visual distance of other kea

Kea must not be held singly unless the following applies:

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

Life stages and gender requirements:

a) Adult females: It is preferable that females be grouped with males in multi sex enclosures – if possible they are housed in mixed sex exhibits with equal male/female ratio or more males than females represented where possible.
b) Adult males: may be held in single sex groups.
c) 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.
d) 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:

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

Monitoring:

a) 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.

Multi-species exhibits:

a) DOC approval required.
b) all species are able to access species specific areas.
c) Aggressive interactions are not evident between species
d) All species are in good physical health and exhibiting natural behaviours.
e) If exotic species included, appropriate signage included.

5.4.3 Behavioural enrichment

Environmental enrichment is a means by which the captive environment is enhanced through the introduction of complexity and unpredictability into the environment (Young, 2003). It aims to increase captive animals' behavioural choices to allow expression of natural behaviours, thereby enabling the animal to fulfil its motivational requirements. Through provision of a more stimulating environment, the incidence of abnormal behaviours (such as stereotypies) and stress can be reduced or eliminated thus positively impacting on animal welfare (Young, 2003).
It is defined by WAZA (2005, pp.63) 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". 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, 2018, 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).

5 types of environmental enrichment are identified by Bloomsmith et al and include social, occupational, physical, sensory and nutritional enrichment (cited in Young, 2003).

Kea are highly intelligent (Gadjon, 2005) and have developed to survive in a complex environment. They fall into the category of a high priority species as described by Kreger *et al.,* (1998) and are considered to require high levels of complexity and novelty in their environments to prevent stereotypies. Any enrichment programmes must be highly variable, evolving and adaptable and encompass the keas physiological, psychological and social requirements. Where possible, routines should be flexible to ensure the reduction of any anticipatory behaviour. As any degree of stereotypic performance has been linked with a deficit in the captive environment (Mason, 1991), it may be concluded that there are potential welfare issues in holding kea in captivity that require careful management.

Animal Welfare – the 5 domains

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). 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 Programmes

All holders of kea must to develop a written enrichment programme that is available to all staff and volunteers. Enrichment should aim to stimulate natural behaviour including play, foraging, nesting, roosting and social interaction.

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 may include either naturalistic or man-made objects. The message which an individual facility wishes to convey to the public will dictate which design is preferred - both are considered highly effective to decrease abnormal behaviours and increase natural behaviours assuming they are used inventively. Behavioural enrichment should be rotated on an ad lib, non-cyclic system and provided on a daily basis. Setting up a rigid timetable for a highly intelligent species is counter intuitive to the concept of enrichment – enrichment must be unpredictable to be enriching.

A list of enrichment types and items should be made available to keepers for reference. A combination of two or three items should be picked out at random from each type on a daily basis so that birds do not end up with predictable regimes. If there is repetition of one or two enrichment items on subsequent days that is part of the unpredictability.

Enrichment can be broken into five categories, nutritional, sensory, physical, occupational and social 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).

Nutritional

While the nutritional requirements of kea 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 kea, 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 kea 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

Sensory

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

Olfactory (smell): Kea appear to be very responsive to smell. 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 that olfaction can be used as enrichment, varying flavours by offering different food items and using extracts (lemon, vanilla, honey) to flavour water can add interest to the food presented.

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, 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

Physical

Physical enrichment includes adding to the existing captive environment by planting native vegetation and using different substrates and furnishings. 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). Comfort behaviours can be facilitated by providing perches on which kea can preen and water features, whether a stream or bath, for the kea 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 kea 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).

Occupational

Occupational enrichment involves the kea 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). 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.
Captive facilities use pinecones 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 kea sits 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 kea (Auckland Zoo, 2010).
Occupational enrichment involving food not only stimulates manipulation skills but 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).

Social

Social enrichment involves elements which require cooperation of multiple birds. As social play is less prevalent in adult kea, this strategy may work better in enclosures of juvenile and sub-adult kea (Bond & Diamond, 2004). These enrichments involve kea working together to receive a food reward in a puzzle which cannot be resolved by a single kea. The keeper can get involved directly in kea enrichment in having the birds watch them burying an item or manipulating one to encourage investigation by the kea and foster interaction between keeper and kea.

Items which require cooperation or interaction from other kea or keepers:

- Puzzles requiring cooperation
- Kea are motivated to watch keepers pulling items apart or burying them
- Training sessions would also fit into this – must be fun and positive

Be inventive and have fun! Anything that could be broken off and ingested will need to be monitored carefully, particularly where there are juveniles present. However, kea are unlikely to swallow most items unless they think they are food. Watch for white objects that may illicit a fat response – anything that is white and able to be manipulated may be considered high-energy food (fat) and ingested. This has been noted by hunters who have observed kea eating white candle wax instead of fat at the site of a deer carcass (Maloney, pers. comm., 2009).

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 kea enrichment.
The feeding enrichments may pose an overfeeding risk to the kea 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 kea if they are to be effective enrichment; 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 kea adults are highly

neophobic meaning this is a necessary consideration when planning to introduce novel enrichment objects. Beginning regular enrichment when kea 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 kea 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.

Enrichment ideas and information can also be found at the following websites:
Auckland Zoo's – Kea Enrichment Manual
The Shape of Enrichment – www.enrichment.org
Animal Enrichment – www.animalenrichment.org

Best Practice 10

Behavioural Enrichment.

a) Behavioural needs must be met through provision of a complex enclosure which stimulates both physical and mental activity.
b) All holders of kea must develop a written enrichment programme that is available to all staff and volunteers.
c) 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).
d) For an enclosure of 180m³ the following must be made available (larger enclosures require a proportional increase in these requirements) to ensure complexity and encourage increased physical and mental activity:
    - A variety of perches of varying composition, levels, angles and stability between flight areas.
    - A variety of large complex enclosure furniture pieces (rotting log/s, stream, trampers hut, ponga logs, climbing apparatus, rock wall/pile) which encourage manipulation.
    - A minimum of 2 new browse or small furniture items introduced into the enclosure per week (substrate, logs, straw (remove if wet), human objects etc).
    - Positive keeper interactions – training/conditioning a minimum of twice weekly.
    - A minimum of two feeds per day (in addition to browse presentation) presented in different ways (e.g. scatter feed spread out in enclosure trays, furniture holes) to encourage foraging over an extended period of time.

