Husbandry Guidelines
for

Emus

Dromaius novaehollandiae

(Aves: Casuariidae)

Date	By	From	Version
2009	Kelly Swarbrick	WSI Richmond	v 1

DISCLAIMER

This Emu Husbandry Manual is intended to present the current scientific, experiential and practical understanding of the captive care of Emus. Some contributions lend themselves to scientific rigor, where material presented is supported by peer-reviewed literature. Other contributions are based, out of necessity, on the collective experience of professional keepers, because relevant scientific literature is scant or non-existent. The author cannot be, and is not, legally, financially or in any other way, responsible for the application of techniques described within the Manual. When undertaking any procedures or techniques outlined in the Manual, it is up to individual workers to assess the unique circumstances of their situation, apply common sense, and subsequently apply any procedures or techniques at their own risk. In all cases, the reader of this Manual is cautioned not to use this manual as an exact step-by-step guide, but rather as a starting reference point for further case-specific studies.

OCCUPATIONAL HEALTH AND SAFETY RISKS

Exhibiting Emus falls under the medium risk category (hazardous). This is due to their powerful legs that could deliver a nasty kick. Emus generally have a docile nature and are non-aggressive towards people however keepers should be cautious when working with Emus, because as with all animals, they can be unpredictable (E&HS 2004).

In order to minimise the risk of finding yourself in a situation where an Emu could turn on you, it is best to be accompanied by someone when entering the enclosure at all times. This person could act as your second set of eyes, which is very handy when trying to clean enclosures or when providing food for Emus because these activities often divert your attention away from the birds.

In the breeding season, males are known to become more aggressive therefore extra care should be taken during these times. If in doubt, do not enter the enclosure until you are with someone or consider other options (e.g. can the food be hauled over the fence of the enclosure?).

It is recommended that a means of escape be provided for keepers within the Emu enclosure, particularly if aggressive birds are kept. This can be accomplished by leaving a gap of 40cm at the bottom of the fence so if necessary a person could escape, leaving the Emus behind (E&HS 2004).

Zoonoses such as those listed in Table 1, can be passed from Emus to humans and therefore simple precautions should be taken such as washing hands after handling the birds, and before eating and drinking (Rosenwax 2008). Minimising the risk of contracting zoonoses can also be achieved by upholding a clean living environment for the Emus (in order to reduce the spread of disease), and always wear appropriate PPE clothing and facemasks when cleaning. Gloves and facemasks can also be worn when handling the birds.

Table 1: Examples of Zoonoses that can be passed from Birds to Humans.

DISEASE	SYMPTOMS IN BIRDS	SYMPTOMS IN HUMANS
Viruses (including "Bird Flu")	Range from mild respiratory (breathing) problems to fatal pneumonia	Headaches, sinusitis, sore eyes (conjunctivitis)
Chlamydia (Chlamydophilosis or Psittacosis)	Non-specific signs of being sick such as "fluffed up" and lethargic, weight loss, watery green droppings and/or eye and nostril discharges	Fevers, coughing, weakness, lung lesions, atypical pneumonia and meningitis
Bacteria	Range from severe diarrhoea, wasting, arthritis, breathing difficulties to death	Range from diarrhoea, vomiting and abdominal pain to severe fevers, tuberculosis (rare), swelling of lymph nodes and/or arthritis
Fungi	Respiratory (breathing) problems, vomiting, diarrhoea	Ringworm (extremely rare), pneumonia, meningitis
Giardia	Diarrhoea, weight loss, anorexia, poor growth and death in young birds, dry skin and feather picking	Weight loss, diarrhoea, severe abdominal cramps
Mites and Lice	Feather picking, self-mutilation (uncommon)	Short-term skin irritation, allergy to bites

(Rosenwax 2008)

Appropriate PPE should be worn such as gloves, protective clothing, boots, facemask etc when using disinfectants and other chemicals for cleaning enclosures. It is important to

remember to wear sunscreen (30+), a hat and sunglasses when working outside to reduce the risks associated with exposure to harmful UV rays.

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1 Introduction

The curious and docile nature of Emus, *Dromaius novaehollandiae*, brings much enjoyment to people who observe or work with them in captivity. These large, flightless birds are an Australian icon and are seen throughout zoological institutions, wildlife parks, and farms worldwide.

The relationship between man and Emus has been a rocky one; two species and one subspecies of Emu have sadly been wiped out. Emus have been regarded as a pest to farmers in the past and attempts have been made to cull numbers however luckily for the Emus, many attempts failed due to their tough constitution and ability to continue running despite injury.

The agility and speed of Emus has aided them in escaping major threats to their survival. Their bodies are built to withstand the harsh climatic conditions of Australia and their ability to locate food in a diversity of locations has definitely benefitted their survival. In fact, Emus will basically have a go at consuming almost anything and surprisingly can withstand swallowing even the harshest of objects (rubber plugs to name one).

Once considered a major threat to the farming industry, Emus are now farmed themselves in Australia and largely overseas. Emus are farmed for their meat, eggs, leather, feathers and oil. Emu oil has a long list of benefits on the human body and is used as an alternative treatment for skin problems, hair loss, arthritis and many other medical conditions.

Emus have a very interesting social structure, with males playing the major role in rearing chicks. It is the father, not the mother, who incubates the eggs and raises the young. The little bundles of creamy fluff with black squiggly stripes are irresistibly cute to anyone who encounters them.

Emus are hardy animals and this is most likely why they are so easy to care for in captivity, that is of course, if appropriate measures are undertaken to provide them with their physical and behavioural needs. Their resilience in captivity also comes as a disadvantage to them because they are able to withstand enclosures that are not entirely suitable. I have visited a handful of institutions which house Emus and found that over half of them were too small and lacked adequate enrichment furniture such as ponds in which they love to swim.

The objective of this husbandry manual is to outline the minimum standards for keeping Emus in captivity; however I urge keepers to exceed those standards. I hope that whoever reads this manual gains as much enjoyment out of it as I have had writing it.

Kelly Swarbrick

1.1 ASMP Category

No Regional Program, Management Level 3.

1.2 IUCN Category

Least Concern (BirdLife International 2008).

2 Taxonomy

2.1 Nomenclature

Class: Aves
Order: Casuariiformes
Family: Casuariidae
Genus: *Dromaius*
Species: *novaehollandiae*

(Christidis & Boles 2008)

2.2 Subspecies

There are three extant subspecies in Australia:

- *Dromaius novaehollandiae novaehollandiae*
- *Dromaius novaehollandiae woodwardi*
- *Dromaius novaehollandiae rothschildi*

Figure 2.1 indicates profiles to help distinguish between the three subspecies.

		
Dromaius novaehollandiae novaehollandiae	*Dromaius novaehollandiae woodwardi*	*Dromaius novaehollandiae rothschildi*

Figure 2.1: Extant subspecies of *Dromaius novaehollandiae* in Australia

Dromaius novaehollandiae novaehollandiae:-

On maturity and during breeding season, these birds have a cream-colored (or whitish) ruff or bib of feathers starting a few inches below the head. The pendulous pouch is larger than in the other two sub-species and sways during strut. The metatarsus bone is shorter with a larger diameter. The body is wider than the other two subspecies. This subspecies orginated in southeastern Australia (Ramey 2007).

Dromaius novaehollandiae woodwardi:-

On maturity and during breeding season, these birds have a ruff or bib of feathers starting a few inches below the head. This ruff appears darker than that of *D. novaehollandiae novaehollandiae* and the pendulous pouch is not as apparent. The body is slender and the legs longer than that of *D. novaehollandiae novaehollandiae*. Overall the feathers are paler than the other two subspecies. This subspecies originated in northern Australia (Ramey 2007).

Dromaius novaehollandiae rothschildi:-

On maturity this bird does not have a ruff or bib. It looks 'flat-chested' compared to the other two subspecies. The pendulous pouch is almost non-existent in this emu. Like *D. novaehollandiae woodwardi*, the metatarsus bone is long with a small diameter, making this bird taller than *D. novaehollandiae novaehollandiae*. The feathers are the darkest of the three subspecies. This subspecies originated in southwestern Australia (Ramey 2007).

Extinct Species/Subspecies

A subspecies known as the Tasmanian Emu, *Dromaius novaehollandiae diemenensis*, became extinct around 1865.

Two dwarf Emu species of Kangaroo Island and King Island, *Dromaius baudinianus* and *Dromaius ater,* became extinct shortly after European settlement in the early 19th century. (Christidis & Boles 2008)

2.3 Recent Synonyms

None found.
Emus are sometimes wrongly classified in the Order: Struthioniformes.

2.4 Other Common Names

- Spotted Emu
- Larger Emu
- Great Emu
- Aboriginal terms for the Emu:
  - barrimal (Djadja wurrung Language File)
  - myoure (Gunai Language File)
  - courn (Jardwadjali Language File)
  - bigaumcha, Bigorumgar (Jodajoda Language File) (Wesson 2001)

Note: **Dromaius novaehollandiae**, in Latin, means "fast-footed New Hollander".

3 Natural History

The Emu, *Dromaius novaehollandiae*, is a large, flightless bird placed in the Ratite group along with all other species of flightless birds: Ostrich, Rhea, Cassowary (closest relative), and Kiwi (Jeffrey 2001). Emu is surprisingly not an Aboriginal word and seems to have been derived from an Arabic word that means “large bird” (San Diego Zoo 2008).

Emus have been living in Australia for an extremely long time, in fact their ancestors called Dromornithids (part of the Australian megafauna), coexisted with dinosaurs. Originally there were three different species of Emu, but unfortunately due to hunting by Europeans in the 19th century, there is only one species left today (Wikipedia 2008).

On one hand, humans have wiped out two species of Emu as well as the Tasmanian subspecies of Emu, and reduced Emu numbers within local wild populations on the mainland. On the other hand, agricultural development and water provided for domestic stock, has enabled the Emu to live in Australia’s Outback, which was once too dry for its survival (San Diego Zoo 2008).

