Brown kiwi (*Apteryx mantelli*)
husbandry manual

Ian Fraser and Tracy Johnson

Twenty-four hour old Brown kiwi chick (photo: Peter Morrin)
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1. PREFACE

The production of this husbandry manual has been supported by the Kiwi Recovery Group and by CMaG: ARAZPA NZ, the regional zoo association. It has been reviewed and endorsed by representatives of those bodies, and by the Kiwi Captive Management Advisory Committee (KCMAC). All of these groups agree that the minimum standards and recommended best practice presented herein reflect current standards and practices in husbandry of Brown kiwi and that this document meets the needs of the Kiwi Recovery Group in terms of clear standards for captive management. This document will be reviewed in 2011.

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Kiwi Recovery Group Leader

Lynn Anderson
CMaG: ARAZPA NZ Chairperson

Tony Billing
KCMAC Chairperson

Suzy Barlow
Captive Management Coordinator for Kiwi

2. INTRODUCTION

This husbandry manual has been prepared for all institutions holding Brown kiwi, *Apteryx mantelli*, in captivity. It reflects the collective experience of many individuals and organisations that have held kiwi in captivity over the past four decades, and seeks to document current best practice in husbandry of captive kiwi.

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

Consistent terminology is used throughout the document. Recommendations or guidelines are worded using ‘may’, ‘can’, ‘should try to’ etc, whereas requirements or minimum standards are worded using ‘must’.

Neither is it the intention of this manual to reproduce a lot of material published elsewhere. This manual should not be considered in isolation, but as part of a series of documents that lay out why and how we care for kiwi in captivity. These include:

*Kiwi Recovery Plan: 2008-2018* (Holzapfel et al., 2008). Describes the current conservation status of kiwi and lays out overall strategy for the recovery of all kiwi taxa in New Zealand over the next ten years.
Kiwi Best Practice Manual (Robertson & Colbourne, 2003 (updated 2007)). Provides information on numerous aspects of practical (mostly in situ) kiwi work including handling, marking and transport.

Kiwi First Aid and Veterinary Care (Morgan, 2008). Provides information on the treatment of sick and injured kiwi.

Operation Nest Egg Best Practice Manual (Bassett, in prep). Will provide detailed information on kiwi egg incubation and chick rearing.

Captive Management Plan for Kiwi (KCMAC & DOC, 2004). Describes the goals and objectives of the captive population of Brown kiwi (scheduled for review in 2009).

All kiwi holders should be familiar with the documents listed above and should refer to them whenever they are seeking information on kiwi issues not covered in this manual. All of these documents can be downloaded free of charge from the Department of Conservation’s website (www.doc.govt.nz).

With continuing developments in kiwi husbandry, it is the intention that this manual will be reviewed and updated biennially (every two years). People with an interest in the husbandry of kiwi, especially those that care for kiwi on a daily basis, are encouraged to contact the Captive Management Coordinator (see section 2.3) with suggestions and comments that can contribute to the next review.

2.1 Taxonomy

Class: Aves
Super order: Palaeognathae
Order: Apterygiformes
Family: Apterygidae
Species: Brown kiwi Apteryx mantelli

Previously the species was referred to as ‘North Island Brown kiwi’. Since the formal description of rowi and Haast tokoeka, (formerly referred to as South Island Brown kiwi), the species is confined to the North Island, and hence the ‘North Island’ epithet is now superfluous.

The captive population of Brown kiwi is managed intensively through CMaG: ARAZPA NZ’s captive management programme (the New Zealand Species Management Programme) in accordance with the goals and objectives set out in the Kiwi Recovery Plan (Holzapfel et al., 2008) and the Captive Management Plan for Kiwi (KCMAC & DOC, 2004).

The currently accepted taxonomy of kiwi (see Holzapfel et al., 2008) divides the Brown kiwi population into four sub-populations (or provenance populations) based on genetic distinctiveness:

- Northland
- Western North Island: King Country – Taranaki – Wanganui
- Eastern North Island: Bay of Plenty – East Coast – Hawkes Bay
- Coromandel
At the time of writing (2009), there are no Coromandel provenance kiwi held in captivity and the Brown kiwi programme manages the remaining three provenance taxa and a small group of mixed-provenance birds. The mixed-provenance birds are scheduled to be ‘phased-out’, i.e. no longer bred in captivity and/or released to the wild over the next few years (KCMAC & DOC, 2004).

Great Spotted kiwi (Apteryx haastii) are also held in very small numbers in captivity (at two institutions) but are currently not managed as part of a full captive programme by ARAZPA, as the captive population is too small to warrant such management.

2.2 Conservation Status

Brown kiwi are classified as ‘nationally vulnerable’ - (Miskelly et al., 2008) and as Endangered in the IUCN Red List (Birdlife International 2008).

For more details on the conservation status of other kiwi taxa refer to the Kiwi Recovery Plan (Holzapfel et al. 2008).

2.3 Captive Management Co-ordinator

Suzy Barlow
ARAZPA Senior Species Management Officer,
Based at:
Hamilton Zoo,
Brymer Road, Hamilton, 3240
(PO Box 15265, Hamilton 3243)
New Zealand

Email: suzy@arazpa.org.au
Phone: +64 7 849 7349
http://www.arazpa.org.au

Note: the European and North American captive populations are managed jointly under the American zoo association’s Species Survival Plan (SSP) Programme. The species co-ordinator is Kathleen (Kathy) Brader, National Zoo, Washington, DC. Kathy may be contacted at: braderk@si.edu

2.4 Timeframe of the plan

As set out in the Kiwi Recovery Plan (Holzapfel et al., 2008), this husbandry manual will be reviewed biennially (2011, 2013, etc) and kiwi holders will be notified when an updated version is available. Those involved with kiwi captive management are encouraged to comment on or submit new information for updates of the husbandry manual at any time to the Captive Management Coordinator.

3. IDENTIFICATION METHOD
3.1 Individual Identification

Reliable, safe and permanent individual identification of all kiwi involved in the captive management programme is essential for the maintenance of the programme (e.g. to track parentage of new individuals and to enable the identification of genetically appropriate pairings) and to assist with the ongoing husbandry of the birds in captivity (e.g. for tracking information such as medical treatment and behavioural data on individual birds).

Transponders are preferable to metal leg bands as the identity of a bird can be checked with a minimum of disturbance (e.g. no need to handle a bird or remove it from its roost box), and metal leg bands have been known to ‘open up’ and consequently be lost from a bird or cause leg injuries. Leg bands can also become tangled with vegetation in an enclosure which can also lead to injuries. The use of leg bands on kiwi held as part of the captive management programme (c.f. injured kiwi or chicks hatched in captivity as part of BNZ Operation Nest Egg) is to be phased out.

Transponders (also known as microchips) can be embedded in kiwi from about 10 days of age (R. Jakob-Hoff pers. comm.) by a suitably trained person (see Kiwi Best Practice Manual (Robertson & Colbourne, 2003) for details on what constitutes a suitably trained person). It is recommended that the procedure is performed only when the chick has regained its hatch weight.

Internationally, the most widely used transponders and scanners used to identify captive animals are the Trovan brand. However, for captive kiwi in New Zealand, both Allflex or Trovan brand transponders are used, with Allflex being used by the majority of holders. Whichever brand is used ensure that the transponders and scanners comply with NZISO standard 11785: 2001 as this standard ensures that the transponders can be read by a range of different scanners (i.e. ensuring that Allflex scanners can read Trovan transponders and vice versa). The cost of transponders is approximately $10-15 each.

The transponder should be inserted under the skin below the right wing (as described in Robertson & Colbourne, 2003). Care must be taken to ensure that the transponder is correctly located, for example, that it is not inserted into the body cavity itself.
The following people have experience at inserting transponders into kiwi (this is not a complete list of suitably experienced people, but is intended to provide holders with a suitable person in the area if they do not have a current provider for this service):

John Potter, Auckland Zoo, Auckland.
Michael Goold, Hamilton Zoo.
The Vet Centre, Otorohanga.
Trevor Kelly. Rotorua Vet Centre, Rotorua.
Linda Hayes, Beak and Claw Veterinary Services, Hastings.
Tamsin Ward-Smith, Cape Kidnappers and Ocean Beach Wildlife Preserve.
Claire Travers, Rainbow Springs and Kiwi Encounter, Rotorua.
Emma Bean, Rainbow Springs and Kiwi Encounter, Rotorua.
Carmel Richardson, Rainbow Springs and Kiwi Encounter, Rotorua.
Brett Gartrell, Massey University Wildlife Health Centre.
Katja Geschke, Wellington Zoo, Wellington.
Corry-Ann Langford, Willowbank Wildlife Reserve, Christchurch.
Ami Brown, Willowbank Wildlife Reserve, Christchurch.
Clare Green, Rangiora Veterinary Centre, Rangiora.