5.4.4 Training and Conditioning

Training is used in captive facilities to aid in the husbandry, health, advocacy and enrichment of a diverse range of species. However, birds are not routinely trained for basic husbandry practices (worming, health checks, crating, etc) as it is considered less resource-intensive to catch birds up on an annual basis. Yet with minimal input, training for basic husbandry procedures can significantly reduce stress and increase positive interactions for the public, keeper and kea as well as provide an enrichment opportunity.

Public encounters and keeper talks are extremely powerful tools that provide a direct link to the birds via the keeper. By providing a personal interaction that illustrates a relationship between humans and kea, the public is more likely to be able to identify with and, as a result, care for the species in the wild. Live interpretation is generally considered to be the most effective method of getting across conservation messages (WAZA, 2005).

Relevance

Training and conditioning should be relevant to the husbandry of the species and have direct welfare benefits to the individual birds. It should include basic management techniques inclusive of stationing, body presentation, weighing and crating. These behaviours will ensure less stress when moving birds or performing basic health checks. Additional behaviours sought by trainers should be relevant to captive management, aid in behavioural research and/or should aim to send important

advocacy messages to the public. Expression of behaviours which are not natural for the bird or for the express purpose of public entertainment should not be undertaken.

Methods

Only positive reinforcement methods during training should be used. Food deprivation techniques are not appropriate and are considered unethical. Bridging techniques to reinforce desired behaviours should be used – a whistle, voice command or clicker can be used for this purpose depending on trainer preference. Training techniques and advice may be found in "Don't Shoot the Dog", Pryor, 2002.

All social groups (except breeding pairs during reproductive season) should have a minimum of twice weekly husbandry routines (5-10mins per bird per session). Routines must cover basic husbandry and health requirements (weighing, crate training, checking body etc). Additional training to capture desired behaviours for advocacy (encounters) may also be developed if birds are receptive to training regime.

Trainers

At least two people should be trained in all aspects of husbandry and training/conditioning to ensure that if one person is on leave a secondary trainer can take over. Multiple trainers also add to the enrichment value of the training as there will be natural variation in training technique between trainers.

All training events and regimes (aims and outcomes) must be recorded in daily diaries.

Best Practice 11.

Training and Conditioning.

(Training can also be used as an enrichment tool to increase complexity).

Methods

a) Only positive reward methods must be used. No food deprivation techniques may be used to train or condition birds.
b) Training/conditioning to be conducted twice weekly for 5-10 minutes per bird/or 30 minutes for a larger group (whichever is less). The goal being to illicit the following behaviours that enable health checks and husbandry procedures:

- Targeting and stationing: basic training to allow for development of other behaviours (refer below) and for ensuring stress free interactions (particularly when there are dominant/subordinate interactions between birds).
- Weighing: for the purpose of attaining regular weights of birds.
- Crate training: to allow for stress free movement of birds between enclosures.
- Body presentation (spreading wings, allowing touch on keel and feet) for parasite and basic health checks.

Training must be at a level and speed which is comfortable to the individual bird/s (some birds may remain uncomfortable in close proximity to staff and only accept targeting/stationing while others require increasing stimulus).

Relevance

a) Training must include the following basic management techniques; stationing, body presentation, weighing and crating.
b) All other behaviours sought are relevant to captive management, aid in behavioural research and/or send important advocacy messages to the public.

Staff

a) A minimum of two committed persons who are confident and competent in basic kea training methods. Staff must detail each training session's objectives and results in a daily diary.

Those birds involved in breeding behaviour may not respond to training between the months of June - January however training must resume once reproductive activity has finished or if a bird within the pair is expressing stereotypic behaviours

5.5 Feeding Standards

This section includes the following information:

- Diets and supplements
- Presentation of food
- Seasonal/breeding changes in feeding requirements

Kea are opportunistic omnivores. In the wild kea are known to forage on almost 200 different food items from over 100 species of plant and a variety of animal food sources including insects and

their larvae (Clarke, 1970; Brejaart, 1988), animal carcasses (Brejaart, 1988; Schwing 2010), and live animals. Live animals include both native and introduced species, the chicks (Huttons shearwater) and eggs (shear water, Tokoeka brown kiwi and whio (McMurtrie *et al.,* 2004, cited in Reid, 2008) of other native bird species and introduced mammals such as mice (Beggs and Mankelow 2002, cited in Reid, 2008), and sheep (Brejaart 1988; NHNZ, 2003). Kea also scavenge carcasses as well as human rubbish and food around areas of human habitation and tourist locations throughout the South Island (Diamond & Bond 1999).

5.5.1 Diets and supplements

It is important to provide captive kea with a diet that has a nutritional content as similar as possible to the wild kea diet to avoid dietary-associated health problems due to nutritional deficiencies or excesses (MPI, 2018). 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 kea (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 kea; these requirements include appropriate proportions of vitamins, minerals, proteins, carbohydrates, fats and water throughout all life stages. Since wild kea 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 kea so that natural feeding behaviours can be expressed (MPI, 2018; Hoffmeister, 2011).

Recommended Diets – frequency, make up and amounts

Captive kea should be fed an artificial diet at least 2 times daily. This diet can consist of fruit, vegetables, seeds, invertebrates (or a protein supplement) and parrot pellets (specific examples of captive kea diets are shown in the **Appendix 3**). 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 (MPI, 2018; 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 kea with care taken to remove all labels off fruit (Hoffmeister, 2011). Treat items such as nuts (however, see below the caution on using too many nuts) 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 (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.

Enclosure vegetation may also be seen as a food resource for kea and so may need replacing over the course of a year. Digging up of grasses and perennials to access the roots or grubs in the soil is normal foraging behaviour for kea and provision of grass in the enclosure will provide additional

interest and activity for the birds. Small shrubs and large trees may also be food sources. The introduction of browse species on a daily basis can reduce the amount of damage to planted trees.

Browse species of particular interest to kea include cabbage tree (*Cordyline australis*), *coprosma* species, puha (*Sonchus oleraceus*), and willow.

Amounts per bird: This will depend on size and presentation of food. However care must be taken to ensure that all food groups are given in appropriate proportions (i.e. foods at the bottom of the food pyramid should comprise the majority of feed and foods closer to the top in decreasing quantities).

Parrot food pyramid from avianenrichment.com

Proteins: Kea may be given whole uncooked beef or horse bones (preferably with the marrow inside the bones) to feed on. This will provide interest, ensure beak health as well as provide the opportunity to fulfil natural behaviours.