In 1932, following a hot summer, wild Emus in Western Australia went on a rampage in search of food and water. Under pressure from farmers, the Australian Government sent a Royal Australian Artillery unit to Western Australia, led by Major Meredith and armed with machine guns and 10,000 rounds. It was estimated that 20,000 Emus were causing the damage. So began the Great Emu War.

Surprisingly, “the birds proved to be more adept in terms of both camouflage and strategic retreat than the soldiers themselves, and they dispersed rapidly in small groups when they were shot at” (Folch 1992).

Less than a week after the war had begun, the Defence Minister ordered a withdrawal. Only 12 Emus had been killed and onlookers were amazed at the fact that Emus could keep running once they had sustained injuries (GEA 2001). Major Meredith was quoted: "If we had a military division with the bullet-carrying capacity of these birds it would face any army in the world. They could face machine guns with the invulnerability of tanks. They are like Zulus...." (GEA 2001).

It is the biology of the Emu that aided them during the Emu War. Their ability to run at such fast speeds (up to 50km/h) is due to their extremely specialised pelvic limb musculature and powerful feet with three forward facing toes. They are the only birds to have calf muscles. Emus are also very good swimmers (Wikipedia 2008).

On very hot days, Emus pant, using their lungs as evaporative coolers, to maintain their body temperature. In cooler weather Emus breathe normally, and rely on their large nasal passages, which have multiple folds inside to recycle air and create moisture for reuse. As cool air passes into the lungs, it warms due to the extraction of heat from the nasal region. When the Emu exhales, the “cold nasal turbinates [highly folded nasal passages] condense moisture back out of the air and absorb it for reuse” (Wikipedia 2008).

Another biological aspect of the Emu, which provides protection from hot weather conditions, is its plumage. The tips of the double-shafted feathers are black, which absorbs solar radiation, and the feathers are loosely packed in a way which insulates the skin. The insulation provided by the coat prevents the heat from flowing to the skin (Wikipedia 2008).

Emus also cool themselves down by holding out their tiny 20cm rudimentary wings, so that heat can be dissipated from the veins that flow close to the skin (Alderton 2004).

The feathers of Emus are not as water resistant as other bird's feathers and when it is raining, the Emus aren't a very pretty sight, and smell rather like a wet dog (Billabong Sanctuary 2007).

As with all birds, the Emu does not have teeth and therefore needs to swallow pebbles to help the gizzard grind up the food. Their eyes are covered with a clear like membrane (second eyelid) to protect them against both dust and moisture loss (ASDP 2008).

The Emu has a pouch in its throat (inflatable neck sac) that is part of its windpipe and is used for communication. It is over 30 cm long and very thin-walled. When this pouch is inflated, Emus can make deep booming and grunting sounds. Only the female Emu makes drumming sounds. These sounds occur most notably in the breeding season and can be heard up to two kilometres away (San Diego Zoo 2008).

Since 1987, Emus have been commercially farmed for their meat, oil, leather, and feathers. A pair of Emus may produce:

> Ten eggs a year under good captive conditions, which yield on average 5.5 chicks. At the end of the 15 months, these would yield 4m^2 of leather, 150kg of meat, 5.5kg of feathers, and 2.7 litres of oil. Eggshells of infertile eggs, are suitable for carving (AMO 2001).

The Emu is a famous Australian icon, appearing on the Coat of Arms along with the Kangaroo since both animals are believed to be unable to walk backwards (thus implying that Australia is a forward-moving nation) (San Diego Zoo 2008).

The Emu has featured on a number of Australian stamps and Emu feather plumes famously decorated the hats of the Australian Light Horse Brigade. Amazingly, there are 600-gazetted places named after the Emu in Australia, and during the 19th and 20th centuries, many Australian companies and products were also named after the Emu, including the Emu branded beer produced by Swan Brewery in Western Australia (Wikipedia 2008).

3.1 Morphometrics

3.1.1 Mass And Basic Body Measurements

Note: The following measurements have been derived from data based on individual Emus therefore they are not indicative of the measurements of the overall Emu population.

Table 3.1: Mass and Basic Body Measurements of *Dromaius novaehollandiae.*

Height	150 – 190cm	(Simpson & Day, 1994)
Length (bill to tail)	1340mm	(MSU 1998)
Wing Length	20cm	(Billabong Sanctuary 2007)
Leg Length	1045mm 995mm	(MSU 1998) (Biewener & Main 2007)
Length of Femur	244mm	(Biewener & Main 2007)
Length of Tibiotarsus	424mm	(Biewener & Main 2007)
Length of Tarsometatarsus	327mm	(Biewener & Main 2007)
Foot Length	155mm 170mm	(MSU 1998) (Biewener & Main 2007)
Length of skull (bill + cranium)	160mm 155mm	(MSU 1998) (TWU 2008)
Length of bill	65mm 90mm	(MSU 1998) (TWU 2008)
Head-body length (neck)	~570mm	(Estimate from Emu at Oakvale Farm)
Weight	30 to 55kg*	(San Diego Zoo 2008)

**I was unable to find records on the specific weights of the three subspecies.*

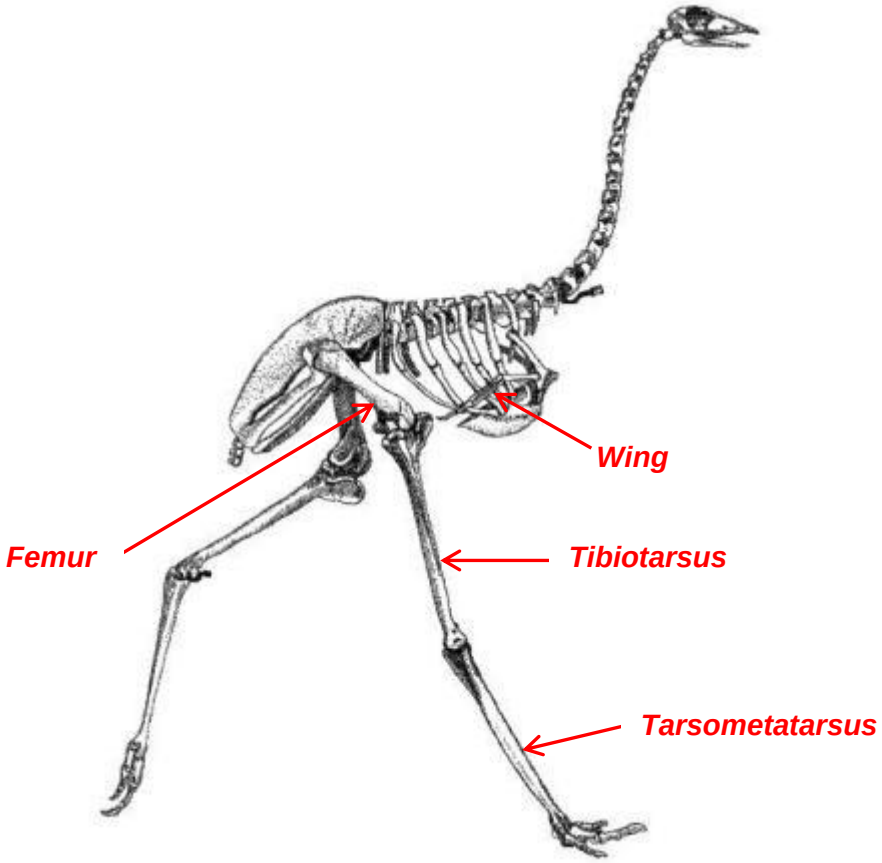


Figure 3.1: Skeleton of Emu *Dromaius novaehollandiae* (Post 2008)

3.1.2 Sexual Dimorphism

Physically, it is hard to distinguish between male and female Emus because they are similar in appearance, however the female Emu is larger in mated pairs, weighing about 5kg more than males (Ivory 1999). The female's body plumage is darker before breeding, black feathers cover the head and neck (Simpson & Day 1994).

3.1.3 Distinguishing Features

Emus have three toes in a tridactyl arrangement, a feature which allows them to run. Emus, along with all Ratites, differ from other birds because they lack a keel, which is a breast bone to which flight muscles are attached. Emus also lack a 'preen gland' therefore their feathers are dry and not oily (Wikipedia 2008).

Emus are also the only birds with "gastrocnemius muscles [calf muscles] in the back of the lower legs" (Wikipedia 2008).

The shaggy body feathers of the Emu are greyish brown in colour; the shafts and tips of the feathers are black (DEC WA 2007). A unique feature of the Emu feather is that it has two shafts, a main shaft and secondary shaft. Emus have a shaggy appearance because their shafts lack tiny hooks to bind them together; therefore they hang limply from their body (Billabong Sanctuary 2007).

Black feathering occurs on the Emus face and on the back of their necks. The sides of their neck are blue in colour (Alderton 2004). Emus have short black bills and eyes that are reddish in colour (Alderton 2004) (Figure 3.2).

Figure 3.2: Adult Emus at Oakvale Farm & Fauna World

Juvenile Emus are similar to adults except for the following differences: they are smaller, their brown bodies are duller, they have a dark head and neck which is lacking the blue skin, and their plumage is finely barred (Simpson & Day 1994) (Figure 3.3).

Figure 3.3: Adult Emus (top) and Juvenile Emu (bottom)

Emu chicks are downy and cream in colour with dark brown to black body stripes (Figure 3.4). The stripes are arranged in a “squiggly pattern on top of the head” (Billabong Sanctuary 2007). When viewed from above, the colouration of the Emu chick helps break up the outline of the body, making it harder for predators to spot them (Billabong Sanctuary 2007).