Trovan transponders and scanners are available from:

Advanced Identification Ltd.
PO Box 48087
Blockhouse Bay
Auckland
Phone (09) 820 7543

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

See Kiwi Best Practice Manual (Robertson & Colbourne, 2003) for further information.

If required (e.g. if two chicks are required to share a brooder), colour bands may also be used on young kiwi as a temporary alternative identification method until they are old enough to have a transponder inserted. Bands can be fabricated from electrical insulation (plastic) tape, with the tape doubled back on itself enough to ensure that no part of the adhesive side of the tape is in contact with the bird’s leg. The band must move over the tarsus easily but should not be large enough to slip over the foot or hock of the bird. Such temporary bands should be checked every day and should be removed as soon as the chick has been fitted with a transponder.

3.2 Sexing Methods

The two most common ways to sex kiwi are by morphological measurements and molecular techniques such as feather sexing. As the sex of captive kiwi often determines where they are placed within the captive population, this information is required as soon as possible in a bird’s life, preferably before birds are transferred for the first time.

Morphological sexing is only possible on adult birds, where the bill length can determine whether the individual is female (e.g. bill length over 120mm for central Northland birds, bill length over 107 mm for Waikaremoana birds (Robertson & Colbourne, 2003)). Birds with bill length below these figures may be adult male OR sub-adult females, and consequently molecular techniques must be used to confirm the sex of the individual concerned.

Wild caught birds that come into captivity and are incorporated into the captive management programme (e.g. injured birds that are released after treatment) must be sexed using molecular techniques unless they are confirmed as female by morphological measurements. Wild caught birds that have been injured and are being treated in captivity are not required to be sexed.

Chicks that hatch in captivity as part of BNZ Operation Nest Egg are not required to be sexed unless this has been identified by project partners (e.g. release site personnel, research partners) as a requirement.
### Minimum Standard 2. Sexing.

All Brown kiwi that hatch in captivity (excluding BNZ Operation Nest Egg birds) must be sexed using molecular techniques (DNA feather sexing) within four months of hatching.

All Brown kiwi 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 unless they are confirmed as female by morphological measurement.

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#### 3.2.1 DNA Feather Sexing:

The sex of kiwi is identified through the presence or absence of female specific DNA isolated from tissue extracted from the base of a sample of feathers. To date, this method has correctly sexed over 95% of samples submitted. Feathers collected from birds as young as three days old and feathers stored for up to seven years have been correctly identified.

The method of collection is straightforward:

1. Pluck approximately six feathers from each bird (the chest is a good site from which to take the sample).
2. To avoid potential contamination of the samples, avoid touching the shaft of the feather where it attaches to the bird’s body.
3. Place the feathers in a paper envelope.
4. Label the package with your name, institution name, date, and individual ID of the bird (band number or colour/transponder number).
5. Store at room temperature.
6. Send off the samples in an envelope with a covering letter or email to:

   Michelle Houston  
   Equine Parentage and Animal Genetics Services Centre  
   Drysdale Road  
   Massey University  
   Private Bag 11222  
   Palmerston North  

   06-356 9099 ext 7261  
   fax 06-350 5621  
   ebtu@massey.ac.nz

Results are generally received in less than one week and, at the time of writing, Massey University have offered to undertake the analysis of **kiwi** feathers at no cost.

Once the results are received, please inform the Captive Management Coordinator (see section 2.3) so that studbook information can be updated.
4. NATURAL HISTORY

4.1 Adult wild weights and measurements

Adult weights and measurements vary significantly between individuals, and between the different provenance populations of Brown kiwi. As with other ratite species, females are heavier than males and have significantly larger bills.

From Heather & Robertson (2005).
Figures are given as minimum – mean – maximum

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>1720 – 2250 – 3060 g</td>
<td>2090 – 2750 – 4010 g</td>
</tr>
<tr>
<td>Bill length</td>
<td>81 – 100 – 120 mm</td>
<td>111 – 130 – 157 mm</td>
</tr>
</tbody>
</table>

Refer to the Kiwi Best Practice Manual (Robertson & Colbourne, 2003) for more morphometric data, including known differences between measurements for different provenance birds.

Figure 2. Bill measurement (photo: P. Graham)
4.2 Body Condition Index

The McLennan Condition Index (in Robertson & Colbourne, 2003) can be used to assess the relative condition of different sized birds. The index is calculated by dividing the weight of the bird (in grams) by its overall length (in mm). Data from eastern provenance wild Brown kiwi at Waikeremoana have a mean condition score of 2.79 (S.E. 0.35, N=19) for males and 3.18 (S.E=0.45, N=9) for females (McLennan, unpub. data).

The length is most simply measured using a tape measure. Hold the bird upside down and place the end of the tape measure on the pads at the base of the tibia. Then measure down the ventral side of the body to the tip of the kiwi’s bill. The length of each bird in captivity should be recorded annually.

Facilities should aim to maintain the captive Brown kiwi they hold within a condition score of 2.09 – 3.49 for males and 2.28 – 4.08 for females (90% confidence intervals of means listed above).

More data on the condition score of wild Brown kiwi (especially those of other provenances) will be collected in future.

4.3 Distribution and habitat (from Holzapfel et al., 2008)

Brown kiwi habitat includes native forests, pine forests, swamp, scrub and even rough farmland. Territory size varies from 2 - 100 hectares per pair.

Archaeological and historical evidence show that Brown kiwi were once found in southern Northland, the Waikato (Mt. Pirongia) and Mt. Hikurangi (East Cape), but have been extinct from these areas since the 1970s. Little is recorded about the historical presence of kiwi on off-shore islands.

Latest estimates report that the overall population of Brown kiwi is still declining. Although populations of Northland and Coromandel provenances are expected to increase over the next ten years (assuming current management efforts are maintained) population decreases for western and eastern provenance Brown kiwi in unmanaged sites will more than offset those gains.

Kiwi populations in unmanaged sites (i.e. populations without predator control or supplementation with BNZ O.N.E) are currently estimated to be declining at 2-3% per annum.

The Brown kiwi population is estimated at 25,000 birds. Although the mainland populations are declining overall, where active predator or breeding management is being undertaken, their numbers are increasing.
Table 2: Population Trend Estimates of Brown kiwi (from Holzapfel et al., 2008)

<table>
<thead>
<tr>
<th>Species</th>
<th>2008 population</th>
<th>2018 population (projected assuming continuation of current management effort)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northland</td>
<td>8,000</td>
<td>8,500</td>
</tr>
<tr>
<td>Coromandel</td>
<td>1,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Eastern North Island</td>
<td>8,000</td>
<td>6,500</td>
</tr>
<tr>
<td>Western North Island</td>
<td>8,000</td>
<td>6,500</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25000</strong></td>
<td><strong>23,500</strong></td>
</tr>
</tbody>
</table>

Two small populations of kiwi of mixed provenance have been established at Pukaha/Mt Bruce (Wairarapa) and in the Rimutaka Forest Park (Wellington) by releasing birds previously held or bred in captivity.

![Map of New Zealand showing kiwi sanctuaries](image)

Figure 3. (from Holzapfel et al., 2008). Present distribution of kiwi (*Apteryx* spp.) in New Zealand and location of five DOC kiwi sanctuaries (note: symbol does not reflect the extent of these sanctuaries).
4.4 Habits, social structure

Brown kiwi are nocturnal, foraging for food at night and resting in underground burrows, rotten logs or thick vegetation during the day. They are monogamous and strongly territorial, especially during the breeding season. Brown kiwi chicks are precocious, first leaving the nest burrow approximately 5-6 days after hatching. Chicks are not fed by their parents at any stage and disperse from the natal territory at 2 – 5 weeks of age (Heather & Robertson, 2005).

4.5 Feeding behaviour

Gizzard and faecal analysis have shown that Brown kiwi eat a wide range of animal and vegetable matter including earthworms, beetles (adults and larvae), other invertebrates and the leaves and fruit of several plant species (Reid et al., 1982). Recent research indicates that vegetable matter is a more significant source of nutrition for kiwi than was previously thought (Potter et al., 2006). They use their well developed senses of smell and hearing to detect invertebrates in the leaf litter or just underneath the soil surface, and obtain them by probing into the ground or leaf litter with their long beaks.

Kiwi’s are opportunistic feeders and on occasions have also been observed fishing for small eels and freshwater crayfish in shallow pools and streams (T. Billing pers. comm.).

4.6 Reproduction

Incubation in Brown kiwi is undertaken exclusively by the male, in contrast to other kiwi species where incubation is shared by both male and female (or by male and female and helpers). Eggs are usually laid in June – December in a burrow, hollow log, or under thick vegetation. Brown kiwi lay 1-3 clutches of 1-2 large (124 x 80 mm; 440 g) white eggs each season. Eggs of a single clutch are laid about three weeks apart and are incubated (by the male) for 75-90 days (Heather & Robertson, 2005).