Treats: May be used during training periods and should be given in small amounts only (e.g. cashew nuts).

Supplements:
Additional supplementation may be required for birds leading up to and during the breeding season, and for those birds that are immune compromised or need dietary supplements for health reasons.

Toxic Foods:

Many foods that we would consume are toxic to other species and parrots are no exception. The following foods are toxic to parrots and must not be fed to kea: This is not a complete list:

- Avocado
- Chocolate
- Onions
- Mushrooms
- Caffeine Dried
- Beans
- Rhubarb leaves
- Cabbage and other members of the brassica family

Toxic browse items include but are not limited to:

- Onion Weed – *Asphodelus fistulosis*
- Black Nightshade- *Solanum nigrum*
- Bittersweet Nightshade – *Solanum dulcamara*
- Jerusalem Cherry – *Solanum pseudocapsicum*

- Karaka – *Corynocarpus laevigatus*
- Other *Solanum* species including potato
- Tutu (Cariaria Spp.)
- Yew (Taxus baccata)
- Hemlock (Conium maculatum)

5.5.2 Presentation of food

The daily allowance of food must be divided into multiple feeds over the course of the day, between multiple feeding sites. This will encourage birds to forage throughout their entire enclosure, thereby helping them maintain a higher level of fitness and mental wellbeing.

Dispersing the food and feeding areas will also ensure subordinate birds are not restricted in their feeding (a dominant bird cannot monopolise a single feeding tray or hopper). It is recommended that there is at least one feeding site per bird and that visual barriers are available between feed sights.

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 (MPI, 2018; Hoffmeister, 2011). Feeding stations should be raised up off the ground at a height of approximately 1.5m and it is recommended that these stations are covered to prevent food becoming wet and mouldy. Some kea 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).

Food (ideally in the form of enrichment and browse), must be provided last thing in the afternoon to ensure that kea have interest in their environment during the highest activity times -- dusk and dawn.

5.5.3 Seasonal/breeding changes in feeding requirements

It is recommended that during the peak breeding season (June - November) the frequency and amount of food (and particularly food high in calcium) offered to breeding pairs is increased.

In institutes which breed kea, 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. Additionally, protein-rich foods, should be offered to fulfil increased energetic demands during this time (King & Wilkinson, 2006). These demands can also be met by offering nectar to breeding pairs.

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. This predominantly benefits female kea by making sure they are in good breeding condition and are thus able to produce and rear healthy chicks (King & Wilkinson, 2006).

Food consumption by the female is likely to decline significantly during the week preceding egg laying, with a sudden resurgence of appetite observed once the female has laid an egg (Pullar, 1996).

Best Practice 12.

Feeding Standards.

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

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

a) Enough food that a small amount is left over after feeding. This will vary seasonally and individually and should be monitored and adjusted accordingly.
b) 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) and parrot pellets. High energy foods such as nuts may also be used in limited quantities for training.
c) Browse items.

Presentation of food:

a) Food must be presented at least 2 times daily (in addition to browse) in two different forms to encourage active foraging throughout the enclosure
b) 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:

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

Food hygiene:

a) All foods must be stored appropriately to ensure they remain fresh and free of pests.
b) 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.

5.6 Breeding Requirements

This section includes information on:

- General breeding recommendations
- Nesting/breeding requirements
- Requirements of young
- Methods of hatching/rearing/manipulation

Kea take 3-4 years to reach breeding age and then breed between the months of July and January. Clutches of 2-4 eggs are usually produced and the eggs are incubated by the female for about 23-28 days. The male feeds her by regurgitation while she is incubating and brooding, and she in turn feeds the nestlings by regurgitation. The fledging period is 90-100 days.

Breeding recommendations

Breeding may only be carried out by a facility once a breeding recommendation has been secured from the Captive Coordinator.

Preferential breeding rights will be given to those holders who show a commitment to holding kea in optimum conditions (enrichment, advocacy, health, enclosure design, training) AND, hold or have the ability to hold founder and genetically important individuals, particularly those which are unrepresented in the population.

Reproduction

Some pairings may become aggressive while reproductively active. Birds should be carefully observed for signs of increased aggression to others held in the enclosure, or toward visitors if in a walk through aviary.

The progeny should be removed from the breeding aviary well before the next breeding season. Conflict and injuries are likely to occur when juveniles interfere with the nest site and attempt to interact with the breeding pair. The adult male can become particularly aggressive to his male progeny.

Young birds can be transferred to a colony situation where they learn to socialise with a larger group of birds. Birds introduced into male-female groups will eventually select their own mates.

Breeding frustration

Reproductive-age females have shown adverse social responses when repeatedly prevented from reproducing. This is described as “breeding frustration” and females who show this behaviour can become very aggressive to their conspecifics. Keepers need to be aware of any behaviour change of both male and female kea leading up to and during the breeding season. Organisations holding mixed-sex groups or female-only groups must have a management plan in place for any ongoing and serious aggression within their groups (i.e. multiple next boxes, the ability to separate birds temporarily).

New pairings

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. **Refer** to Section 5.4.1 for details.

5.6.1 Nesting/breeding requirements

It is necessary to ensure that all captive kea are managed as a single population, thereby ensuring maximum genetic diversity within the captive population and avoiding inappropriate breeding. Any captive kea breeding must only occur when it is recommended by a National Kea Captive Co-ordinator.

Nest boxes

At the beginning of the breeding season, nesting material should be made available to pairs within the enclosure whether they are recommended to breed or not. This is true for male-only groups also. Nesting/breeding pairs may become territorial during this time, so disturbance of the nest box should be kept to a minimum. If other kea are housed in an enclosure with paired birds, monitoring should be increased to ensure that overt territorial aggression does not occur between birds.

In captivity, most pairs breed on the ground rather than using the traditional nest log or box. Research into kea nest site preference in the wild showed that kea prefers to nest on coarse gravel, followed by gravel and sand. Areas with silt and clay, or areas with boulders, were not popular for nesting (Fredenberger et al. 2009). A semi-natural nest site can be constructed by placing a plywood box of approximately 1 metre square at ground level and then lining it with rocks inside and out. An access door should be included to allow for nest cleaning and observations. The birds can gain access to the nest area through a 200 mm diameter concrete pipe, or equivalent, of approximately 1.5 metres long (Pullar, 1996). Nesting materials that may be provided for kea should include tussock, logs (for shredding), wood chips (untreated), fern fronds and moss.