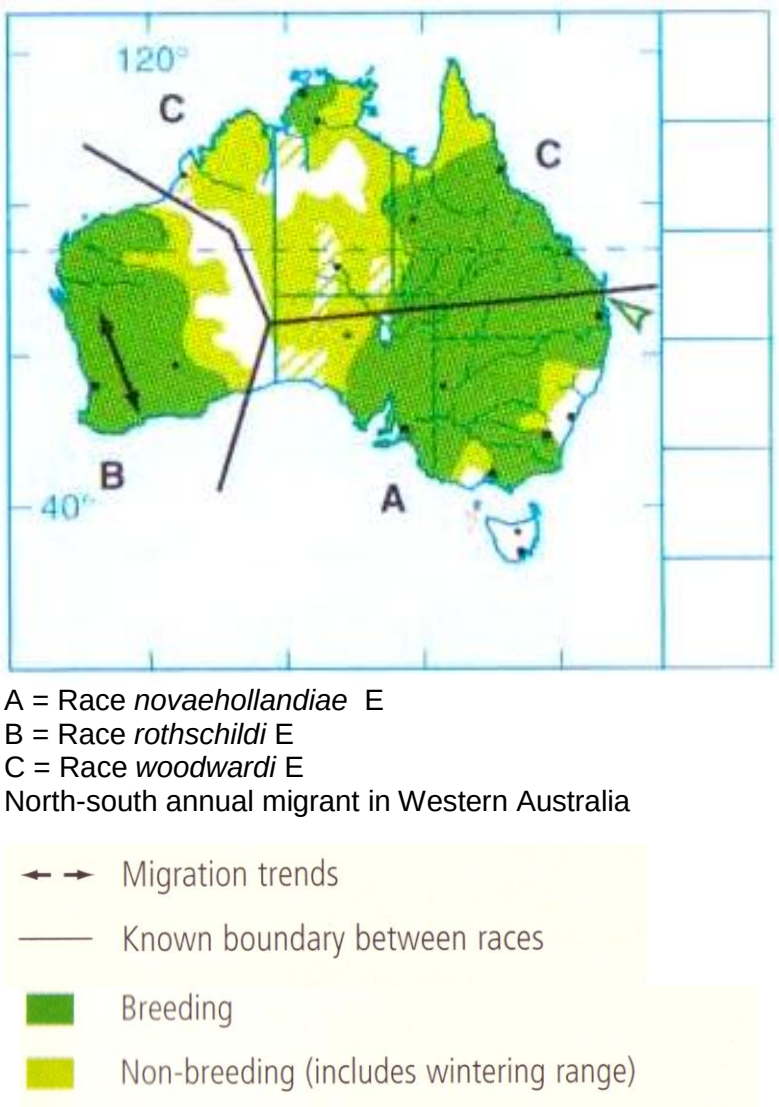
Figure 3.4: Emu Chicks

3.2 Distribution and Habitat

Emus occur naturally in all states on the Australian mainland (Billabong Sanctuary 2007). A subspecies known as the Tasmanian Emu, *Dromaius novaehollandiae diemenensis*, once inhabited Tasmania, however it soon became extinct after the arrival of Europeans (AMO 2001). Also extinct are two dwarf subspecies of Emus that lived on Kangaroo Island and King Island, *Dromaius baudinianus* and *Dromaius ater* (AMO 2001).

Despite these major losses, Emu numbers have increased since European settlement due to the abundance of man-made watering holes for domestic stock as well as the Emu's ability to reproduce rapidly. "It is estimated that the wild Emu population is 625,000-725,000, with 100,000-200,000 in Western Australia and the majority of remaining populations in New South Wales and Queensland" (AMO 2001).

Simpson & Day's *Field Guide to the Birds of Australia* (2004) maps the distribution of the three extant subspecies of Emu, *Dromaius novaehollandiae novaehollandiae* (in the southeast), *Dromaius novaehollandiae woodwardi* (in the north), and *Dromaius novaehollandiae rothschildi* (in the southwest) (Figure 3.5).



A = Race *novaehollandiae* E
B = Race *rothschildi* E
C = Race *woodwardi* E
North-south annual migrant in Western Australia

Figure 3.5: Distribution of the three extant *Dromaius* subspecies

(Simpson & Day, 2004).

Emus prefer to live in sclerophyll forests and savannah woodlands however they are well adapted to live in habitats throughout most of Australia, ranging from coastal regions to high in the Snowy Mountains (AMO 2001). Emus are also found in outback Australia, where temperatures of 48°C are not a rare occurrence but can also drop below 0°C (CWS 2006).

Within these geographic ranges, Emus are highly nomadic and will wander vast distances as the availability of food and water changes according to climatic conditions (Billabong Sanctuary 2007). In Western Australia, Emus follow a distinct seasonal pattern by migrating northward in the summer and southward in the winter (San Diego Zoo 2008). The wanderings of Emus do not appear to follow a pattern on the east coast (Wikipedia 2008).

Emus are rarely found in rainforest areas or desert areas within the interior. They are also generally absent from south-east coastal regions where areas are heavily populated by humans (DEC NSW 2005).

Although the total population of Emus has increased on mainland Australia since European settlement, there are still some local wild populations of Emus at risk of extinction due to their small size. There are a number of threats to these small populations including deliberate killing, clearing and fragmentation of habitats, being hit by vehicles, predation of young and eggs by foxes, feral and domestic dogs, feral pigs, and burning of habitats at frequent intervals (DEC NSW 2005).

Emus were once widespread on the NSW north coast but are now only found in coastal and near coastal areas between Evans Head and Red Rock and west to the Bungawalbin region. Recent records have also been obtained in the Port Stephens area. “The Emu population in the NSW north coast bioregion and Port Stephens Local Government Area has been listed as an endangered population under the Threatened Species Conservation Act” (DEC NSW 2005).

Emus are found over most of the state of Western Australia except for in the waterless deserts and the Nullarbor Plain. Emus are greatly reduced in numbers on most of the Swan Coastal Plain and much of the wheatbelt due to human settlement (DEC WA 2007).

Although Emus are endemic to Australia, they are farmed on a large scale in North America, Peru and China, and to a lesser extent in other countries (Wikipedia 2008). There are now hundreds of Emu farms in Australia and overseas, with about one million domestic Emus in the United States alone (Billabong Sanctuary 2007).

3.3 Conservation Status

Least Concern (BirdLife International 2008).

3.4 Longevity

3.4.1 In the Wild

In the wild, Emus live for an average of 5 to 10 years (Billabong Sanctuary 2007). They have been recorded to live for up to 19 years (maximum) (ASDP 2008).

3.4.2 In Captivity

Emus have a much longer life expectancy in captivity, up to 35 years (San Diego Zoo 2008). They have been recorded to live for up to 40 years (maximum) (ASDP 2008).

3.4.3 Techniques Used to Determine Age in Adults

There are no known techniques used for determining the age of adult Emus however it is possible to tell the difference between juvenile Emus and adult Emus (refer to section 3.1.3 (Figure 3.2)).

Emus are fully-grown at twelve to fourteen months of age and do not reach sexual maturity until they are approximately two years of age. This fact may also enable you to roughly determine the age of an adult because if the Emu is fully-grown and not breeding, you can assume it is between 1-2 years of age. (San Diego Zoo 2008).

Although unreliable, the weight of an Emu could possibly indicate their stage of development. “The body weights of emus have been reported to be about 40 kg at 64 weeks of age, 40.6 kg at 70 weeks of age, and approximately 55 kg at maturity” (Dunk *et al.* 2003).

Skulling is a technique used to determine the age of birds and is based on “the extent of pneumatization in sections of the skull overlying the brain (the frontals and parietals)”. A young bird’s skull consists of a single layer of bone; skull pneumatization is the gradual formation of another layer of bone beneath the original layer of bone. Depending on the species, this process may take from four to twelve months.

Recognisable patterns are produced in the distribution and extent of air pockets and small visible columns of bone developing between the two layers of bone. These patterns can actually be seen through the thin layer of skin on top of a bird’s head by brushing aside the crown feathers using water (Figure 3.6).

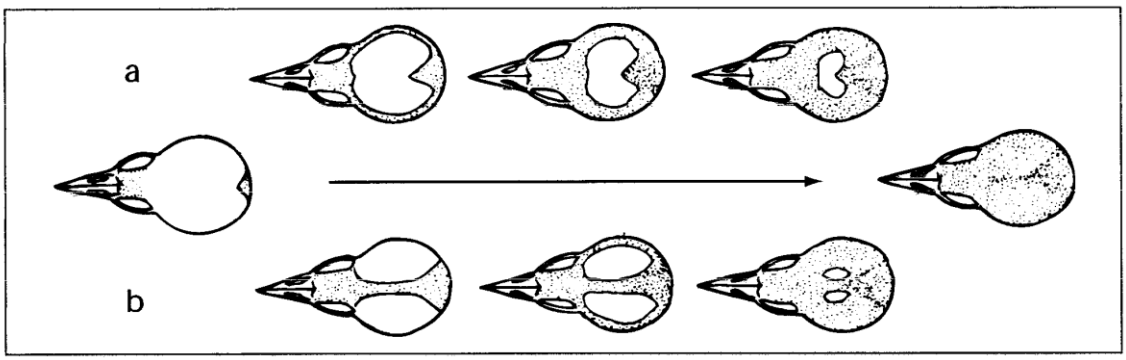


Figure 3.6: *Two common sequence patterns of skull pnematicization (a) periferal pattern (b) medial line pattern.*

Various studies have been carried out in order to determine the age of different bird species. Jannett (1983) conducted a study on 'A Quantitative Method for Age Determination of Adult Birds'. Jannett (1983) hypothesised that the differential growth of bones would provide a means for identifying ages of adult birds. White Leghorn chickens of two different age cohorts were used for the study and the variables were the weights of different bones within the body. Jannett (1983) concluded that: "the technique provides a means of separating adult classes of birds hitherto not distinguishable on the basis of plumage".