Male Brown kiwi have been known to breed in the wild in their first season after hatching (i.e. at approximately one year of age) and females have been recorded breeding in their second season (approximately 2 years of age).

Hatch weights of Brown kiwi in the wild are recorded as approximately 305g for Northland provenance birds (Colbourne et al., 2004) and 320-390g for Eastern provenance birds (McLennan et al., 2004). Hatch weights of 56 Northland provenance Brown kiwi partly incubated and hatched at Auckland Zoo between 2002 and 2005 as part of BNZ Operation Nest Egg weighed 276g – 357g – 431g (minimum – mean – maximum) (Auckland Zoo, unpublished data).

Growth rates of Eastern Brown kiwi chicks in the wild range from a high of approximately 6.3g per day at day 30, to 0.9g per day at day 500 (approximately 16 months old) (McLennan et al., 2004).
4.7 Protected species’ role in ecosystem

Kiwi are predators of invertebrates found in the litter and soil of native and exotic forests, and other habitats where they are found.

4.8 Threats in the wild

The main threats to Brown kiwi populations in the wild are recruitment failure due to predation from introduced mustelids, especially stoats, and predation of adults by dogs and ferrets (Holzapfel et al., 2008). Habitat loss resulting from changing land use is a threat for some populations (IUCN, 2007) and competition for food with introduced pests such as possums and rats may also contribute to kiwi population decline in unprotected areas (Holzapfel et al., 2008).

The small size and fragmented distribution of some Brown kiwi populations increases their vulnerability to stochastic events such as fire or disease outbreaks, and to genetic effects such as inbreeding depression and genetic drift. It is also possible that some low density Brown kiwi populations suffer from an Allee effect, whereby potential breeding animals are unable to find mates where the population density is low (Holzapfel et al., 2008).

5. CAPTIVE HUSBANDRY

5.1 Housing/Environment Standards

The 14 captive facilities in New Zealand that currently hold Brown kiwi are spread over the length and breadth of the country. They therefore occupy a wide range of different climatic conditions which may influence some husbandry methodology. Consequently not all the information provided here will be suitable for all institutions. However, the Minimum Standards must be met by all kiwi holders.
Minimum Standard 3.
Enclosures (including nocturnal houses).

a) Enclosures for a single kiwi (older than six months of age) must have a useable area of at least 30 m$^2$.
b) Enclosures for a pair of kiwi (older than six months of age) must have a useable area of at least 50 m$^2$.
c) Enclosures must not contain more than two adult birds.
d) All enclosures must contain at least one roost/nest box per bird. These must always be available for the kiwi to use.
e) Roost/nest boxes must be positioned in free-draining locations and be sheltered from direct sun, and strong winds. They must be constructed of suitably robust material, be large enough to accommodate all birds in the enclosure and be constructed in such a way as to prevent light shining directly into the roost/nest chamber of the box (e.g. by the provision of a tunnel entrance or internal dividers (see figure 2 for examples)).
f) All enclosures containing kiwi over six months of age must contain at least one fresh water container measuring 250mm long x 200mm wide x 50mm deep.
g) Birds must be able to maintain a distance of at least 2.5m from the visitors if they choose to do so (i.e. the minimum distance between visitors and the rear wall of the adjacent part of the enclosure must be at least 2.5m).
h) If you have an enclosure containing two kiwi, materials suitable for dividing the enclosure in two parts (to assist with integrating pairs of birds and to control aggression if required) must be held on site.
i) In enclosures used to display kiwi (including nocturnal houses), where visitors are not completely separated from the birds, (i.e. where walls or glass viewing windows do not completely isolate kiwi from visitors) all reasonable steps must be taken to ensure that the birds are not able to be harmed by visitors.
j) All off-display kiwi enclosures must be kept secure at all times (except when they are attended by staff) so as to minimise the risk of theft or vandalism.
k) Enclosures must meet the requirements set out in the Code of Welfare for zoo animals (Code no. 5, 2004).
l) All enclosures built or substantially renovated after 2008 must be constructed in such a way and of such materials as to exclude all mammalian predators and pests except mice.
m) A pest control system must be in place around kiwi enclosures to minimise the risk of pests entering any kiwi enclosures. All predator traps (or poison bait stations) must be checked and maintained regularly to ensure their effectiveness.

5.1.1 Size

Except for juvenile kiwi (less than six months old) or kiwi undergoing medical treatment or quarantine, all enclosures, including for display or a nocturnal house, must have a useable surface area of at least 30 m$^2$ for a single kiwi and at least 50 m$^2$ for a pair of kiwi.

Kiwi less than six 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 (e.g. brooders, small enclosures, if required to limit movement of injured birds).
5.1.2 Materials for housing and enclosure location

With the exception of enclosures for juvenile kiwi (less than six months old) or kiwi undergoing medical treatment or quarantine, the substrate for all enclosures should be soil, with a layer of leaf litter above it, to allow kiwi to forage for natural food.

Kiwi less than six months old or undergoing medical treatment or quarantine can be held on any substrate suitable for housing an individual of that life stage and/or medical condition (e.g. artificial grass mat such as ‘astroturf’, rubber matting etc).

Enclosures should be located as far as possible from areas where loud noises are likely to occur (e.g. busy roads and service roads) so as to minimise disturbance, especially to breeding birds. Enclosures should also be located in areas that are not prone to flooding. The ground slope of the enclosure is not important, although it is recommended that an enclosure on sloping ground is preferred, especially for kiwi that are earmarked for release to the wild, as this may improve their level of fitness.

Internal divisions within enclosures used to separate birds should be constructed of a durable solid material, at least 1 m in height. Permeable material such as a soft plastic mesh can be used as a temporary barrier when introducing birds to each other, but should not be used to permanently separate birds.

As staff may have to enter an enclosure when kiwi are active (even in outdoor enclosures), entry to enclosures should be via a double door system, though the internal ‘door’ can simply be a solid gate in a 1 m high internal wall.

Outdoor enclosures must exclude mammalian predators and pests, specifically cats, dogs, mustelids and rats, and therefore must be constructed of materials suitable for that purpose. Commercial predator-proof fences (see Appendix I, page 41 for details of commercial suppliers) are suitable for housing kiwi. The lower 0.5m of the inside perimeter of the enclosure should be a solid material (such as plywood) rather than mesh so as to minimise the risk of kiwi damaging their bills if they run them along the perimeter of the enclosure.

Both the perimeter and internal divisions of outdoor enclosures should be designed to minimise the risk of kiwi burrowing under walls and escaping, or entering an adjacent enclosure. A footing extending either 0.6m down into the ground or horizontally into the enclosure(s) (but covered by soil) is adequate.

Where possible (i.e. where the kiwi on display are completely separated from visitors by solid walls or glass), Nocturnal houses should be well sound-proofed. Glass viewing panels should be double-glazed or should use glass designed to reduce noise transmission (e.g. ‘Hush’ glass panels). It is also advisable to have the visitors’ viewing area fitted with a soft floor covering (e.g. carpet, cork or rubber tiles) to minimise noise levels.

5.1.3 Security
All off-display kiwi enclosures must be kept secure at all times (except when they are attended by staff) so as to minimise the risk of theft or vandalism. The use of alarm systems, especially monitored alarm systems, is recommended as this can help deter intruders and can also detect and report other problems like power failure and fire. Note that loud alarm sirens should not be located where they will disturb kiwi.

All reasonable steps must be taken to ensure that kiwi on display to visitors are secure from theft, physical disturbance and injury.

5.1.4 Shelter/screening

Throughout New Zealand there are a wide variety of kiwi nest and roost box designs, each of which has been designed to suit a particular environment. Essentially each nest or roost box should provide the birds with a sheltered and secure area which fully accommodates the physiological needs of the bird. As kiwi are nocturnal the roosting or nesting chamber of these boxes must be free of direct light and must comply with the standards identified in Minimum Standard 3 (see page 16).

At least one roost box per bird must be provided in each enclosure and kiwi must have access to the roost boxes at all times (NB. for the purposes of this manual the terms nest box and roost box are interchangeable). It is recommended that a single bird has two or more boxes to choose from and that a pair of kiwi are provided with at least three boxes.

Boxes should be constructed of wood (10mm H3 treated plywood is often used), be large enough to easily accommodate two adult birds (approx 400 x 400 mm), and have a tunnel and/or internal dividers to minimise the amount of light reaching the roosting/nesting cavity. All boxes should also have a hinged lid to provide staff with easy access to the bird(s) when required.

Roost boxes should not have a wooden base, and should be dug into the ground (100 – 500 mm). Boxes should be replaced every two-three years because of the increased risk of Aspergillus spp spores in the rotting wood causing disease in kiwi.