Although there is significant variation in successful nesting boxes, it is imperative that all natural nesting materials are dry, clean and free of mould spores. Materials must be non-toxic (e.g. untanalised timber).

Feeding

Food should be increased as appropriate during this period to ensure the female is not depleted of calcium etc (refer nutrition section). Egg/s should not be removed from non-breeding pairs without substituting with dummy egg/s.

Females will lay a number of eggs (up to 7) over a period of a week. Birds have been observed eating their own eggs in captivity (KCT, 2009). It is not known if this occurs in the wild although there is evidence that they do eat the eggshells (Barrett, 2008). If eggs continue to be eaten, fertile eggs may be removed and placed in an incubator, while dummy eggs are secreted into the nest instead. Once the female has completed laying eggs and is sitting, then the fertile eggs may be returned to complete incubation. Incubation takes approximately 3-4 weeks (23-28 days) (Woolcock, 2000; Fijn,2003) and during this time the female is provisioned by the male. Once the chicks have hatched out the male will continue to provision the female who will regurgitate the food to the chicks. The male will not directly feed the chicks until they venture outside the nest.

Nesting sites

For captive breeding programmes to be successful, it is important to provide reliable nesting sites and roosting assemblages in the captive environment. Kea 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 kea, 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.

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.

5.6.2 Requirements of young

Development of young

Kea chicks are dependent on their parents for an extended period of time (two months from hatch to fledging and up to an additional 4 months thereafter). Kea chicks hatch after 23-28 days incubation (Woolcock, 2000; Fijn, 2003) at a mean mass of 18.0g (Woolcock, 2000) and thereafter develop rapidly (~600grms at 28 days)

Parent raised chicks tend to put on weight earlier but show a similar trend of weight gain (KCT, 2009). Although no special foods are required for chicks directly, additional food should be made available to the parents to feed to the chicks. Once the young begin to leave the nest, they will investigate the food provided to the group as a whole.

5.6. Methods of hatching/rearing/manipulation

Preventing breeding

Birds without a breeding recommendation must be prevented from breeding. Kea are intelligent, and individuals may, therefore, require different techniques to manage reproduction.

Eggs may be removed and replaced with dummies; pricked, frozen or shaken to kill the embryo. Natural eggs should be candled a week or two later to confirm that they are no longer viable. Dead eggs should be clearly marked and the nest monitored for new eggs laid.

Some birds seem able to recognise faults in infertile or dummy eggs and will eject them from the nest and re-lay.

Rearing young – parent vs hand rearing

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 DOC and/or the Species Coordinator.

No kea chick should be hand reared individually. During rearing kea chicks must have a nest mate to avoid imprinting on humans.

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.

Contact the captive coordinator and husbandry advisor for hand-raising techniques.

Best Practice 13.

Breeding Requirements.

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

a) 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.

b) 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 they are in prime breeding condition during the breeding season.
- 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.
- Kea chicks must be parent raised (unless otherwise approved by the Captive Coordinator).

c) 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.

Preferential breeding opportunities will be given to those holders who show a commitment to holding their kea in optimum standards.

6. TRANSPORTATION

All transfers of kea between captive institutions within New Zealand must only occur as a recommendation from the captive coordinator.

Over short distances (i.e. from one enclosure to another within a single institution) kea can be transferred in a solid carry cage (available from any vet practice) which the kea cannot stick its bill through. Cage must have the following;

- Non-slip floor surface (newspaper/toweling/mat of a type not able to be ingested)
- Ventilation
- Water supply with refilling capabilities on the outside of cage or a suitable moist food such as apple or melon.

Kea 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 2018 (MPI, 2018), and the Animal Welfare (Transport within New Zealand) Code of Welfare 2018 (MPI, 2018) 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 (MPI, 2018), as this document gives details on the minimum requirements for all aspects of transportation within New Zealand.

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).

Best Practice 14.

Transportation.

a) All transfers of kea between captive institutions within New Zealand must only occur as a recommendation from the captive coordinator.
b) Ensure appropriate transport containers are used. Over short distances from one enclosure to another within a single institution kea 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 kea beak access outside the cage.
   - Water supply with refilling capabilities on the outside of cage or suitable moist food available.
c) Ensure compliance with IATA container requirements where relevant (external transfers). Air transport containers must comply with the principles specified for the relevant International Air Transport Association (IATA) container requirements.
d) Ensure appropriate hygiene protocol during transfer. All transport boxes should be wiped down with disinfectant (e.g. Trigene) after use.

The success of the kea 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 kea programme at their institution (e.g. deaths, hatches, plans to increase or decrease the number of kea enclosures etc).

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 Species360 should be used. This is currently the Zoological Information Management System (ZIMS).

End of breeding season/studbook data reports

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 kea holders by email by the Captive Coordinator). For those holders using ZIMS, a ZIMS Taxon Report for the requested timespan covers this requirement.

Best Practice 16.

Records.

a) An individual record must be maintained for every kea ever held at an institution. Holders must inform the Captive Coordinator as soon as practicable about any significant developments in the kea programme at their institution (e.g. deaths, hatches, plans to increase or decrease the number of kea enclosures etc).

b) Record of individual kea 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.

c) An end of season report must be submitted to the Captive Coordinators for kea each year, detailing developments. A template will be provided by the species coordinator for this purpose. Information required:
   - Records of kea 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.

8. ACKNOWLEDGEMENTS

Thank you to the staff at captive management facilities throughout New Zealand who have provided information for the update of the Kea Husbandry Manual and their ongoing commitment to improve the care and welfare of the kea they care for at their organisations.

Acknowledgement must also go to Tamsin Orr-Walker (Kea Conservation Trust), who not only produced the first version of the Kea Husbandry Manual, but also provided input to this version and has for many years been a strong advocate for high levels of care for captive kea and the important advocacy role kea in our care play for their wild cousins.
Thanks also to Kerry Weston, the Kea Recovery Group Leader for her support in the update of this Husbandry Manual

And lastly, the programme would like to acknowledge Bruce McKinlay (Department of Conservation) for his many years (two decades) of hard work improving the lives and conditions of captive kea across New Zealand. Much of Bruce's work to drive higher standards for captive kea has not always been noticed and when it is, it has often has not been popular; however, Bruce's work has been critical in the improvement of the lives of many kea in human care throughout the country – thank you Bruce!