The all-time best method for determining the age of adult birds, no matter what the species may be, is good record keeping! Records of Emus should be kept from hatching. It is the most reliable way to determine the age of adult Emus. Other techniques for determining the age of birds can create confusion and are also very time consuming compared to looking up a record.

4 Housing Requirements

4.1 Exhibit/Enclosure Design

Emus are large, long-necked, flightless birds with strong, powerful legs and therefore enclosures must be designed in a way to cater for these physical traits. Fences must be strong enough to resist Emus running or throwing themselves at them but flexible enough not to cause injury during such collisions. Any concrete or synthetic surfaces should be non-slip and outdoor pens should be grassed. It is a good idea to gravel fence lines since Emus will often walk the fence to check out the public as they walk by. Gravel prevents the Emus from wearing out the ground (E&HS 2004).

Enclosure Design Principles

Enclosures should be designed to reflect the specific habitat of Emus. Recommended furnishings for Emu enclosures include an "open planted enclosure with large amounts of grasses and low shrubs and open areas for running" (EPA QLD).

Enclosures should be designed to reduce aggression between Emus, by the appropriate use of complex habitat and visual/physical barriers (EPA QLD).

Floors and substrates of Emu enclosures should be designed, constructed and maintained so they are non-slip, supportive to the Emus and minimise risks of injury and disease (EPA QLD).

Shelter must be provided in Emu enclosures to protect Emus from climatic extremes and for shade and protection from the elements (EPA QLD). Refer to section *4.5 Weather Protection* for information on shelters.

Enclosure Fencing

Outdoor enclosures should include fencing with either wire mesh or high tensile wire with droppers and tensioners. The use of barbed wire or electric wires is not appropriate for Emus. Materials used for fencing must be robust and free of obstacles that may snag Emu legs or necks. If wire mesh is used, mesh size should be small enough to prevent Emu legs or necks becoming entangled. The maximum recommended mesh size for adult Emus is 50mm x 50mm (E&HS 2004, EPA QLD).

Fences and any changes in the angles of Emu fences must be highly visible to prevent accidental collision. To minimise injury to the Emus, fence support posts, stays and straining wires should be positioned on the outside of the enclosure wherever possible. The minimum internal fence height for adult Emus is 1.5m. Fencing for Emu chicks should include a 30cm 'kicking board' at the base of the fence to prevent them from putting their legs through the mesh. Fences should be checked on a regular basis to ensure they are kept secure and in good repair (E&HS 2004, EPA QLD).

Enclosures should be designed in a way as to minimise the entry of predators, pests and wild animals of the same or similar species (EAPA 2004). Fox-proof fencing and any means of rodent-proofing is recommended.

Where an institution's perimeter fence forms part of the boundary of an Emu enclosure, visual or other suitable barriers must be provided to protect the Emus from outside disturbances (EPA QLD).

If aggressive Emus are kept within an enclosure, it may be a good idea to provide a means of escape for keepers. This could be achieved be leaving a 40cm gap at the bottom of the fence, through which a person could escape and the Emus could not. This however would not suitable for enclosures in which chicks are housed (E&HS 2004).

Aggressive Emus, or Emus agitated by the public, will require double fencing or other suitable barriers along enclosure fence lines and viewing areas (EPA QLD).

Enclosure Ponds

Emus love to swim or wallow in water and so all enclosures should be equipped with a pond. Ponds must be constructed from a suitable material which is non-damaging to the health of Emus and provides adequate grip for the Emus' feet. Ponds should be designed in a way to allow easy access in and out of the water and access points must have secure footings. The recommended depth of water for an Emu pond is between 200mm and 1 metre (EPA QLD).

Pond water should be aesthetically pleasing and maintained to a high quality to promote animal health and welfare. Enclosures should be serviced by a tap and hose for cleaning purposes and filling of the pond. Ponds should be flushed, scrubbed and refilled whenever necessary and always free from floating debris, substances that produce undesirable colour, odour or foaming, and undesirable aquatic life such as algal blooms (EPA QLD).

Natural ponds are a good alternative to man-made ponds. The enclosure at Oakvale Farm and Fauna World contains a natural pond which houses fish, and a variety of water birds.

Enclosure Hygiene

Emus are generally messy feeders and are capable of passing large quantities of faeces in a short period of time. With this point in mind, substrates within Emu enclosures should be of a material that is easily cleaned since faeces would need to removed daily to prevent fouling of the enclosures. Feeding stations and drinking water must also be kept clean and free of faeces at all times to prevent contamination. Fresh water should be provided daily and must always be provided separately from ponds used for bathing (EPA QLD).

4.2 Holding Area Design

The Holding Area should be designed so that:

- The Emu can freely stand up, stretch and turn around.
- The Length is at least three times the Emu's length.
- The Breadth is at least one and a half times the Emu's length.
- It has adequate protection from the weather.
- It has Emu-proof fencing: For information regarding fence height/ materials refer to section *4.1 Exhibit/Enclosure Design*.
- It allows safe access for the keepers and does not include blind spots.

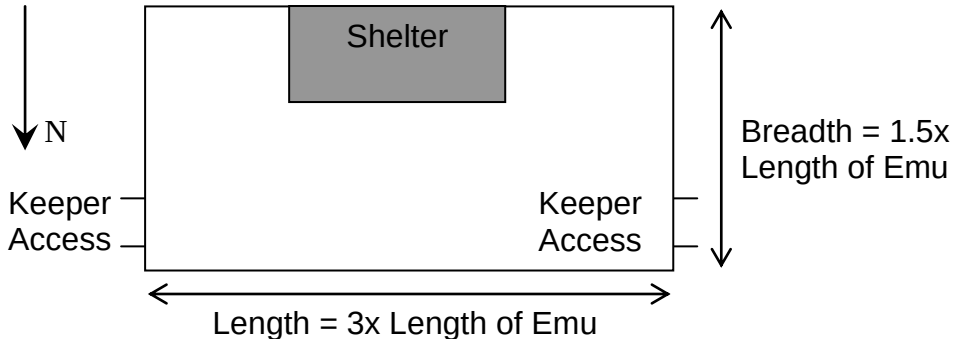


Figure 4.1: Example of Holding Area

4.3 Spatial Requirements

The following Spatial Requirements have been obtained from the Exhibited Animals Protection Act: *General Standards for Exhibiting Animals in New South Wales*.

- The size and shape of enclosures must provide freedom of movement, both horizontally and vertically.
- The Emus must be able to avoid conflict with each other and/or other species if housed in an interspecies enclosure.
- The enclosure must allow for the Emus to avoid, or withdraw from, contact with other animals or with people.
- There must be enough space within the enclosure to permit exercise and behavioural enrichment.
- Emus must have enough space within the enclosure to be provided with their social, breeding and husbandry needs.

The minimum enclosure size for adult Emus is 200 square metres for an individual animal with 100 square metres added for each additional animal. Emus may be housed as single animals, pairs, trios (one male to two females) or communal groups with equal numbers of both sexes in large enclosures (EPA QLD).

4.4 Position of Enclosures

Enclosures and shelters within enclosures should face north to trap the warmth of the sun and avoid cold southwesterly winds. This aspect will also give protection from the westerly sun.

4.5 Weather Protection

The 'Code of Management for the Farming of Emus' states that all Emus need to be "protected from climatic extremes and Emus that are kept in yards or an extensive range must be provided with adequate shade and protection from the elements".

Shelters within enclosures should be closed in on three sides and constructed in vicinity of where you would usually find them each day. The shelter at Oakvale Farm and Fauna World is placed at the front of the Emu's enclosure and covers the area in which they get fed. Examples of shelters that may be used in Emu enclosures are shown below (Figure 4.2).

Figure 4.2: Examples of Shelters that could be used in Emu Enclosures

4.6 Temperature Requirements

Emu enclosures do not require any heating or air conditioning. All birds are endothermic and therefore can withstand a wide range of temperatures. It is a good idea to incorporate ponds within Emu enclosures so that on hot days Emus can choose to go swimming and cool down. The shade provided from trees and shelters will also protect the Emus from the sun's harsh rays.

4.7 Substrate

Grass and dirt commonly make up the substrates of Emu enclosures. Gravel can also be used alongside the fence and edges of enclosures since Emus will wear out the ground in these areas due to walking the fence line (E&HS 2004) (Figure 4.3).

Figure 4.3: Examples of Substrates *[1. Grass 2. Grass and Dirt 3. Gravel]*

Grass and dirt substrates are easily maintained by raking. Gravel is easy to hose clean however faeces and other wastes could build up underneath the gravel and harbour diseases. Gravel is also difficult to change and would be harder on the feet of the Emus. Leaf litter or mulch as part of the substrate is desirable because Emus often use this material when they are nesting.

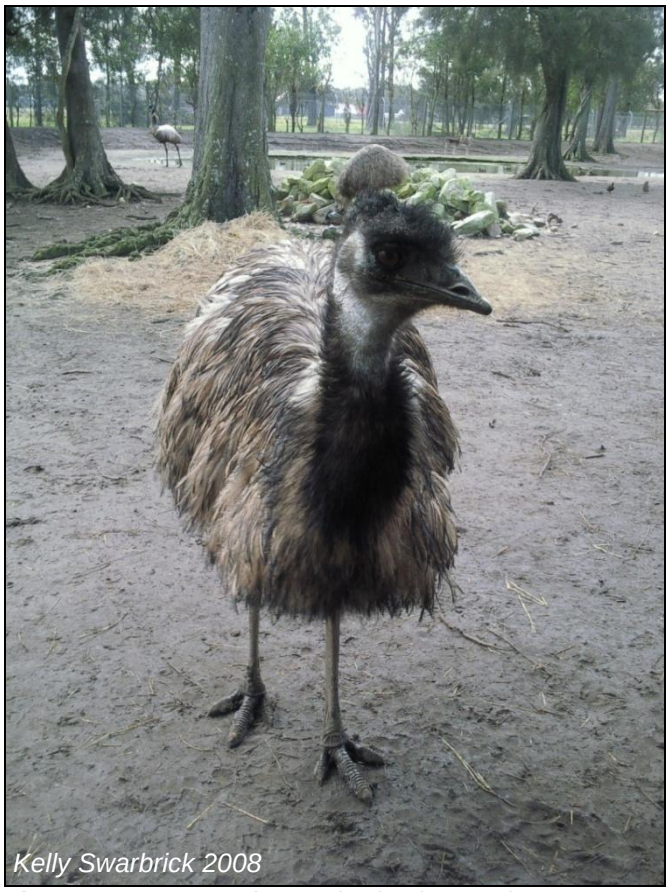


Figure 4.4: Emu Enclosure (Oakvale Farm)

The Emu enclosure at Oakvale Farm & Fauna World consists of a dirt substrate. This was once a grassy area however due to trampling and being eaten by the Emus, grass no longer exists.