In cooler environments (i.e. where the ambient temperature falls below freezing in winter) boxes should be insulated in some way: for example by completely burying the box in the ground (up to the level of the lid) or insulating the roosting/nesting cavity using natural domestic insulation material but not fibreglass or plastic based products. In warmer environments it may be beneficial to install an overhead irrigation system which, in addition to the shade and shelter provided from any trees in the enclosure, can cool the surrounding environment and moisten the ground. Care should be taken to ensure that the use of any overhead irrigation system does not compromise the environmental conditions in any nest or roost box by flooding them.

5.1.5 Water

Fresh water must be provided at all times. Water dishes must be large and deep enough (approx 250 mm long x 200 mm wide x 50 mm deep) to allow birds to submerge their entire bill and bathe in. Water features and pools can be used in enclosures but care must be taken to ensure that birds can easily exit the pool should they fall in.
Figure 4. Plans of two types of plywood roost/nest box. Left hand side: top view. Right hand side: side view.
5.1.6 Furnishings and vegetation

A thick layer of leaf-litter (20 – 50 mm) should be placed in all kiwi enclosures and added to when it becomes compacted, every two to four weeks. **Care must be taken to ensure, as far as practical, that leaf-litter used in kiwi enclosures is free from harmful material** such as small metal or plastic objects, and/or herbicide/pesticide residue, which may be ingested by kiwi. Leaf-litter and soil should be screened with a metal detector (e.g Fisher 1212X or Garret ACE) before being placed in the enclosure. Holders must also take reasonable steps to ensure that soil used in kiwi enclosures, especially **nocturnal houses**, is free from foreign objects. Rotting logs or tree stumps should be provided for behavioural enrichment of the birds.

Leaf litter should **not** be collected from disturbed habitat (e.g. forest edges), nor should eucalyptus mulch or shredded bark be used, because of the increased *Aspergillus* spore counts in these areas (Joseph, 2000). Eucalyptus trees and mulch are also associated with cryptococcosis, a fungal disease which has caused mortality in several kiwi (Hill et al., 1995; Malik et al., 2003).

In nocturnal houses, the subsoil and leaf litter should be removed and replaced with fresh material at least once a year to prevent excessive build-up of soil contaminants and faecal material.
Enclosures should also contain shrubs/trees. A covering of vegetation in an enclosure will help ensure that the soil remains soft enough for kiwi to probe into and may provide some food (fruit) for the kiwi if appropriate species are planted. Plant cover will also generate leaf litter.

The following species are good for outdoor enclosures:

- Pigeonwood – *Hedycarya arborea*
- Kahikatea – *Dacrycarpus dacrydioides*
- Hinau – *Elaeocarpus dentatus*
- Mahoe – *Melicytus ramiflorus*
- Kanuka – *Kunzea ericoides*
- Rewarewa – *Knightia excelsa*
- Flax (Harakeke) – *Phorimium tenax*
- Coprosma – *Coprosma spp.*
- Lemonwood (Tarata) – *Pittosporum eugonoides*

The following species have grown well in some nocturnal houses:

- Brown tree fern (Wheki) - *Dicksonia squarrosa*
- Ponga (Wheki) - *Dicksonia fibrosa*
- Soft tree fern (Katote) - *Cyathea smithii*
- Silver fern (Ponga) - *Cyathea dealbata*
- Black Ponga (Mamaku) - *Cyathea medullaris*
- Crown fern (Piupiu) - *Blechnum discolor*
- Kanuka - *Kunzea ericoides*
- Nikau - *Rhopalostylis sapida*
- Flax (Harakeke) - *Phorimium tenax*
- Bush Astelia - *Astelia fragrans or Astelia grandis.*
- Kohekohe - *Dysoxylum spectabile*
- Kawakawa - *Macropiper excelsum*

The following plant species must not be used in any kiwi enclosures as they are known, or thought, to have caused illness or death in captive kiwi (see Shaw & Billing 2006):

- Onion Weed – *Asphodelus fistulosus*
- Black Nightshade - *Solanum nigrum*
- Bittersweet Nightshade – *Solanum dulcamara L*
- Jerusalem Cherry – *Solanum pseudocapsicum*
- Karaka – *Corynocarpus laevigatus*
5.1.7 Humidity/temperature/thermoregulation

Although kiwi become lethargic during periods of hot weather, they are relatively robust and can tolerate a wide temperature range. Nevertheless, the temperature in indoor enclosures (nocturnal houses) should remain below 25°C. Most indoor facilities have indicated that they maintain a temperature range of 14-20°C.

High humidity promotes the growth of moulds and fungi (including *Aspergillus* spp.) while dry, dusty conditions (i.e. low humidity) predisposes birds to respiratory aspergillosis (Joseph, 2000). Therefore humidity within nocturnal houses should be maintained within a moderate range, 50-60%, if possible.

The rate of air exchange within nocturnal houses also affects *Aspergillus* spore counts, so kiwi houses should be well ventilated; achieving at least 12% air exchange per hour (Walraven, 2004).

Steps should be taken, e.g. watering, to ensure that the substrate of enclosures remains soft enough (at least in some areas) for kiwi to probe into the soil with their bills.

5.1.8 Lighting

A variety of different lighting regimes and devices are currently used in reverse light cycle displays (i.e. nocturnal houses) in New Zealand. Currently nocturnal displays operate with between six and fourteen hours of ‘darkness’ in each 24 hour period. A shorter period of ‘darkness’ (8 – 10 hours) may encourage more activity in kiwi on display. It is recommended that the day/night cycle be changed at least once every three months to mimic changing day lengths in the natural environment (i.e. shorter nights to emulate summer and longer nights to emulate winter).

No ideal levels for brightness (lux) have been developed and establishing an appropriate level of brightness during the night phase is largely a process of trial and error. Nocturnal houses should be bright enough (during the night phase) for visitors to see the kiwi clearly while still being dark enough to encourage the birds to forage in the enclosure.

Ideally, lights used for the day phase of the cycle should provide adequate lighting to support the growth of live plants in the exhibit. See appendix 1 for a list of lighting types currently used in some of the nocturnal houses in New Zealand.

5.2 Health Care Standards

5.2.1 Environmental hygiene and cleaning

Avoid build-up of food debris in enclosures by removing all food scraps around feeding sites daily. Feeding sites should be moved regularly (at least weekly, and preferably daily) to further reduce the risk of a build-up of food scraps.
Nest and roost boxes must be cleaned as required (i.e. if faecal material has accumulated within the box) and should be moved periodically to prevent a large build up or concentration of faecal material in one area. The soil immediately under a roost/nest box should be removed from an enclosure whenever boxes are moved. Boxes should also be cleaned, disinfected by washing with Virkon, Trigene or similar disinfectant, and rinsed thoroughly from time to time. Boxes washed with Virkon or Trigene must be completely dried, then allowed to stand for at least 24 hours before placing back with bird due to the respiratory irritation associated with these disinfectants. Boxes in which kiwi are nesting should not be moved or disinfected during the breeding season.

As far as possible, ensure that no foreign material (e.g. tacks, screws, tape, nails, hairclips, jewellery) is introduced to kiwi enclosures. Kiwi readily ingest such material and this has caused the death of several kiwi in captivity. Be especially vigilant after extensive enclosure renovations or construction of new enclosures. A metal detector should be used to periodically to search for small metal objects in enclosures. A metal detector should definitely be used following any construction work in or significant renovation of an enclosure.

Feed dishes and/or tubes must be cleaned daily in hot water and detergent. They should also be rinsed thoroughly with water before drying to remove detergents. Feed dishes and/or tubes should also be disinfected regularly with a commercial disinfectant such as Trigene or Virkon (and rinsed thoroughly), especially if swapped between birds.

Food preparation surfaces and areas must be kept clean at all times and should be constructed of impermeable material such as stainless steel or formica.

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<tr>
<td>a) All water dishes must be cleaned and re-filled with fresh potable water daily.</td>
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<td>b) All food dishes (or tubes) must be cleaned daily.</td>
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<tr>
<td>c) As far as is practicable, all food scraps and leftover food must be removed from enclosures daily.</td>
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<tr>
<td>d) Roost/nest boxes should be cleaned if faecal material has accumulated within the box (unless this is likely to interfere with breeding).</td>
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<tr>
<td>e) All areas used for the preparation of kiwi diet must be kept clean.</td>
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### 5.2.2 Known health problems

A range of diseases and trauma may affect kiwi. Common problems include traumatic gastritis caused by ingestion of metallic foreign bodies, egg binding in females, obesity and diseases associated with heavy parasite loads.

Refer Morgan (2008), Kiwi First Aid and Veterinary Care, for a list of health problems associated with kiwi and their treatment.
Do not hesitate to contact other kiwi holders and experienced kiwi veterinarians for advice on health issues affecting kiwi. If you are unsure who to talk to, please contact the Captive Management Coordinator for advice.