9. REFERENCES

AvianBiotech.com. Retrieved 2nd March 2010 from (http://www.avianbiotech.com/Diseases/PBFD.htm)

Avian Enrichment.com. Retrieved 10th March 2010 from www.avianenrichment.com/diet.htm.

Bond A, Diamond J. 1992. Population Estimates of Kea in Arthur's Pass National Park. Notornis 39: p 151-160.

BirdLife International. 2017. Nestor notabilis. The IUCN Red List of Threatened Species 2017:. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22684831A119243358.en. Accessed on 04 June 2024.

Brejaart, R. 1988. Diet and Feeding Behaviour of the Kea (*Nestor notabilis*). Publisher

Brejaart R. 1994. Aspects of the Ecology of Kea, Nestor notabilis (Gould), at Arthur's Pass and Craigieburn Valley. [dissertation]. Otago:Lincoln University.

Bull, P.C.; Gaze, P.D.; Robinson, C. J.R. 1985. The Atlas of Bird Distribution in New Zealand.

Burdr.com. Retrieved from *http://www.burdr.com/2009/12/oscar-the- featherless-bird/*

Carlstead K. 1998. Determining the Causes of Stereotypic Behaviours in Zoo Carnivores. Toward Appropriate Enrichment Strategies. In Shepherdson DJ, Mellon JD,

Clarke CMH. 1970. Observations on Population, Movements and Food of the Kea (Nestor Notabilis). Notornis 17: 2, p105 – 114.

Cooper JJ, Nicol CJ. 1995. Stereotypic Behaviour in Wild Caught and Laboratory Bred Bank Voles (Clethrionymus Glareolus). Animal Welfare 5: 245-257

Christidis L, Boles WE. 2008. Systematics and taxonomy of Australian birds. Collingwood, Australia Csiro. http://www.amazon.com/Systematics-Taxonomy- Australian-Birds-Christidis/dp/0643065113/ref=sr_1_1?ie=UTF8&s=books&qid=1234297668&sr=8-1

Crawford, J. 2007. Kea Exhibits: The Dynamics of Kea Behaviour and Interpretive Signage on Visitor Interest. Unpublished. Unitec, New Zealand.

Croke V. 1997. The Modern Ark. The Story of Zoos: Past, Present and Future. New York: Avon Books Ltd. 272p.

Dawson EW. 1959. Supposed Occurrence of *Kākāpo* , Kaka and Kea in Chatham Islands. Notornis 8: 4, p 106-115.

Derraik, J.G.B, Tompkins, D.M., Alley, M.R., Holder, P. and Atkinson, T. 2008. Epidemiology of an avian malaria outbreak in a native bird species (Mohoua ochrocephala) in New Zealand.

Diamond J, Bond A. 1999. Kea Bird of Paradox. The Evolution and Behaviour of a New Zealand Parrot. California: University of California Press, Ltd.

DOC. 2001. Black Robin Recovery Plan. 2001-2011. Threatened species recovery plan 40. Department of Conservation. Wellington, New Zealand.

DOC. 2007. Approved guidelines for assessing applications to hold absolutely protected wildlife for advocacy and public display February 2007. Downloaded from DOC website December 2009.

ECAN. 2005. Land Management Fires Hill and High country. Environment Canterbury.

Elliott, G. & Kemp, J. 1999. Conservation Ecology of kea (*Nestor notabilis)*. Department of Zoology. Dunedin, University of Otago.

Elliott, G. & Kemp, J. 2004. Effect of hunting and predation on kea, and a method of monitoring kea populations Results of kea research on the St Arnaud Range. Department of Conservation Science Internal Series 181

Elliott, G.; Kemp, J. In press: Historical changes and current status of a kea (*Nestor notabilis*) population: A population viability analysis. New Zealand Journal of Ecology.

Engebretson, M. 2006.The welfare and suitability of parrots as companion animals: a review. Universities Federation for Animal Welfare The Old School, Brewhouse Hill, Wheathampstead, Hertfordshire AL4 8AN, UK.Animal Welfare 2006, 15: 263-276.ISSN 0962-7286

Fijn, N. 2003. The Kea. Photographs by Rod Morris. Reed publishing Ltd. Auckland, NZ.

Fraser, I., 2004. Kiwi Husbandry Manual.

Friedman M, Jenkinson T. 2003. Kea, *Nestor notabilis* Behavioural Enrichment. Auckland Zoo Native Fauna Division.

Freudenberger, L. Scherber, C. Erasmi, S. Orr-Walker, T. 2009. Where do Kea nest? Predicting habitat suitability based on Ecological Niche Modelling and Niche Factor Analysis. Faculty for Forest and Environment, University of Applied Sciences Eberswalde, Alfred – Möller – Str. 1, 16225 Eberswalde, Germany

Gajdon GK. 2005. Kea Cognition. Biology of Cognition. University of Vienna. Retrieved 2nd April, 2005 from http://bnc.univie.ac.at/index.php?

Grant, A., O'Donnell, C., Garland, P. 1993. Population viability analysis. Kea (*Nestor notabilis)* and Kaka *(Nestor meridionalis).* New Zealand Department of Conservation and IUCN/SCC Captive Breeding Specialist Group. Christchurch, NZ.

Grant, A. 1993. Wild Kea Management Statement Canterbury Conservancy Miscellaneous Report Series Number 4, Department of Conservation.

Grant WB, Holick MF. 2005. Benefits and requirements of vitamin D for optimal health: a review. *Altern Med Rev* 10 (2): 94–111. PMID 15989379

Hancocks D. 2001. A Different Nature. The Paradoxical World of Zoos and Their Uncertain Future. California : University of California Press.

Heather, B. and Robertson, H. 2015. The Field Guide to the Birds of New Zealand. Penguin , New Zealand

Hitchmough R. 2002. New Zealand Threat Classification System Lists. Threatened Species Occasional Publication 23. Wellington: Department of Conservation. 210p.

Holdaway, R. N., Worthy, T. H. 1993. First North Island fossil record of kea, and morphological and morphometric comparison of kea and kaka. Notornis 40:95-108

Holdaway, R. N., Worthy, T. H. 1997. A reappraisal of the late Quaternary fossil vertebrates of Pyramid Valley Swamp, North Canterbury, New Zealand. New Zeal J Zool 24:69121

Hutchins M.(Eds.), Second Nature. Environmental Enrichment for Captive Animals. Smithsonian Institution Press. p 172-183.

Jackson J.R. 1960. Keas at Arthurs Pass. Notornis 9: 2: p39 -58.