Grass substrates are more aesthetically pleasing however not always manageable. To combat this problem, sections of grass could be maintained by fencing them off.

Grass seeds could be planted in a fenced off section within the enclosure and the Emus could have access to it once the grass is fully-grown. During this time another section could be fenced off and more grass seeds planted. This way fresh grass could always be available.


Figure 4.5: Emu Enclosure (Hunter Valley Zoo)

The Emu enclosure at the Hunter Valley Zoo looks impressive with lush, green grass.

The Emu chicks at Oakvale Farm & Fauna World are allowed to wander around freely in the park with access to any substrate they desire: whether that be grass, dirt, gravel, or mud.

Figure 4.6: Free-range Emu Enclosure (Oakvale Farm)

4.8 Nestboxes and/or Bedding Material

Emus will use vegetation and/or debris from within their enclosure for building nests. Nests may consist of a thin mattress of grass or other trampled vegetation alongside a bush or other protective covering such as a tree or mound of rocks, or among dead and dry fallen branches. Sometimes eggs are laid on the bare ground and surrounded by materials such as sticks, twigs, dry leaves, bark, straw, and feathers (Beruldsen 2003).

Examples of materials that are used for building nests are shown in the figures below (Figures 4.7 & 4.8). The only material that may need to be provided for nesting is straw however Emus will usually use the hay that is given to them for feeding.

Figure 4.7: Materials used for Nesting *[1. Straw 2. Twigs 3. Leaves and Bark 4. Long Grass]*

Figure 4.8: Materials used for Emu Nest (Oakvale Farm)

4.9 Enclosure Furnishings

There are a variety of furnishings that can be used in Emu enclosures (Figures 4.9-4.17).

Figure 4.9: Rocks

Rocks of all different shapes and sizes can be used.

Rocks can be used to separate sections of the enclosure or placed in mounds.

Rock mounds can be used by Emus to set up their nests next to as they provide some form of protection.

Long grass looks great in enclosures as it provides a very naturalistic setting.

Grass can also be eaten by the Emus and used for nesting material.

Figure 4.10: Long Grass

Figure 4.11: Bracken Fern

Bracken Fern looks very effective when opting for a naturalistic setting.

Emus also enjoy Bracken Fern as a food item. At Healesville Sanctuary in Victoria, a dozen Emus ate out every trace of Bracken Fern in an eighty-acre area within eighteen months (Fleay-Thomson 1996).

For this reason, Bracken Fern could be provided as browse within pots throughout the enclosure on a regular basis.

The furniture within the Emu enclosure at Featherdale Wildlife Park consists of logs, rocks, a small drinking pond and a bridge.

Figure 4.12: Logs, Bridge , Rocks (Featherdale Wildlife Park)

Figure 4.13: Artificial Creek, Logs, Trees (Featherdale Wildlife Park)

A man-made creek also runs through the Emu enclosure at Featherdale Wildlife Park.

Ponds not only look great within Emu enclosures, they are also used for behavioural enrichment.

Emus love the water and are often seen swimming in the pond at Oakvale Farm & Fauna World.

Trees are essential furnishings in Emu enclosures. They provide shade, a natural setting, and leaves may be eaten.

Figure 4.14: Pond, Trees (Oakvale Farm & Fauna World).

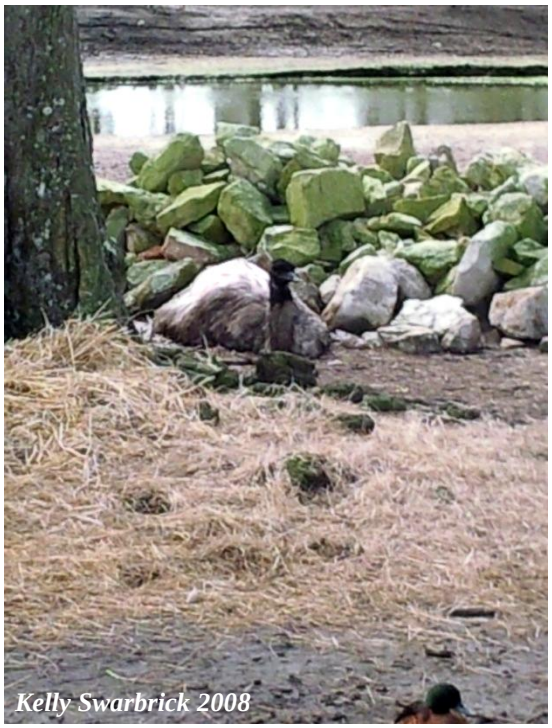


Figure 4.15: Nesting amongst Furniture. (Oakvale Farm and Fauna World)

This male Emu (above) has chosen to nest between a pile of rocks and tree at Oakvale Farm & Fauna World. The nesting material he chose consisted of twigs, leaves, hay and feathers.

Large grassy bushes or shrubs can be used for a number of things within an Emu enclosure. They can be used as visual barriers, provide shade, and can provide suitable areas in which the emus can set up their nests!

Figure 4.16: Use of Shrubs as Furniture.

Figure 4.17: Human Furniture enjoyed by Animals at Oakvale Farm & Fauna World.

The free range animals at Oakvale Farm and Fauna World make use of Human Furniture!

Behavioural Enrichment Furniture

Emus are very curious animals and therefore would be interested in most behavioural enrichment furniture that is placed in their enclosure.

At Oakvale Farm and Fauna World, the Emus love to investigate the jewellery that is worn by keepers. They peck at jewellery such as earrings and watches. For this reason a large shiny object would go down well as a form of behavioural enrichment furniture. A good idea would be to hang an object such as a large shiny disco ball from a tree within their enclosure (Figure 4.18). The Emus would be mesmerised by it and hence entertained for hours!

Figure 4.18: Shiny Disco Ball in Tree

In Queensland, Aboriginal hunters have lured Emus by climbing a tree, lowering a ball of Emu feathers and rags and twirling it rapidly. The fascinated Emus would all gather around the tree and the Aboriginals would spear at them from above (Parker 2000). Since we know from the Aboriginal hunters that this method works for captivating Emus, hanging a ball of feathers and rags from a tree would also be a fantastic form of behavioural enrichment furniture.

Sprinklers are much loved by the Emus at Oakvale Farm & Fauna World. Once placed inside the enclosures and turned on, the Emus will run around through the mist or sit down and enjoy the shower.

Objects such as Kong toys filled with leafy greens or plastic bottles containing shiny objects can also be used to enrich the Emus. Food items concealed in large ice blocks may also go down well.

5 General Husbandry

5.1 Hygiene and Cleaning

Cleaning the Enclosure:

Emu enclosures commonly consist of large paddocks with dirt/grass substrate, and natural furniture such as trees, rocks, logs, ponds and bushes. For this reason, the cleaning of such enclosures generally only involves raking, scrubbing water and feed dishes, and occasionally turning substrate and replacing enclosure furniture. Chemicals are normally not required for these tasks as scrubbing with water or water with a small amount of human dishwashing detergent often does an exceptional cleaning job. When scrubbed items are rinsed off with either a hose or pressure cleaner and left to dry in the sun, pathogens are killed off due to the UV light in approximately a few hours.

The following table outlines the cleaning regime for the Emu enclosure at Oakvale Farm & Fauna World. Cleaning needs to be carried out on a daily, weekly, monthly and annual basis. Ponds that are man-made (with concrete bottom) would also need cleaning on a weekly basis by emptying them and scrubbing with a broom. The pond within the Emu enclosure at Oakvale Farm & Fauna World naturally exists therefore does not require regular maintenance since it is refreshed with rainfall.

Table 5.1: Cleaning Regime for Emu Enclosure at Oakvale Farm & Fauna World

Cleaning Task	Occurrence	Method
Rake Enclosure	Every 1-2 days	Rake waste such as faeces, environmental debris (e.g. excess leaves, branches), and leftover food into piles and shovel into the wheelbarrow for disposal.
Clean Self-filling Water Dish	Daily	Using steel wool, scrub out the water dish and pump. Make sure dish refills with fresh, clean water.
Clean Feed Dishes	Daily	Hose with fire hose and scrub with steel wool, leave to dry in sun. Use a second feed dish when cleaning the first feed dish.
Clean Hay Feeder	Weekly	Remove old hay from bottom of rack, brush any cobwebs off and remove any pests such as slugs, rats, spiders.
	Monthly	Pressure clean hay feeder and allow to dry in sun before filling with new hay. Use towel to soak up excess water to fasten the drying process.
Turn Substrate	As Required	Turn substrate using pitchforks, shovels or dingo digger. Substrate would require turning before planting grass seeds.
Replace Enclosure Furniture	Every 6 Months or Annually or as Required	Furniture such as logs and rocks can be replaced with new furniture. The occurrence of this task depends on the furniture e.g. how long a log lasts out in harsh conditions depends on the log itself.
Clean Browse Pots	Weekly	Scrub out pots using steel wool and water or water and small amount of dishwashing detergent.
Clean Shelter	Monthly	Brush cobwebs off, scrub with steel wool and water or water plus detergent. Rinse with water or pressure clean if necessary.
Remove Weeds	As Required	Weeds can be pulled out by hand or by using weeding equipment (e.g. hoe). Weeds should be removed because they may be toxic to Emus.