5.2.3 Preventative procedures (health monitoring)

Regular weighing

Adult kiwi should be weighed whenever they are being handled (e.g. for transfer to another enclosure or for treatment) and their weight recorded in their individual specimen record or file. They must be weighed at least twice annually as a minimum standard, however for sound management practices monthly weighing is recommended. Birds that are undergoing treatment for injury or illness, or are suspected to have health problems, should be weighed more frequently. Chicks should be weighed daily until they reach 800g (refer to Best Practice BNZ ONE manual) to monitor growth rates.

Birds can be weighed by placing them in a box (a modified cardboard ‘cat carry’ box is sufficient) and using an electronic scale, or placing the bird in a bird bag and using a 1, 3 or 5 kg (depending on the size of the bird) spring balance.

The length of all birds should also be measured periodically, so that the McLennan Body Condition score can be calculated (see section 4.2).

Faecal sampling

Faecal sampling of captive kiwi must be undertaken at least every six months to identify common gastrointestinal parasites. If parasites are detected, treatment should be considered and administered as appropriate (refer Morgan, 2008 – Kiwi first aid and veterinary care). Note that kiwi often carry low to moderate parasite loads without showing clinical signs of illness. A veterinarian should be consulted and other factors (such as bird weight and appetite) should be considered when deciding whether or not to treat kiwi for parasites.

Kiwi less than 6 months old should have faecal samples analysed for *Coccidia* at least every month, as young birds are especially prone to illness due to infection by this parasite (Morgan 2009, pers comm.).

If uncontaminated faecal samples cannot be found in the birds’ enclosures then the birds may be held in a clean carry box until they have produced the required sample.
Monitoring food consumption

Daily records of the amount of food offered to kiwi and removed from the enclosure each day can provide an early indication of ill health or other developments such as egg laying. Therefore this information should be recorded for each bird (or each pair of birds) in the animals’ individual specimen records or a daily diary.

5.2.4 Treatments and Veterinary Procedures

Refer Morgan (2008), Kiwi First Aid and Veterinary Care.

5.2.5 Procedure if animals die

It is a Department of Conservation requirement (Wildlife Health Standard Operating Procedure) that all dead kiwi undergo necropsy (post-mortem examination) to attempt to determine the cause of death and to provide other information that might contribute to our understanding of the species.

Any dead kiwi must be submitted to a veterinarian for necropsy. The Captive Management Coordinator must also be informed of the bird’s death as soon as possible.

Holders should ensure that the veterinarian undertaking the necropsy provides them with a detailed report on the findings of the necropsy. Once necropsy results have been received from the veterinarian a copy must be forwarded to the Captive Management Coordinator.
Massey University’s Wildlife Health Centre provides a diagnostic service on contract to the Department of Conservation (DoC). Institutions holding kiwi will not be charged for any birds submitted to Massey University for necropsy.

Other veterinarians experienced with kiwi pathology can undertake necropsy of dead birds, however the DoC will not pay any charges associated with this service.

For detailed information on how submit birds to Massey University for necropsy see http://wildlife.massey.ac.nz, or Morgan (2008). A summary of this information is provided below:

1. **Do not freeze the carcass.** Wet the carcass thoroughly with clean water to reduce the temperature of the carcass quickly, and refrigerate it as soon as possible. Do not put it in the freezer as this will damage tissues and make a full investigation more difficult. Only freeze the carcass if it is unable to be delivered within 36 hours of discovery.

2. Complete a Wildlife Submission Form. This can be downloaded from http://wildlife.massey.ac.nz or copied from Appendix 2. The purpose of the form is to identify the specimen, list any background information that may help identify the cause of death, state any special information the submitter is seeking about the sample, aside from cause of death, and to record if there are 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 bags 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 too much in transit. Label the package **urgent, perishable** and/or **keep cool, do not freeze** and courier to:

   Attention: Maurice Alley/Brett Gartrell/Kerri Morgan  
   Room 8.28  
   Vet Tower  

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**Minimum Standard 7.**  
**Procedures if kiwi die in captivity.**  

All kiwi that die in captivity must undergo necropsy by a suitably experienced veterinarian.

The Captive Management Coordinator for kiwi (see section 1.3) must be informed about the kiwi 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 Management Coordinator by the institution where the bird was last held (i.e. the institution that submitted the bird for necropsy).

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.
Email (to B.Gartrell@massey.ac.nz) or phone the Wildlife Health Centre on (06) 350 5329 (Weekdays) or (06) 350 5955 (Weekends) to inform them of the carcass being sent. **Do not send carcasses over the weekend** as most courier companies do not deliver on Saturdays or Sundays, nor do they refrigerate packages.

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.

### 5.2.6 Quarantine procedures

Pre- or post-transfer quarantine is undertaken to minimise the risk of transferring diseases between institutions or between an institution and the wild.

A full quarantine period (as set out in minimum standard 7) need only be undertaken by either the receiving OR the sending institution, not both. The two institutions involved in the transfer should discuss quarantine options and decide which facility will undertake to hold the birds in quarantine. Commonly it is the sending institution that will do the quarantine, but this can be reversed if the parties involved agree to it.

Results from faecal analysis should be available from the laboratory providing the analysis 24 hours after they received the sample.

If the receiving institution is doing the quarantine the sending institution must still 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 ARKS software can use a modified specimen report while institutions not using ARKS software should use a report such as the one shown in Appendix 3 (courtesy of Westshore Wildlife Reserve).
Minimum Standard 8
Kiwi transfer and quarantine.

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

a) Birds should be isolated in quarantine for a minimum of 14 days after arrival or before being transferred (depending on whether the quarantine is being undertaken by the sending or the receiving institution). If birds that have been/are about to be transferred are held in an enclosure with other birds then ALL birds in the enclosure must undergo the quarantine, including all medical checks and faecal and blood sampling and analysis.

b) Enclosures containing birds undergoing post-transfer quarantine must be serviced after other enclosures containing kiwi. Enclosures containing birds undergoing pre-transfer quarantine must be serviced before other enclosures containing kiwi.

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 for eggs of endoparasites (Ascarid, Heterakis, Capillaria, Strongylate and Coccidia) at the start and again on day seven-nine of the quarantine period (to allow for analysis to be completed before the quarantine period ends).

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 kiwi.

g) Except where birds have been transferred to undergo medical treatment, only birds that have undertaken the quarantine procedure outlined here, and have been found to be healthy, should be released into the general kiwi population at your facility. If medical checks or samples reveal health problems these should be resolved or adequately controlled before the birds are released from quarantine.

h) A complete copy of the bird’s individual record must be sent by the sending institution to the receiving institution.

i) All kiwi being transferred must undergo a thorough physical examination by a veterinarian prior to transfer (regardless of whether the quarantine is being conducted by the sending or receiving institution).

Where possible, birds should undergo the quarantine period in a special quarantine facility, isolated (separate air flow, water system etc) from other kiwi enclosures. Ideally, staff attending to kiwi in quarantine should not be servicing any other kiwi at your facility.

5.3 Behavioural Notes

5.3.1 Common captive behavioural needs

In association with the shelter, substrate and dietary requirements outlined elsewhere in this manual, the regular provision (probably every two to four weeks in nocturnal houses, less often in outdoor enclosures with good tree cover) of fresh leaf litter and rotting logs/tree trunks will meet the behavioural enrichment needs of kiwi in captivity.
5.3.2 Behavioural enrichment activities

In addition to leaf litter and rotten logs, live earthworms or other invertebrates should be regularly spread about in all kiwi enclosures to encourage birds to forage naturally for food. Live invertebrates must be provided at least twice weekly to kiwi held in indoor enclosures.

Care must be taken to ensure that this additional source of nutrition does not cause birds to become overweight. If this is the case then the amount of artificial diet offered should be reduced (rather than reducing or eliminating the live invertebrates from the diet). If mealworms are used for enrichment/nutrition they should be limited to approximately 10 g per day or less (approximately 60 large mealworms per bird per day) as they have a particularly high fat content.

**Minimum Standard 9. Behavioural Enrichment**

Live invertebrates (e.g. earthworms, cricket nymphs, locust nymphs, wax moth larvae, mealworms (in limited numbers) huhu grubs, putirī moth larvae) must be provided at least twice weekly to kiwi held in indoor enclosures.

5.3.3 Sharing of enclosures

Kiwi are strongly territorial and the introduction of another bird into the territory/enclosure of an existing pair is likely to lead to the death or injury of one or more birds.

Adult kiwi should be held singly or in breeding pairs. It is possible to hold two adult males together, especially if they have been housed together from an early age. It is also possible, though riskier, to hold two adult females together in a single enclosure. This should not be done without first consulting the captive management coordinator.