Jackson, J. R. 1962. The life of the Kea. Canterbury mountaineer 31: 120-123.

Jackson J.R. 1963. The Nesting of Keas. Notornis 10: 5: p319 - 326.

KCT, 2009. Summer Survey. Unpublished report.

Keiper R.R. 1969. Causal factors of stereotypies in caged birds. Animal Behaviour 17: 1: p 114-119.

Kemp J, Van Klink PA. 2009. A preliminary assessment of the by-kill of kea (*Nestor notabilis*) during aerial 1080 operations for invasive mammal control. Department of Conservation.

Kemp JR, Young L, Mosen C, Bolitho L, Orr-Walker T, Yockney I, Elliott G. 2022. Irruptive dynamics of invasive carnivores and prey populations, and predator control, affect kea survivorship across the Southern Alps. New Zealand Journal of Zoology:1-26.

Kreger MD, Hutchins M, Fascione N. 1998. Context, Ethics and Environmental enrichment in Zoos and Aquariums. In Shepherdson, DJ, Mellon JD, Hutchins M.(Eds.), Second Nature. Environmental Enrichment for Captive Animals. Smithsonian Institution Press. p. 59-82.

Mallapur A, Waran N, Sinha A. 2005. Factors influencing the behaviour and welfare of captive lion-tailed macaques in Indian zoos. Applied Animal Science 91: 3-4: p 337-353.

Mason G J. 1990. Stereotypies: a critical review. Animal Behaviour 41: p 1015-1037.

Meehan, C.L., Garner, J.P., Mench, J. A. 2004. Environmental enrichment and development of cage stereotypy in Orange-winged Amazon parrots (Amazona amazonica). Dev Psycholbiol 44: p 209-218.

Massey University et al. 2018. Kākā (*Nestor meridionalis*) Husbandry Manual

Mench J.A. 1998. Environmental Enrichment and the Importance of Exploratory Behaviour. In Shepherdson DJ, Mellon JD, Hutchins M. (Eds.), Second Nature. Environmental Enrichment for Captive Animals. Smithsonian Institution Press: p30-46.

NHNZ, 2006. Native Birds of New Zealand. A 4 DVD Documentary Collection. NHNZ Ltd.

Orr-Walker, T., Adams, N., Waran, N. 2005. Evaluation of captive kea (*Nestor notabilis)* management practices in New Zealand and their effect on behavioural repertoire. Unitec, New Zealand.

Pryor, K. 1999. Don't Shoot the Dog. Bantam Books, New York.

Pullar T. 1996. Kea (Nestor notabilis) Captive Management Plan and Husbandry Manual. Threatened Species Occasional Publication No. 9. Wellington: Department of Conservation. 15 p.

Reid, C. 2008. Exploration Avoidance and an Anthropogenic Toxin (Lead Pb) in a Wild Parrot (Kea: *Nestor notabilis*). A thesis submitted to the Victoria University of Wellington in partial fulfilment of the requirements for the degree of Master of Science in Ecology and Biodiversity. Victoria University of Wellington. New Zealand.

Robertson, C.J.R., Hyvonen, P., Fraser, M.J., Pickard, D.R. 2007. Atlas of bird distribution in New Zealand. The Ornithological Society of New Zealand. Inc., Wellington,

Sandell M , Smith HG. 1997. Female aggression in the European starling during the breeding season. Animal Behaviour 53: 1: p 13-23.

Schoenecker B, Heller KE, Freimanis T. 2000. Development of stereotypies and polydipsia in wild caught bank voles (Clethrionomys glareolus) and their laboratory-bred offspring. Applied Animal Behaviour Science 68: 4: p 349-357.

Schwing, R. 2010. Scavenging behaviour of kea (*Nestor notabilis*). Notornis 57:98-99.

Temple, P. 1978. Readers Digest.

Temple, P. 1996. Book of the Kea. Hodder Moa Beckett Publishers Ltd. Auckland, New Zealand.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. 2008. New Zealand Threat Classification Manual. Science & Technical Publishing Department of Conservation. Wellington, New Zealand.

WAZA. 2005. Building a Future for Wildlife - The World Zoo and Aquarium Conservation Strategy.

Woolcock, D. 2000. Husbandry and management of kea (*Nestor notabilis)* at Paradise Park, Hayle. International Zoo Year Book, Zoological Society of London. 37:146-152.

Weston KA, Gorman N, Matt Hickson M, Nichols M, Young L, Curtis R, Benson J, Witehira M. 2021. Research Priorities: mitigation of negative impacts on kea from the use of aerial 1080. Unpublished report docCM-6530802. Department of Conservation, Christchurch.

Weston KA, Kemp J, McInnes K, Aley J, Orr-Walker T, Dearlove T, McAulay J, Young L. 2023. Kea (*Nestor notabilis*): A review of ecology, threats and research gaps for conservation. Department of Conservation, Wellington, New Zealand.

Weston KA, Sloan F, Hodgson, B, Kemp J, Orr-Walker T, Dearlove T, Greene T, Goodman A, McAulay J, McLean L, Van Hal J, Young L. 2024. Te Rautaki Whakaora Kea / Kea Recovery Strategy 2024–2034. Department of Conservation, Wellington, New Zealand.

Young RJ. 2003. Environmental Enrichment for Captive Animals. UFAW Animal Welfare Series. U.K : Blackwell Science Ltd.

Young LM, Kelly D, Nelson XJ. 2012. Alpine flora may depend on declining frugivorous parrot for seed dispersal. Biological Conservation 147(1):133-142.

Young, L.M., Handley, L., Whitehead A.M., Yockney, I.J., Watson, M., Weston, K.A., Hickson, M., Benson, J., Curtis, R., and Giacon, I. 2022. Does aversion training wild kea on anthraquinone repellent in non-toxic bait mimics prior to 1080 operations improve post-operation survival outcomes? A case study at Arthur's Pass National Park and central Westland. Department of Conservation Internal Report, 49 p.

Appendices

Appendix 1 “Protocol for Implanting Transponders”

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 suitably qualified avian veterinarian.