Nesting Materials:

Emus use natural vegetation that is readily available in their enclosure for making nests therefore provision and changing of nest material is not necessary. Refer to Section 4.9 for examples of nesting material.

It is important to remember when cleaning Emu enclosures that some sort of nesting material be left for them to build nests with. Even though the nesting season is May to August, breeding may take place in any month (Beruldsen 2003).

Use of Chemicals:

If routine cleaning is not sufficient and a disinfectant is required, there a number of commercially available products that are safe to use for both the keepers and animals. At Oakvale Farm & Fauna World, we often use a product called Animal House (Appendix A) for cleaning enclosures (includes scrubbing of perches and tree forks in Koala Village). This product dissolves oil, grease, blood, urine and faeces quickly. It is very easy to use and requires minimal PPE (gloves, glasses) - therefore it is user friendly. Animal House is non-residual and biodegradable and is supplied to major Zoo's and theme parks within Australia, including Taronga Zoo and Dreamworld (Glason Group 2008).

Animal House would be an excellent choice for disinfecting furniture and feed dishes within an Emu enclosure. Another product that is commonly used within Zoological and Wildlife Parks and could be used for cleaning Emu enclosures is called F10SC Veterinary Disinfectant (see attached MSDS). This product boasts a total microbial spectrum kill (bactericidal, virucidal, fungicidal, sporicidal) and has no adverse side effects on people, animals, or on equipment and surfaces. It is also ecologically friendly and biodegradable (Chemical Essentials 2008).

Chlorine is often used for cleaning animal enclosures because it is a very effective disinfectant. However, it is can be harmful to the respiratory system of keepers and emus, and is corrosive to metal surfaces; therefore it is best to use one of the products mentioned above for cleaning Emu enclosures.

Pest Control:

Rodent Control – use a host specific rat and mouse poison such as Racumin – Bayer Animal Health (Appendix B). This product targets rodents with minimal risk of secondary poisoning. Bait stations are to be distributed throughout enclosure. The number of baits to be used depends on the size of enclosure, and degree of rodent problem.

Fox Control – fox proof fences around the Emu enclosure are the most effective means of fox control.

Wild Animal Control – wild animals such as ducks or nocturnal animals may help themselves to the food that is left out for the Emus. There aren't many effective control measures to prevent this from happening however if it is a huge problem, it may be necessary to remove uneaten food from enclosures at the end of each day.

Invertebrate Control – Invertebrates pests such as snails and slugs are actually controlled by the Emus themselves because they eat them! Pesticides can be used to control excess invertebrate pests. Make sure the product is animal friendly.

5.2 Record Keeping

When looking after Emus in captivity, detailed records should be kept on the following things:

- Identification: This includes species, any given names to individuals, sex, band or microchip numbers and any features of the Emu that distinguish it from other individuals within the enclosure. (*This record may only need to be made once during the lifetime of the Emu however may need to be updated if banding has changed or if the visual features of the Emu have changed (e.g. juvenile – adult or events have occurred that physically alters the Emu for good such as an injury)).*

- Parentage: Any known information on the parents of the Emu, also whether the Emu was wild or captive born, date of birth or estimated date of birth.

- Previous History: Gather any information on the Emu from previous owners and veterinarians (*may only need to be recorded once, however records may need to be updated if further history of the Emu becomes available).*

- Current Environment: How the Emu is housed i.e. what type of habitat, where the enclosure is located, the diet of the Emu, any other species that may also be housed within the enclosure, the type of water provided within the enclosure, any disinfectants that you may be using to clean the enclosure, and general husbandry practices such as enrichment provided (*records may need to be updated on a daily, weekly, monthly or yearly basis).*

- Observations and Symptoms: The Emus temperament and behaviour patterns (note any behavioural problems), condition of faeces, any changes in the Emus diet, and any recent exposure to unusual circumstances (e.g. exhibit upgrades may disturb the Emus), and environmental factors such as stress or chemicals (*Emus would be observed on a daily basis, observations can be recorded in keeper notebook and then transferred to the appropriate record file if any notable events have occurred).*

- Veterinary Examinations: Reason for the veterinary examination, any findings of the Veterinarian, any treatments, medications administered or operations performed on the bird. (*Veterinary examinations need to be recorded every time, whether they are daily, weekly, monthly, or yearly*)

- Reproductive Stage: Condition, behaviour (are they are hazard to keepers when defending their nests?), any sighted matings and the date of observing these matings, location of the nest within the enclosure (is it in a safe area? does the location of the nest present a hazard to keepers when entering the enclosure?), numbers of eggs seen in nest, any changes of diet (the male Emu will rarely leave the nest; even for drinking, eating, or defecating) (*Breeding occurs every year (generally May to August) however it may take place in any month depending on conditions*) (Beruldsen 2003).

- Movements: Within the park (i.e. relocation of Emu to another enclosures) or between institutions (*Could occur at anytime, record movements as required).*

- Size and Weight Measurements: Record the date that the measurements were taken, identification of Emu, height, weight, bill to tail, measurements of limbs (e.g. length of Femur, length of Tibiotarsus, length of Tarsometatarsus), length of neck (head to body). (*Size and weight measurements should be recorded as soon as possible after chick has hatched (providing that it is safe to get a hold of the chicks without putting yourself in danger), measurements could be recorded on a weekly basis in chicks and then on a monthly basis in juveniles, and a yearly basis in adults (or whenever required).*

- Births/ Deaths: record date of birth (date of hatching), any deaths (whether known or unknown), and any reasons as to why this death occurred (e.g. old age, accidental, injury etc), include results of any post-mortem examination. It is also advisable to record whether any eggs have been rejected (as a notable event, not a death).

- Any other Notable Events: Such as escapes, attacks, treatments administered without Veterinary examination (e.g. wormers, routine parasite control, vitamin supplements etc).

The maintenance of good records is an integral part of good management, whether that is within a Zoo, Wildlife Park, or on a Farm. There are a number of reasons for keeping records in your workplace. Good animal management is one reason however records are also very useful for research.

Records provide data for research (scientific papers) and husbandry. Records allow you to fill in the gaps of existing knowledge on different species. Records are also very important with respect to cooperative breeding.

Cooperative breeding programs are based on studbooks. The studbooks trace each specimen back to the wild, through as many generations and zoos as required. Studbooks are only possible if each institution keeps quality records on that specimen. Cooperative breeding programs suffer if they cannot rely on studbooks.

ARKS (Animal Record Keeping System) was developed by ISIS (International Species Information System) in December 1985.

> ARKS allows a keeper at a single institution to record the local history of each specimen in an electronic database…ARKS software helps the record keepers to enter individual animal information from its birth to death (U. P. Forest Department, 2008).

Animal data from nearly 650 Zoos and Aquaria worldwide are sent to the main ISIS database. This keeping system has increased the co-operative work of Zoos throughout the world and is considered an extraordinary resource (U. P. Forest Department, 2008).

5.3 Methods of Identification

Identification of Emus is important for not only record keeping but also for protection against theft. Microchip identification systems are commonly used for Emus. Microchips provide an effective means of identification in Emus because they are aesthetically pleasing to the public and do not present any hazards to the bird. “At hatch, microchips are inserted in the pipping just behind the head with an implant gun and needle” (Jeffrey 2001).

There are some disadvantages of microchipping, particularly if the Emu needs to be microchipped at a mature age. Anaesthetic is generally required and there is also a risk of the puncture wound becoming infected (microchip would most likely be implanted on the left breast of an older Emu). There are also risks involved in catching the Emu for microchipping. Visually you cannot distinguish between birds which have been microchipped (Rosenwax, 2008).

Leg bands have also been used as forms of identification in Emus. Numbered leg bands can come in a variety of colours therefore making it easier for keepers to distinguish between individual birds. They are however not as aesthetically pleasing as microchips and also pose the risk of injuring the birds if they become entangled in something or if the birds decide to play with the bands in order to get them off (Jeffrey 2001).

Tattooing has also been successfully used in Emus as a means of permanent identification however once again this form of identification is not as aesthetically pleasing as microchipping and requires a certain level of skill in the first place (Jeffrey 2001).

Photo identification may also be used as a means of identifying Emus however it may be hard to distinguish between individual Emus in the same enclosure even with photos because they tend to look very similar (even between females and males).

5.4 Routine Data Collection

Refer to section *5.2 Record Keeping* and include any relevant information that may be needed for ongoing studies, for example if you were doing an ongoing study on how clutch size affects the weights of Emu eggs, you would need to routinely collect data on every nest of eggs that are laid (count number of eggs in nest and weigh each egg).

6 Feeding Requirements

6.1 Diet in the Wild

Emus are omnivorous meaning they eat both plants and animals, however their diet mainly consists of vegetation (Billabong Sanctuary 2007).

Emus eat the fruits of plants such as Quondong, Sandalwood *Santalum* spp. and Zamia Palm *Macrozamia riedlei* (Figures 6.1, 6.2, 6.3). Other parts of plants that Emus consume in the wild include native flowers, young shoots, green grass, leaves, and seeds (DEC 2007). When available, Emus will also consume water plants such as duckweed and filamentous algae (Billabong Sanctuary 2007). They eat very little dry matter or roughage (DEC 2007).

Figure 6.1: Quondong.


Figure 6.2: Sandalwood.

Figure 6.3: Zamia Palm.

Emus consume small vertebrates such as lizards and a large variety of invertebrates such as grasshoppers, beetles, caterpillars, land snails, moth larvae, crickets, and ants (San Diego Zoo 2008, Billabong Sanctuary 2007).