Adult kiwi (especially females) living in pairs have been known to kill their mate (even when they have been paired together for several years without any apparent aggression). Same sex ‘pairs’ are more likely to show aggression toward one another and must be monitored carefully.

Kiwi can be housed with other native species (note that the DOC Guidelines for holding protected wildlife for advocacy purposes (DOC, 2007) states that exotic and protected native species cannot be held together). Kiwi have often been held in nocturnal houses with ruru (morepork) and have occasionally been held in large walk-through aviaries displaying a range of native avifauna.
5.3.4 Handling/physical restraint

From Kiwi Best Practice Manual (Robertson & Colbourne, 2003).

No one should handle kiwi without first having been trained and supervised by someone experienced with handling the species. Kiwi require special care when being handled because they are easily injured as they have a very brittle sternum, weak pectoral muscles and ribcage, and a long thin bill. They also have an ability to shed feathers easily, especially during wet conditions or if the bird’s feathers are even slightly damp. In addition, kiwi are able to seriously injure handlers with their claws.

Special care must be exercised when holding kiwi, both for the safety of the kiwi and for that of the handler. When handling kiwi for the first time, you should be instructed by an experienced handler in what to do.

Method for juvenile, sub-adult and adult kiwi (but not chicks less than three weeks old) (Robertson & Colbourne, 2003):

1. Always hold kiwi firmly by the bare part of their legs, preferably with the body cradled on a forearm or, if you are sitting down, on the upper legs. A firm grip around both legs is needed to prevent a bird lashing out with one leg and twisting around which may damage the upper part of the leg being held, or the sharp claws may inflict serious wounds to the handler. If a bird does get one leg free, allow the bird to rotate in your hand to prevent its upper leg from being damaged.
2. Do not hold the bird by the feathered portion of its legs as kiwi very easily drop their feathers.
3. Never hold a kiwi solely by the bill or around its body, as both bill and ribcage are delicate and the bird could be easily injured.

Method for kiwi chicks (less than three weeks old):

Kiwi chicks are fragile, especially in the first week or so of life when they have a large internal yolk sac. Cradle kiwi chicks in two hands, with hands cupped underneath the bird’s feet. The bird can be lightly restrained with the thumbs.

5.4 Feeding Standards

5.4.1 Diets and supplements

The diets used by the 14 institutions currently holding kiwi in New Zealand are all based on ox-heart and are all adequate for the maintenance, and often breeding, of Brown kiwi. It should be noted however that eggs produced by birds in captivity are generally smaller than eggs produced in the wild (KCMAC & DOC, 2004) and current data indicates that adult life expectancy is shorter in captivity than in managed (i.e. predator controlled) sites in the wild (KCMAC & DOC, 2004 and Holzapfel et al., 2008).

Recent research into kiwi diet at Massey University has led to the formulation of a new artificial diet which is expected to be commercially available some time in 2009. It is envisaged that all kiwi holders will adopt the new diet within 12 months of it becoming
available (provided no problems become evident from early adopters of the diet). For information regarding recent research contact Charlotte Minson (charlotteminson@gmail.com). For further information on, and on kiwi nutrition generally, please contact Don Thomas (D.V.Thomas@massey.ac.nz).

Always wash your hands before preparing any kiwi food. Ideally, disposable gloves should be worn during food preparation.

Ensure that the ox-heart used for kiwi is from a reputable source (i.e. an abattoir or butcher producing meat for human consumption) as there have been some issues in the past with contaminated meat causing kiwi fatalities. All fat should be trimmed from the ox-heart before it is used in kiwi diet.

Approximately 200-250g of diet should be offered to each adult kiwi each day. Do not overfeed kiwi as they can become chronically overweight (mean weight of a male kiwi = 2.25 kg; female kiwi = 2.75 kg). Birds should be maintained with a McLennan Condition Index (weight/length) score of approximately 3.1 – 3.2 (see section 3).

Either Kiwi Premix or Wombaroo Insectivore Mix must be added to the artificial diet. One facility found that shortly after switching from the premix to Wombaroo several birds they held began to suffer from dermatitis. Although a direct link was never proven, facilities using Wombaroo should monitor their birds closely for signs of dermatitis.

The Kiwi Premix was reformulated in 2000 as the previous formulation was essentially a cat premix and was not suitable for kiwi (Billing 2001). This obsolete kiwi premix (as stocked by Carlyle Veterinary Clinic at the time of writing (March 2009)) should no longer be used by institutions holding kiwi.

Live invertebrates (earthworms, crickets, locusts, mealworms, wax moth larvae etc) should also be offered to kiwi frequently (see section 4.3.2 – Behavioural enrichment activities). Outdoor enclosures with well established plant cover may naturally provide adequate numbers of live invertebrates. If institutions do not feed live invertebrates to kiwi in outdoor enclosures they should check that suitable prey items are available in the outdoor enclosures throughout the year.

5.4.2 Presentation of food

Recommended Best Practice

To mimic natural feeding methods and to minimise desiccation of the diet and the risk of non-target birds (e.g. feral blackbirds) consuming kiwi diet in un-roofed outdoor enclosures, the artificial diet should be placed in a solid impermeable tubes such as a plastic syringe cover or PVC pipe closed at one end, pushed directly into the enclosure substrate or placed in slightly larger diameter pipes or tubes buried in the ground. The feeding tubes should be surrounded by an area of plastic, polythene, rubber or neoprene sheet (approx 400 mm diameter) from which food scraps can be easily removed and which can easily be cleaned - wiped down while in place and periodically removed and thoroughly washed. Neoprene is often used by roofing contractors, who may be able to provide suitable off-cuts free of charge.
Figure 6. Feeding tubes (syringe cover type) and rubber sheet at Auckland Zoo (photos: I. Fraser).

The feeding sites should be moved at least every week (and preferably daily) so as to eliminate the build-up of any food scraps not captured by the plastic sheet. The daily allowance of artificial diet should be divided between multiple feeding sites to encourage the birds to forage throughout their enclosure, thereby helping them maintain a higher level of fitness. In nocturnal houses, dividing the diet into two or more feeds each day (e.g. morning and afternoon feeds) may encourage kiwi on display to forage for longer.

Other methods

The artificial diet can be presented in a standard impermeable feeding dish, although extra precautions to stop food drying out in hot weather or interference from feral birds, or other species in the enclosure, maybe required. To avoid desiccation of the diet in outdoor enclosures during periods of hot weather food should be kept refrigerated and not placed in the enclosure until approximately 30 minutes before sunset. Non-target species can be discouraged from interfering with the diet by using either of the following methods:

1. Placing the dish under a small shelter the sides of which are comprised of strips of relatively heavy, but flexible material (e.g. carpet, thick plastic).

2. Placing a plastic or steel mesh cage over the food dish with a mesh size (approximately 40 mm) large enough to allow kiwi to extract food from the dish but small enough to prevent non-target species getting to the food. The cage must be high enough above the food to prevent non-target species reaching through the cage to the food.

5.4.3 Seasonal/breeding changes in feeding requirements

Although kiwi have been known to breed in captivity without any changes to their usual diet, and eggs have been produced in every month (Johnson, 2004), it is recommended that during the peak breeding season (June - November) the frequency and amount of live invertebrates offered to breeding pairs of kiwi is increased.
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.

5.5 Breeding Requirements

5.5.1 General behavioural notes; forming new pairs

The Brown kiwi population is intensively managed and birds must not be allowed to breed unless they have a breeding recommendation from the Captive Management Coordinator. Such recommendations are contained in the final Annual Report and Recommendations document prepared each year by the Captive Management Coordinator in consultation with captive institutions.

When establishing a new pair at your facility, never introduce a new kiwi to another kiwi’s existing enclosure straightaway. As kiwi are very territorial, especially the females, they will need time to get used to each other via scent and calls, otherwise aggression may occur which can result in death. Pairing birds should always be supervised by an experienced kiwi practitioner. The following steps are provided as a guide to assist holders with successfully pairing two birds:

1. Place the two birds in adjoining enclosures, or a single large enclosure with an internal solid barrier dividing the enclosure in two.
2. Each day transfer leaf-litter from their roost burrows, droppings, vegetation etc from each bird’s enclosure to their prospective mates. This will allow them to get used to each others scent.
3. After approximately 4-7 days swap the two birds over that they occupy the other’s enclosure.
4. After a further 14 days or so open a gate or doorway between the two enclosures to allow the two birds to access to each other’s enclosure. An experienced staff member must be present to observe interactions between the two birds on the night (or night cycle in a nocturnal house) they are first given access to each other. The birds must be able to be separated and isolated in separate enclosures should either bird be overtly aggressive toward the other. Some institutions prefer to allow the birds to have contact through a plastic mesh barrier for a few days before allowing them full access to each other.