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

(Below are suggestions only – holders are encouraged to research suppliers to ensure they can provide safe and quality products)

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 **“**Kea Diets”

Daily Base Diet

1 IC **SPROUTED LEGUMES**

1 ½ IC **PEAS**

1 ½ IC **CORN KERNELS**

150g **BEAN MIX**

200g **GREENS MIX** – coarsely shredded

2 **APPLE**

2 **PEARS**

2 **ORANGE**

2 **BANANA**

2 **KIWI FRUIT**

200g **CARROT** – grated + chopped

100g **GRAPES**

1x **PAWPAW**

Supplement: 20g **Calcium carbonate**

<u>For Monday add</u>:

5 **CORN COB**

200g **BEETROOT**

<u>For Tuesday add</u>:

20 **BEANS (DEC-APRIL)**

1 **BROCOLI (MAY-NOV)**

<u>For Friday add:</u>

200g **COOKED KUMARA**

20 **BEANS (DEC-APRIL)**

2 **CORN COBS (MAY-NOV)**

<u>For Saturday add:</u>

100G **PARSNIP**

200g **MELON**

100g **COOKED PUMPKIN**

<u>For Wednesday add</u>:

Half a **CUCUMBER**

<u>For Sunday add</u>:

1 **MANGO**

<u>For Thursday add</u>:

2 **CORN COB**

1 **CAPSICUM**

½ BAG OF FROZEN BERRIES (NOV-FEB)

Appendix 4 "Audit document"

This audit document has been developed to provide kea holders with a practical means to assess their facility standards in regards kea housing and husbandry and to aid them to achieve best practice standards. The audit document is also a tool for the Department of Conservation to ensure these standards are met as a requirement of the Department of Conservation wildlife permitting.

General	**Evidence required**	**Completed y/n/na**	**Comments**	**Corrective action and date completed**
Husbandry Manual/ Captive Management Plan	To sight: • Current documents accessible to kea staff • Documents signed off by kea staff			
DOC permit	Current DOC permit sighted			

Housing/ environment standards	**Evidence required**	**y/n/na**	**Comments**	**Corrective action and date completed**
General Display	All birds are on public display unless: • In temporary holding facilities (up to 1 year) • Undergoing veterinary treatment or quarantine • Involved in permitted research • Proven to have breeding difficulties on display (*documented evidence required*)			
Size	Enclosure height to be a minimum of 3 m. Kea are held in enclosures of the following size per number of birds (except for quarantine/medical reasons):			

	1 kea - 108m³ (e.g. 6Wx6Lx3m H) *(documented evidence to be sighted as to justification for single holding)* 2 kea - 180m³ (e.g. 10x6x3m) 3 kea - 312m³ (e.g. 13x8x3m) 4 kea - 528m³ (e.g. 16mx11mx3m) 5 kea - 798m³ (e.g. 19mx14mx3m) 6 kea - 1122m³ (e.g. 22mx17mx3m) (Each additional kea = 3m³)			
Materials for housing	Enclosure materials are non-toxic, durable and of strength to prevent kea escape or entry of large vertebrate species.			
Shelter/screening	The following number of shelters, screens and barriers are sighted: • 1 x undercover shelter area (approx 1m²) per bird • 2 x animal visual barriers per enclosure for each pair of birds • 2 x human visual barriers per enclosure for each pair of birds			
Water	Water is accessible at all times as follows: • A main water source 1m² x 200mm deep to allow bathing. • An additional water receptacle at another location in the enclosure (if multiple birds).			
Furnishings, vegetation and substrates	A minimum of 3 different types of each are sighted in the enclosure as follows: • Movable substrates (1 of which is soil). • Ground vegetation (1 of which is grass).			

	• Trees/shrubs • Furniture (including rotten logs and perches)			
Multi-species exhibit	The following is evident in any enclosure which has different species: • All species are able to access species-specific areas. • Acute and/or chronic aggressive interactions are not evident between species. • All species are seen to be in good physical health and exhibiting normal behaviours. • If exotic ungulate species (e.g. Thar, chamois, sheep) are held with kea, appropriate signage is provided to ensure correct advocacy message to public.			
Enclosure Siting	Enclosure is sited in such a way that enables the following: • Sunlight: access to full sunlight for min. 2 hours each day. • Shade: accessible in multiple outdoor locations at all times. • Airflow: throughout external enclosure areas only. • Moisture: no obvious build-up of pathogens, fungus and slime; however, environment should not be arid. • Ambient air temperature: variable throughout the enclosure with adequate cool areas available at all times. • Variety of gradients.			
Security	Enclosure fulfils the following security factors: • Materials are of strength and quality that ensures containment.			

	• Locks and latches attached to all access doors. • 'No public access' areas clearly visible. • Public stand-off barriers to boundary fence. • External perimeter boundary fence is present			

Behavioural Enrichment	Evidence required	y/n/na	Comments	Corrective action and date completed
Behavioural needs	The following basic behavioural needs are catered for in the kea's environment: • Large flight area: a minimum of 1/3rd of the enclosure area with perches to encourage flight between areas. • A variety of perches of varying composition, levels, angles and stability between flight areas. • A variety of complex large enclosure furniture pieces (rotting logs, stream, trampers hut, ponga logs, climbing apparatus, rock wall/pile) which encourage manipulation. • A minimum of two new browse or small furniture items introduced into the enclosure per week (substrate, logs, straw, human objects (tent/swandri etc.). • A minimum of two feeds per day presented in different ways (i.e. scatter versus main feed spread out in enclosure trays, furniture holes etc.) to encourage foraging over an extended period of time.			

Behavioural Enrichment Programme	Daily (unpredictable) enrichment programme to be sighted which includes: A minimum of 1 item from 3 different types of enrichment per day (i.e. nutritional, occupational, physical/sensory or nutritional, social and occupational etc.) on a rotational, unpredictable basis.			

Training and Conditioning	**Evidence required**	**y/n/na**	**Comments**	**Corrective action and date completed**
Methods	Evidence that positive reward techniques used only (no food or social deprivation). State evidence. Training conducted at least twice weekly for 5 - 10mins/bird (or 30mins for a group of birds whichever is less) unless adequate reasons sighted e.g. Breeding season, quarantine bird etc.			
Relevance	Training to include basic management techniques including stationing, body presentation, weighing and crating. All other behaviours sought are relevant to captive management, to aid in behavioural research or to send important advocacy messages rather than for pure public entertainment value.			
Staff	Minimum of 2 staff trained in training methods to ensure continued training when primary trainer away. Up-to-date training records sighted.			