Animal droppings may also be consumed, and if Emus see undigested seeds in their droppings, they peck them out and eat them again (AMO 2001).

To aid with digestion, Emus swallow large pebbles to help their gizzard physically macerate the food they have consumed (Billabong Sanctuary 2007).

In Western Australia, feeding preferences have been observed in migrating Emus: Seeds from *Acacia aneura* are consumed until it rains, after which Emus eat fresh grass shoots and caterpillars. In winter, Emus feed on the leaves and pods of *Cassia*' and in spring, they feed on grasshoppers and Quandong fruit (*Santalum acuminatum*) (Wikipedia 2008).

Emus continually seek out new food sources, even if this means raiding the crops of farmers. Emus will eat cultivated grains such as Wheat *Triticum aestivium*, Barley *Hordeum vulgare* and Lupins *Lupinus* spp. (DEC 2007).

6.2 Captive Diet

At Oakvale Farm and Fauna World, we feed our seven Emus a full 10L bucket of dry food as well as a variety of fruits and vegetables (Table 6.1). Their diet does not change throughout the year. To give the Emus some variety, the type of dry food that is fed out to them is changed on a regular basis (Figures 6.4, 6.5 & 6.6). The season and

availability of produce will determine what fruit and vegetables we feed our Emus on a daily basis. Refer to Table 6.2 for a suggested diet for feeding one adult Emu.

Table 6.1: Food provided on daily basis for 7 Emus at Oakvale Farm & Fauna World.

Food Item	Amount
<u>Dry Feed (depending on availability):</u> • Grain Mix (wheat, barley, sorghum) • Cracked Wheat • Puffed Wheat • Pellets (goat or poultry) • Lucerne Hay	• Approximately 7kg for Grain Mix (wheat, barley, sorghum). or • One 10L bucket worth of dry feed (weight will vary depending on feed given).  • Approximately one biscuit of hay (about 0.5kg -1kg daily – biscuit weight depends on weight of bale and quality of hay).
<u>Produce (depending on availability)</u> *Vegetables* • Leafy greens (e.g. spinach, bok choy, endive, Tuscan cabbage, dark lettuces, iceberg lettuce, chicory, sprouts, rocket, herbs – basil, parsley), • Broccoli – left whole or torn apart, • Cauliflower – left whole or torn apart, • Beans, • Snow peas, • Squash – left whole, • Carrots – cut into pieces, • Zucchini – cut into pieces. *Fruit* • Cherry tomatoes, • Grapes, • Strawberries, • Raspberries, • Chopped apple, • Watermelon – chopped or left whole, • Banana – sliced, skin on, • Melons – chopped or whole.	• One tray of fruit and vegetables each day (tray dimensions: 63cm × 48cm × 15cm). • Tray weight (with fruit & vege): ~7kg  Example of the fruits and vegetables fed out to Emus at Oakvale Farm & Fauna World.

Table 6.2: Suggested Diet for one adult Emu.

Food type	Quantity
Grain Mix (Wheat, Barley, Sorghum)	6 cups per day
Fresh Produce (consisting mainly of dark leafy greens)	1kg per day

Lucerne Hay	1 biscuit per week
Browse (e.g. left-over Koala leaves, Lilly Pilly)	Provide daily or as required

Examples of dry feed that is fed to the Emus at Oakvale Farm & Fauna World:

Figure 6. 4: Puffed Wheat

Figure 6.5: Grain Mix: Wheat, Barley, and Sorghum.

Figure 6.6: Pellets.

Browse:

The Emus at Oakvale Farm & Fauna World occasionally get fed left-over browse (gum leaves) from Koala Village (if browse is still in good condition). Their enclosure is full of *Casuarina* trees, which they are able to peck at *ad libitum.* They eat the seeds of *Casuarina.*

Other examples of browse that can be fed out to Emus include native fruits and berries from plants such as Lilly Pilly and Quondong. The Emus at Oakvale Farm have also

been observed eating the tips and leaves from natives such as Paperbark, Bottlebrush and Lilly Pilly (therefore can also be offered as browse to Emus).

Alternative Diets used by other Institutions:

Different institutions generally feed their Emus different diets (Table 6.3). Diets are generally prepared depending on what is available for the Emus to eat naturally in their enclosures and the budget allocated for feeding these animals.

Table 6.3: Alternative Diets used by other Institutions.

Institution	Emu Diet
Western Plains Zoo Obley Rd Dubbo NSW 2830	• 8-9kg Horse Cubes (between 10 individuals). • Emus have access to natural vegetation and insects within their enclosure. • Bread for occasional treat.
Hunter Valley Zoo Lomas Lane Nulkaba NSW 2325	• At Hunter Valley Zoo there are a number of Emus which are scattered around in different yards and housed with different animal species. • The Emus get a varied diet that consists of multi-purpose pellets and a mixture of fruit and vegetables (grapes, tomatoes, some leafy greens, apples, pears, rockmelon, watermelon, paw paw etc). • This is offered twice daily as some of their macropods are housed in with their Emus. • The multi-purpose pellets are fed in their feed hoppers which get closed off at night time and re-opened with the morning cleaning routine (this prevents feeding all unwanted vermin e.g. ducks, ibis). • The diet does not change throughout the year but the amounts most definitely do! • The Emus receive browse because they offer it quite regularly to the Kangaroos and Wallabies so therefore it is available for the Emus (browse offered are the koala leaves from the day before, if they are still in good condition). • No vitamins or minerals are given to their Emus, but the multipurpose pellets have anti coccidiosis agents within them. • Fruit and vegetables get offered in a feed tray and the pellets are dispensed through a hopper.
Australia Walkabout Wildlife Park 2375 Peats Ridge Road corner of Peats Ridge & Darkinjung Roads Calga NSW 2250	• Six Emus free range over 80 acres of bushland therefore they have access to wild grasses, seeds, flowers, insects etc. • Emus are fed twice a day on macropod pellets and lucerne with the macropods. • The food is presented in troughs on the ground. • They have access to day old koala browse. • Diets don't change for Emus as they can access a wide variety of wild foods. • Supplements are not given for the same reason. • Emus eat stones and pebbles to help digest their food.

Feeding Emus and Preparation of their Diet:

The preparation of Emu diets is a fairly simple task. Dry feed is scooped into buckets using cups or scoops and fresh produce is left whole or cut into pieces roughly the size of golf balls. Leafy greens can be left whole or shredded by hand. It is important that enclosures contain small pebbles, rocks or gravels because Emus swallow these to aid with digestion.

Feeding should be carried out at least once per day. Daily feeding allows the keepers to examine the Emus and their enclosures on a regular basis. Food should be provided under cover if possible. Dry food is easily ruined when it is wet, as mould will readily form in such conditions.

Do not overfeed the Emus; only provide food they will consume within the day. Excess feed will attract unwanted pests such as rats and wild birds (e.g. ducks). Remove any uneaten food before topping up with new food.

6.3 Supplements

Supplements are generally not added to Emu diets in captive environments. This is because they are provided with diets that closely reflect their wild diet. Enclosures usually provide the Emus with access to the vertebrates and invertebrates they would consume in the wild for extra nutrients.

Scientifically formulated and prepared Emu pellets (e.g. Riverina Emu Pellets – Appendix C) contain all essential nutrients for growth and breeding performance. These pellets are mainly fed to Emus that are farmed because it is essential that their meat, oil, and skin etc is of the highest quality. Such pellets can also be fed out to Emus within zoological parks however this form of feeding will most likely incur greater costs and may not be necessary.

During the breeding season, diets can be supplemented with calcium carbonate and multivitamins. Calcium carbonate can be purchased through Vet-N-Pet-Direct (see Appendix D for contact details). Ornithon, a vitamin supplement can be purchased through the Pet Shop Boyz (see Appendix D for contact details).

6.4 Presentation of Food

Dry food should be fed in a feeder that is placed underneath shelter. The feeder at Oakvale Farm & Fauna World is rounded which allows the Emus to access it from many points therefore creating a harmonious environment for communal feeding (Figure 6.7).

Figure 6.7: Feeder used for dry food at Oakvale Farm & Fauna World.

Produce (fruit and vegetables) can be fed in long troughs that allow many Emus to access the food at the one time. Hay can also be placed in the trough on sunny days (Figure 6.8). In most cases hay should be placed in hay feeders for best protection (Figure 6.9).

Figure 6.8: Trough used for fruit, vegetables and hay at Oakvale Farm & Fauna world.

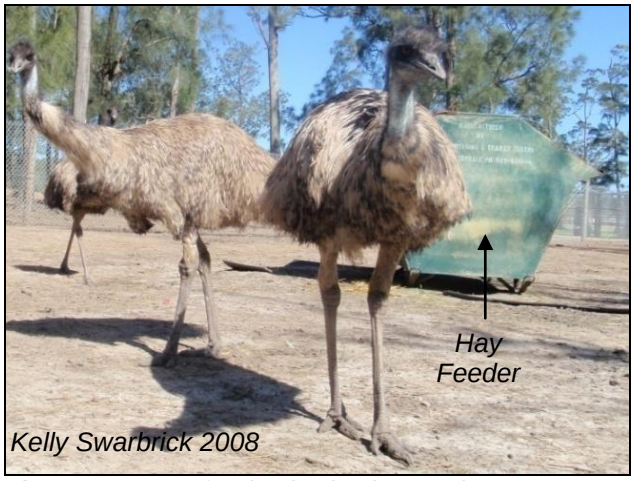


Figure 6.9: Hay feeder (Oakvale Farm)

Fruit and vegetables can also be fed out in trays (Figure 6.10) or occasionally scattered on the ground of the enclosure once a week for enrichment (Figure 6.11).

Figure 6.10: Food presented in tray.

Figure 6.11: Food scattered on ground.

Browse should be placed in water pots so they last longer. Any supplements should be mixed in with food or water.