If one bird has acted aggressively toward the other during their first night (or night cycle) together then they should be separated and contained within the two separate enclosures again before the observer ceases their observation of the birds. Another introduction can be attempted on subsequent days/nights. All direct contact between the two birds should be supervised by an experienced observer until they are convinced that the birds are no longer aggressive toward one another.

Some holders also report that placing the two birds onto a neutral territory also minimises aggression. Regardless of what method is used to integrate birds, it is vital
that staff make direct observations of the birds interactions to ensure that one bird is not overly aggressive toward the other.

Holders should also note that not all kiwi are well suited to display in a nocturnal house situation. If kiwi continue to show signs of stress in an enclosure, such as excessive pacing, lack of appetite, loss of condition etc, they should be moved to a new enclosure forthwith. The Captive Management Coordinator should be informed as soon as possible when it appears likely that a replacement display bird is required. While the Captive Management Coordinator will try and accommodate each holder’s requests, the competing objectives of the captive programme (e.g. advocacy versus captive breeding) may affect the availability of new display birds.

Similarly, while some birds appear to be very well suited to display in a nocturnal house, the requirements of the captive programme are such that all birds capable of breeding will probably need to be held with their mates in off-display breeding enclosures for the majority of their lives. Most display spaces will be filled by juvenile kiwi (six months – two years old).

5.5.2 Nesting/breeding requirements

At the beginning of the breeding season nesting material (e.g. dry grass, broken fern fronds) should be made available to breeding pairs near the entrance of roost/nest boxes.

During the nesting season disturbance of the birds (e.g. enclosure maintenance etc) should be kept to a minimum.

Some female kiwi have been observed sitting in water dishes for extended periods when they are heavily gravid. Holders should consider offering deeper water dishes up to 75mm deep to breeding pairs, especially if the female has shown a tendency to bath in the water dish when gravid.

5.5.3 Requirements of young

Kiwi chicks are precocious, that is they hatch fully feathered and are not fed by their parents. Consequently their requirements are similar to those for adult kiwi. They are usually reared for the first few weeks of their lives in wooden or plastic brooder boxes designed for this purpose.

A comprehensive guide on artificial incubation of kiwi eggs and hand-rearing of kiwi chicks is currently under development.

Until that document is published, facilities seeking information on hand-rearing chicks should contact the institutions currently participating in BNZ Operation Nest Egg: Auckland Zoo (Auckland), Rainbow Springs Kiwi Encounter (Rotorua), Westshore Wildlife Reserve (Napier) and Willowbank Wildlife Reserve (Christchurch), or other captive institutions with chick rearing experience (e.g. Otorohanga Kiwihouse).
5.5.4 Methods of hatching/rearing/manipulation

Kiwi hatching success in captivity has been increased where eggs have been removed from the male several weeks after laying and artificially incubated from that point, with the resulting chicks hand-reared in purpose built brooder boxes. Research indicates that the best time to remove eggs for incubation is when the oldest egg of a clutch is 41 – 57 days old (Robertson et al., 2006). All institutions seeking to breed kiwi should have at least one incubator and brooder for each pair of kiwi they hold for breeding OR have plans in place to transfer eggs to an appropriately experienced facility.

Eggs may be left for longer under males that have high hatching success rates (i.e. males that don’t break or crack eggs). Consult the Captive Management Coordinator before leaving the male to incubate the eggs to full term naturally.

A comprehensive guide on artificial incubation of kiwi eggs and hand-rearing of kiwi chicks is currently under development. Until that document is published, facilities seeking information on hand-rearing chicks should contact the institutions currently participating in BNZ Operation Nest Egg: Auckland Zoo (Auckland), Rainbow Springs Kiwi Encounter (Rotorua), Westshore Wildlife Reserve (Napier) and Willowbank Wildlife Reserve (Christchurch), or other captive institutions with chick rearing experience (e.g. Otorohanga Kiwihouse).

5.5.5 Methods of controlling breeding

If no chicks are required from kiwi already paired together then any eggs laid should be replaced by artificial eggs, and the real eggs removed from the nest. Unless directed to do so by the Captive Management Coordinator for kiwi, eggs should not be removed without an artificial egg replacing them as an empty nest will encourage the female to keep laying. Repeated egg laying may negatively impact on the health of the female.

If the male is still sitting on the artificial egg(s) after approximately 85 days the artificial egg(s) should be removed.

Contact the Captive Management Coordinator to discuss how to dispose of kiwi eggs that are not earmarked for incubation. They may be required for research or cultural purposes.

5.6 Incubation/rearing young

A comprehensive guide to incubation of kiwi eggs and rearing of chicks is currently under development and is due to be published mid-2009. Until the guide is published, facilities seeking information on artificial incubation of kiwi eggs and hand-rearing chicks should contact the institutions currently participating in BNZ Operation Nest Egg: Auckland Zoo (Auckland), Rainbow Springs Kiwi Encounter (Rotorua), Westshore Wildlife Reserve (Napier) and Willowbank Wildlife Reserve (Christchurch), and ask them for copies of their current incubation and rearing procedures.

Facilities holding, or planning to hold, breeding pairs of kiwi are strongly encouraged to send their kiwi husbandry staff to attend one of the kiwi incubation and egg candling
workshops hosted by Rainbow Springs Kiwi Encounter (in association with the BNZ Save the Kiwi Trust). Check the trust’s website (www.savethekiwi.org.nz) for dates of upcoming workshops or contact the staff at Rainbow Springs Kiwi Encounter directly by emailing them on team@nkt.org.nz.

5.7 Transport Requirements

Over short distances (i.e. from one enclosure to another within a single institution) kiwi can be transferred in modified cardboard or corflute 'cat carry' boxes (available from any vet practice) with the ventilation holes taped over so that the bird cannot poke its bill through the holes and thereby risk injuring it. Boxes should be lined with newspaper and absorbent, unscented paper towels. Transport boxes should be wiped down with disinfectant (e.g. Trigene or Virkon S) after each use. Corflute boxes are preferable to cardboard ones as they are more durable.

Over longer distances (i.e. between institutions or transferring a bird to a wild release site) kiwi should be transported in sturdy, purpose-built, wooden boxes with ample ventilation, internal padding, and no holes or gaps through which a bird could poke its bill. For air transport, containers must comply with the principles specified for the relevant International Air Transport Association (IATA) container requirement (Container Requirement 21, IATA 2008).

A DoC transfer permit (Authority to Transfer Protected Wildlife) must be obtained from the local conservancy office prior to transferring a bird between captive facilities. A copy of the permit should accompany the bird in transit.

Refer Kiwi Best Practice Manual (Robertson & Colbourne, 2003) for details on transport box construction and methods.

6. RECORD KEEPING

Record keeping is a crucial element of managing all species in captivity. Specific care should be taken to ensure that all records are accurate and up to date.

6.1 Individual records

Animal records should be maintained electronically to make it easier to maintain a backup copy of all records and to facilitate their transfer to other holders and the captive coordinators. Ideally the software provided by the International Species Information System (ISIS) should be used. This is currently the Animal Records Keeping System (ARKS), but will soon become the Zoological Information Management System (ZIMS).

An example of a manual animal inventory system is available to CMaG: ARAZPA NZ members from the members’ resources section of the ARAZPA website (www.arazpa.org.au) or from the captive management coordinator.
6.2 End of breeding season reports

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

At the end of the breeding season a summary of information collected by the holder during the season is submitted to the Captive Management Coordinator in the form of an end of breeding season report. A template for this report will be provided by the Captive Management Coordinator for kiwi toward the end of the breeding season.

Minimum Standard 10.
Record Keeping.

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

- Individual identifiers (e.g. band numbers, transponder numbers)
- Sex (if known)
- Sexing method (if known)
- Identity of Parents (if known)
- Origin (if wild caught)
- 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

Minimum Standard 11.
End of breeding season report.

An end of breeding season report must be submitted to the Captive Management Coordinator for kiwi by April 7th each year, detailing developments for the period April 1 – March 30. A template will be provided by them. Information required includes:

- Records of kiwi 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.
7. Acknowledgments

We would like to thank and acknowledge the staff at captive management facilities throughout New Zealand who have provided much of the information presented here and who continue to develop kiwi husbandry techniques through their ongoing participation in the captive programme.

Special thanks are also owed to Suzy Barlow (ARAZPA) and Tony Billing (chairman of the Kiwi Captive Management Advisory Committee) for their roles in overseeing the husbandry manual project. Several kiwi experts not attached to any captive facility, including John McLennan, Kerri Morgan, Clea Gardiner and Avi Holzapfel, also provided information for this manual.

Finally, we would like to extend our thanks to the Department of Conservation and CMaG: ARAZPA NZ (the New Zealand branch of the regional zoo association) for providing the funds required to complete this manual.

8. References


DOC (Department of Conservation) 2007. Approved guidelines for assessing applications to hold absolutely protected wildlife for advocacy and public display February 2007. Downloaded from DOC website on 03 March 2009.