Social Structure	Evidence required	y/n/na	Comments	Corrective action and date completed
General	Kea are not held singly except in the following circumstances: • Where birds have been held singly for the entirety of their lives and are proven to be unable to be integrated with other kea (cite evidence) • Undergoing medical treatment • Undergoing quarantine • Have lost their mate and the programme is sourcing a replacement bird			
Life Stages and Gender Requirements	**Females** are housed in male/female pairs or in mixed sex exhibits with equal male/female ratio or more males than females represented where possible. If females are held in single sex groups, and until such time that evidence shows welfare is not compromised, birds should be placed by the authority of the CMC, in facilities with appropriate expertise and standardised monitoring in place to ensure undesirable levels of aggression and/or stereotypies do not occur. **Males:** May be housed in single sex groups. **Juveniles** housed together in mixed sex situation where possible until sexual maturity at 3-4 years. Juveniles may also be housed with other sub-adults or adults. **Current non-reproductive pairs** engaged in normal pair behaviours should not be separated unless a particular bird is required for important pairing at another facility			
Development of new social groupings	If introductions are taking place the following should be sighted:			

	• Kea introductions are seen to take place in appropriate area as per introduction protocol. • Personnel monitoring introductions are experienced in procedures (name of person to be recorded). • Daily records are up to date.			

Health Care Standards	**Evidence required**	**y/n/na**	**Comments**	**Corrective action and date completed**
Environmental hygiene and cleaning	The following basic hygiene protocol is observed: • Daily cleaning of bowls. • Daily removal of gross matter. • Cleaning of water sources (if not daily state reasons why not).			
Health problems	All staff are aware of what behaviour indicates ill health in kea			
Preventative measures	The following information to be sighted in daily and veterinary records: • Daily distance observations • Weights • Thirdly parasite tests • Enclosure checks Additionally: • All staff are aware of procedure in the event of a sick kea. • Any staff that come into contact with wild parrots must follow proper hygiene protocol to prevent cross contamination.			

	• Any staff that come in contact with pet parrots at home must follow proper hygiene protocol as above.			
Treatments and veterinary care	• All birds to have access to vet (contact name and details to be sighted).			
Dead specimens	Sight records of any dead birds (the following information to be included): • Specimens sent to Massey University for full post mortem. • PM report to be sent to CMC and DOC. • Full reporting system to include cause of death, and physical, environmental and behavioural factors leading up to death.			
Quarantine procedures	Sighting of appropriate facilities and quarantine procedures.			
Handling/ physical restraint	Procedures for handling and restraint understood by kea staff.			
Transport	Sighting of transport procedure documentation to include the following: • Appropriate transport containers available (solid, non-slip floor, ventilation, no beak holes) • Compliance with IATA container requirements where relevant • DOC transfer permit where relevant • Appropriate hygiene protocol (cleaning after use)			

Feeding Standards	Evidence required	y/n/na	Comments	Corrective action and date completed
Toxic foods	The following information to be sighted: • List of toxic species listed and signed off by staff. • List accessible to staff in appropriate area.			
Diet	The following information to be sighted: • Diet sheet/s available to staff. • Foods should include all food groups as per minimum standards. • All food groups are represented daily in decreasing amounts (cereal/whole grains, fresh greens/veges, pellets, proteins (meat/bone), fruit/seed, treats/dairy). • Browse provided • Kea weights recorded to monitor food intake as per training standards.			
Presentation of food	Records to be sighted showing: • A minimum of 2 feeds per day (not including browse) presented in at least 2 different ways. • Food enrichment and browse is provided.			
Seasonal requirements	Written evidence of supplementation during colder months/reproductive season etc.			
Food hygiene	• All foods are stored appropriately to ensure they remain fresh and free of pests. • All food preparation areas are kept clean and hygienic.			

Reproductive Standards	Evidence required	y/n/na	Comments	Corrective action and date completed
Forming new breeding pairs	• Formation to be as per species coordinators recommendations. • Introduction of pairs to be monitored and documented by trained staff.			
Nesting/breeding requirements	The following is seen to occur for both breeding and non-breeding groups: • All enclosures have appropriate nesting areas and material (tunnels, nest box, straw etc.) available to the kea • All nesting material (straw) checked to exclude mould spores • Breeding occurs with recommended pairs only • Non–breeding pairs have any eggs produced replaced with dummy eggs			
Requirements of young	• Young are parent raised • Hand-rearing to occur only under specification of species coordinator			
Methods of controlling breeding	• Kea held in single sex groups (male only unless under observation (records to be sighted)) • Non –breeding pairs to have eggs removed and replaced with dummy eggs • Breeding pairs to have eggs surplus to breeding requirements removed and replaced with dummy eggs			
Breeding recommendations	Facilities breeding their kea must show the CMC current recommendation to breed and numbers of offspring allowed.			

Identification	Evidence required	y/n/na	Comments	Corrective action and date completed
Individual ID	• All kea are individually identified as per requirements and records sent to captive co-ordinator. • ID records are current and entered onto relevant programme where possible (e.g. ARKS).			
Sexing methods	• All kea hatched in captivity or brought in from the wild have been DNA feather sexed within four months of hatch. • All other kea are accurately sexed using morphological and behavioural methods. • Accurate records maintained and sexing method recorded.			

Record Keeping	Evidence required	y/n/na	Comments	Corrective action and date completed
Individual kea records	Individual kea records to be sighted and include the following: • Individual identifiers (e.g. band numbers) • Sex & sexing method (if known) • ID of parents (if known) • Origin (wild caught/birth/transfer facility) • Hatch date (if known) • Facility arrival date • Facility departure date (if applicable) • Date & cause of death (if applicable/ known) • Weights • Notes on when faecal (or other) samples taken and results.			

	• Notes on health problems and treatments offered (if applicable) • Important behavioural notes			
End of year report (to be completed by 7th April) to cover the year April 1st – 30th March of the previous year.	The following information to be sighted: • Records of kea hatches, deaths and transfers. • 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 AR&R were achieved (or at least attempted). • Information on planned holdings and requests for more (or less) birds.			

The following information, although not part of the husbandry manual, is a requirement of the permit application and as such is included in the audit.

Advocacy Standards	**Evidence required**	**y/n/na**	**Comments**	**Corrective action and date completed**
Advocacy Plan	Facility kea advocacy plan to be sighted and understood by keeping staff.			
Public information	At least one form of signage must be clearly visible at the enclosure which may include the following information; • Taxonomy and bio-data • Natural habitat and range • Population estimates • What are the wild issues? • What can the public do to help the species? • Links to outside organisations for more information (KCT, DOC)			