Hill, F; Woodguyer, A.J; Lintott, M.A; 1995: Cryptococcosis in a North Island brown kiwi (Apteryx australis mantelli) in New Zealand. *Journal of Medical and Veterinary Mycology* 33: 305-309


Morgan, K. 2008: *Kiwi first aid and veterinary care*. Department of Conservation, Wellington. 103p


Appendix 1  Specialised Products and Suppliers mentioned in the text

Transponders and scanners

Trovan transponders and scanners are available from:

Advanced Identification Ltd
PO Box 48087
Blockhouse Bay
Auckland
Phone (09) 820 7543

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.

Kiwi premix

Contact: Tony Billing
Westshore Wildlife Reserve,
1 Watchman Rd,
Westshore,
Napier 4110
Phone (06) 834 4136
Email: tonyb@napier.gov.nz

OR

Bomac Laboratories Ltd
Cnr Wiri Station Road & Hobill Ave
P.O Box 76-369
Manukau City
Auckland
Phone: 09 262 3169
Fax: 09 262 3008
Email: bomac@bomac.co.nz
Wombaroo insectivore 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/

Feeding tubes (syringe cases)

External cases, (i.e. disposable packaging from 20ml syringes); available from veterinary centres and veterinary supply companies nationwide.

PVC piping; available from hardware stores and plumbing supply stores nationwide.

Pest-proof fences

Pestproof Fences
P.O. Box 11019,
Hastings
Email: paul@pestproofences.co.nz
ph: 07 349 4505
www.pestproofences.co.nz

Xcluder Pest-Proof Fence,
99 Sala Street,
(PO Box 7135), Te Ngae 3042
Rotorua
www.xcluder.co.nz

Lights

Night Cycle: red 40W incandescent bulbs, 60W General Electric mini-tubes, various standard spotlights with red filters

Day cycle: Sylvania Gro-lux tubes, 37W NEC tri-phospher lights

All are available from lighting and electrical suppliers nationwide
Metal detectors

Fisher 1212x and Garret ACE metal detectors are available from $495 from Detection Solutions:
www.detectionsolutions.co.nz

Phone 0800 800 618

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

ARKS and ZIMS animal records software is available from the International Species Information System (ISIS). Visit their website www.isis.org for details.

Pesola balances

Contact: Graeme Taylor

Senior Technical Support Officer (Banding and Wildlife Health)
Research and Development Group
Department of Conservation
PO Box 108
Wellington 6140
New Zealand

Ph (04) 4713294  Fax: (04) 3813057  Email: gtaylor@doc.govt.nz

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 kiwi 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 2  Massey University (Huia) Wildlife Submission Form

WILDLIFE SUBMISSION FORM

Forwarding Instructions
This animal is the property of the Department of Conservation. Please send a copy of test results to: Wildlife Mortality Database Manager, c/- Pathobiology, IVABS, Massey University, Private Bag 11-222, PALMERSTON NORTH

Submitter Details
Surname: ______________________
First name: ____________________
Organisation: ____________________
Address/Box: ____________________
Suburb: _________________________
City/Town: ______________________
Phone (bus.): ____________________
Phone (home): ____________________
Mobile: _________________________
Fax: __________________________
Email: _________________________

Submission Details
Date submitted: __/__/____
Submitter ref: ______________________
Date found: __/__/____
Number at risk: ______________________
Number dead: ______________________
Number alive: ______________________

Mortality
Date animal died: __/__/____
Death circumstances:
- Found dead
- Injured
- Infertile
- Mortal
- Perished
- Trapped and died
- By-catch
- Captured or released

Specimen Details
Animal Details
(Please use separate page for additional animals)
Species/common name: ____________________
Animal ID:
Identification type:
- (Lagardère, morphological, genetic, lipid, etc.)
Individual name:
- Sex: Male ☐ Female ☐ Unknown ☐
- Age Classification: Adult ☐ Subadult ☐ Juvenile ☐ Neonate ☐ Postlarva ☐ Embryo ☐ Egg ☐
- Date of birth/mating: __/__/____
- Age/development phase: __/__/____
- Where born/hatched: Wild ☐ Captivity ☐
- Weight: gm/kg

Location Type
Wild ☐ Captive ☐
Mainland National Park ☐ Mainland Reserve ☐ Mainland Private Sand ☐ Maritime Park ☐ Island ☐ Coastal ☐ Sea ☐ River ☐ Other ☐

Conservancy:
Description:
- Poisons are being used in the area. Please include details of the toxin.
- Special requirements for disposal of body parts, e.g. return to submitter for ×11 requirements, genomics, or forward to Te Papa etc.
- Please state details of which body parts required and invoice submitter for carrier costs.

History
Include any information which you think may be relevant to this case.

Previous health history:
- Clinical signs; external examination; individual treatments; abnormalities (feeding, reproductive, agnostic); breeding history; diet with any changes; exposure to toxins; translocation details; previous clinical pathology (attach relevant reports).

Environmental Conditions
- (excluding climate):
- Encourage subspecies/breed/age; group treatments; in-contact; clutch details if relevant - sire ID/name, dam ID/name, number of eggs, egg by internal, season number, season clutch number, incubation temperature and humidity.

Invoice Instructions
Invoice: Submitter ☐ National Wildlife Surveillance Fund ☐
(Refer to ‘Guidelines for the use of the National Wildlife Surveillance Fund’ for eligibility on the WILDLIFE HEALTH PAGE - WIGOCR-37176)
## Appendix 3  Westshore Wildlife Reserve Kiwi Transfer Document

**WESTSHORE WILDLIFE RESERVE**

**KIWI TRANSFER DOCUMENT**

<table>
<thead>
<tr>
<th>To:</th>
<th>Willowbank Wildlife Reserve.</th>
<th>Address:</th>
<th>60 Hussey Road, Harewood, Christchurch.</th>
</tr>
</thead>
<tbody>
<tr>
<td>From:</td>
<td>Westshore Wildlife Reserve.</td>
<td>Address:</td>
<td>Watchman Road, Westshore, Napier.</td>
</tr>
<tr>
<td>Transfer Date:</td>
<td>14/09/2003</td>
<td>Previous Transfers:</td>
<td>N/A.</td>
</tr>
<tr>
<td>Transfer Method:</td>
<td>Air New Zealand Link, Flight 8475, Napier/Christchurch direct, (depart 1335, arrive 1510).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common Name:</td>
<td>Brown Kiwi.</td>
<td>Scientific Name:</td>
<td>Apteryx australis mantelli.</td>
</tr>
<tr>
<td>Given Name:</td>
<td>Tane.</td>
<td>Provenance:</td>
<td>Bay of Plenty.</td>
</tr>
<tr>
<td>Band Number:</td>
<td>R-88235.</td>
<td>Studbook Number</td>
<td># 326</td>
</tr>
<tr>
<td>Transponder Number and Location:</td>
<td>982 00910 222770</td>
<td>under right wing</td>
<td></td>
</tr>
<tr>
<td>Date of Birth:</td>
<td>21/5/1999.</td>
<td>Sire:</td>
<td>Tarawera (R30234)</td>
</tr>
<tr>
<td>Dam:</td>
<td>Fern. (R30232)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Captive Bred:</td>
<td>✓ Yes.</td>
<td>No.</td>
<td>Natural or Captive reared:</td>
</tr>
<tr>
<td>Paired/Unpaired:</td>
<td>Unpaired.</td>
<td>Name of Mate:</td>
<td>N/A.</td>
</tr>
<tr>
<td>Enclosure Number:</td>
<td>A2.</td>
<td>Enclosure:</td>
<td>Indoor.</td>
</tr>
<tr>
<td>Breeding success/history:</td>
<td>N/A.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Diet:** Beef heart, (cut into thin strips), new formula Kiwi Premix and Rolled Oats. Natural food available in outdoor enclosures, (depending on season and weather).

**Health Status** (include previous health problems) | No health problems ever experienced.

Full veterinary health check prior to transfer: | ✓ Yes. | No. | Weight: | 1800 g. |

Copies of all laboratory test results attached (faecal/blood) | ✓ Yes. | No. |

Copy of veterinary physical examination sheet attached | ✓ Yes. | No. |

Purpose of Transfer: | ✓ CMP Breeding Recommendation. | Display. |

Purpose of Transfer: | Other (state): |

DOC transfer permit number: 12/133

Studbook holder/captive coordinator notified of transfer: | ✓ Yes. | No. |
<table>
<thead>
<tr>
<th>Special Habits or Problems:</th>
<th>No bad habits or problems ever noted.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments:</td>
<td>Good looking bird with a quiet nature.</td>
</tr>
</tbody>
</table>

| Signed: | Name: Tony Billing | Date: 13/10/03. |