Enrichment Feeding:

Every now and then it is a good idea to provide food in one of the following ways to offer enrichment for the Emus:

- Hang bunches of grapes up in trees so they need to stretch up to reach them.
- Leafy greens can also be hung up in trees or hung from the enclosure fence (Figure 6.12).

Figure 6.12: Spinach hung from fence.

- Scatter fruits such as watermelons cut in half around enclosure.
- Place fruit and vegetables in the low forks of trees so Emus have to pluck them down.
- Offer chopped up fruits in large ice cubes.
- Use ropes to hang carrots from trees so they have to work out how to get the carrots out of the knots of the rope.
- Hammer stakes (with no sharp edges) into the ground and tie leafy greens to the stakes using rope.
- Hang stockings of grass seeds from trees so that Emus can eat the grass that grows though the stockings. This may be an exciting challenge for the Emus when the stockings are swinging or blowing around in the wind.
- Provide a variety of browse (refer to section *6.2 Captive Diet* for examples of browse that can be fed to Emus.

7 Handling and Transport

7.1 Timing of Capture and Handling

It is very important to capture and handle an Emu when it is cool so that it will not overheat from exerting too much energy during the heat of the day.

The best time to catch an Emu is early in the morning when it is cool or if necessary later in the afternoon. Conditioning using food can be used as a tool to assist with capture, so the morning feed time is ideal for the capture of emus, when using food to entice emus into desired capture facilities or transport boxes (refer to section *7.3 Capture and Restraint Techniques)*. Capture during the night may be another viable option as the Emus will be less active, and the low visibility may assist the keeper to approach within close proximity without being detected.

It is also best to plan the capture of an Emu when the public are not present, as viewing a capture may be disturbing to the public.

Early morning capture is ideal for internal zoo transfers or for transporting to other zoological parks (within close proximity), because the Emus will have enough daylight to adjust to their new surroundings before dark.

Afternoon capture may be suitable for Emus that are getting transported over long distances because they can adjust to their transport box, travel at night time when it is cool and gather their bearings when they arrive at their destination the next day during daylight hours.

If possible it is also best to avoid capture of Emus during the breeding season because they are more temperamental during this time and therefore the task of capturing may be a lot harder for the keepers, and more disturbing to the Emus.

Sick or injured Emus should not be captured unless absolutely necessary because the extra stress the capture puts on their bodies could be fatal.

Avoid capturing Emus repeatedly on the same day to minimise stress. If they get agitated from the first capture, it is best to give them a break and carry out other necessary captures on subsequent days (Bewg & Kent 2003).

Most importantly, make sure captures are well planned and everything is organised so that the procedure runs smoothly. Prolonged chases or exertion should be avoided; especially when the ambient temperature exceeds 27ºC. Hyperthermia and exertion may result in sudden death or the development of capture myopathy. It is not unheard of that an Emu drops dead from being chased around its enclosure during the heat of the day due to poor planning and incompetency.

7.2 Catching Bags

Catching bags such as large Hessian sacks can be used to restrain Emus once they have been caught, or to transport them over short distances. Strong materials such as Hessian should be used for catching bags because the Emus have sharp claws that could easily rip through bags made of lightweight materials (Figure 7.2). Generally the bags are used to restrain the body of the Emu so that the head and neck are still visible (Figure 7.1). A standard Hessian sack with dimensions 100cm x 60cm has been used for this procedure at Oakvale Farm & Fauna World.

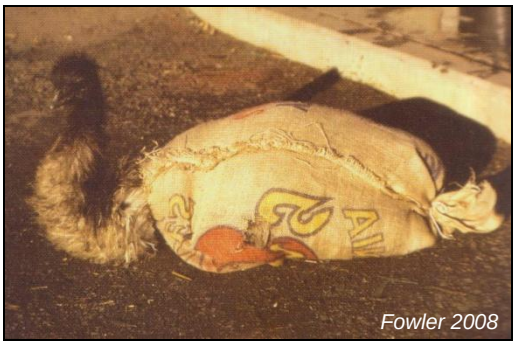


Figure 7.1: Small Emus may be transported over short distances in a burlap sack.

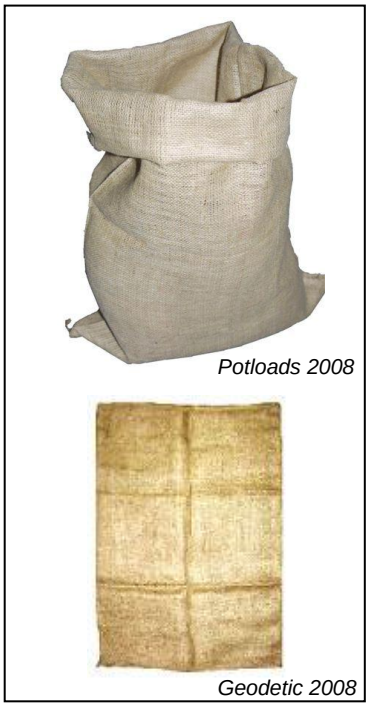
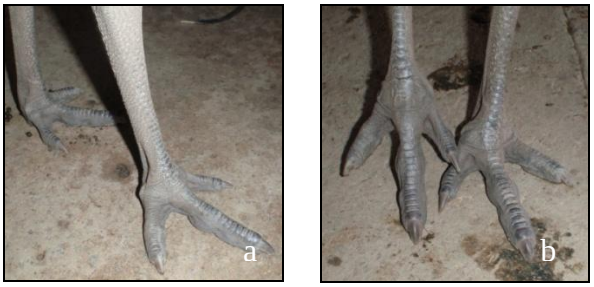


Figure 7.2: Examples of Hessian sacks that may be used for catching bags.

7.3 Capture and Restraint Techniques

Before the capture of an Emu takes place it is essential that keepers are aware of the dangers that are involved in such a process. Generally, Emus are not likely to be aggressive when you enter their enclosure to capture them however they may change their tone once being captured or restrained.

The feet and legs of Emus are their primary defensive and offensive structures (Fowler 2008). With this is mind, suitable attire should be worn during the capture and restraint of Emus. As a minimum, protective clothing such as trousers and long-sleeved shirts should be worn as well as hardy boots (preferably steel-capped). Safety glasses should also be worn to protect the eyes from getting poked by the claw of an Emu. Gloves should also be used when restraining Emu's legs because their legs are very rough (like sandpaper) and can damage unprotected hands. (Figure 7.3)



a – powerful scaly legs

b – sharp toenails.

Figure 7.3: Dangerous structures on Emu (3 months old)

Capture:

In many cases, food is the only tool needed to move an Emu a short distance; using a tray or bucket of food to lead an animal to capture facilities or transport boxes. Food is routinely used as a means to capture and transport Emus at Oakvale Farm and Fauna World.

In many cases, especially with tame Emus, it is possible to walk up to it and restrain it without much of a chase. If this not the case, herding the Emu into a corner using two or more keepers is an effective way to end the chase and therefore allow you to restrain the Emu using one of the techniques mentioned later on in this section of the manual. Nets are generally not needed for the capture of Emus however may be used in times of desperation as long as the Emu is not already highly strung. Very large nets would be needed at these times and care must be taken to not injure the birds.

To capture an Emu by hand, you must overpower it. The following method for capturing an Emu was recommended by Brad Walker (2008), a former keeper from Featherdale Wildlife Park:

- Approach the Emu from behind and in the form of a bear hug, grab a hold of its body and get on top of it.
- Exert downward pressure so that you are pushing it onto the ground.
- Grab a hold of its legs and pull them up to the chest of the Emu.
- You will need two keepers for this exercise because the Emu may lift one person off the ground or swing side to side in order to free a leg which could result in a dangerous kick.

Capture using Transport Box:

Luring an Emu into a transport box using food is also a very effective form of capture.

Food is scattered on the ground by a keeper outside the transport box to get the Emu interested (Figure 7.4).

Figure 7.4: Food is scattered on ground in front of the box.

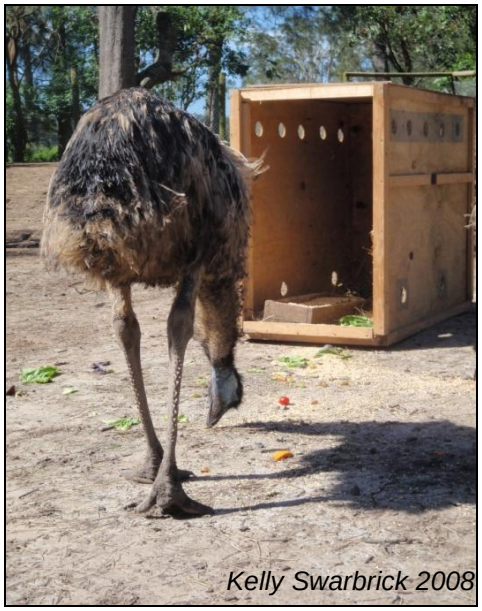


Figure 7.5: Emu follows trail of food into the transport box.

The Emu follows the line of food into the box (Figure 7.5).

If the Emu enters the box to get to the bowl of food, the door can be quickly slid down to keep it enclosed.

If the Emu decides to linger outside the box because it is being cautious, a gentle shove from behind using one or two keepers will get it into the box.

It is best to use this method from when the Emus are chicks so they become conditioned to it (Figures 6.6, 6.7, 6.8 & 6.9).

Box Capture of Emu Chick:

Figure 7.6: Food & water bowl placed inside box.

To capture an Emu chick using a box, first set it up with appropriate floor material such as hay and place food and water bowls inside (Figure 7.6).

Lure the Emu chick into the box with food. Once the Emu chick spots the bowl of feed it will most likely walk into the box, crouch down and enjoy its meal (Figure 7.7).

Emu chicks are not as cautious as adults and can be easily manipulated using food

Figure 7.7: Emu chick busily eating the food that is provided.

Figure 7.8: Emu chick is happy to rest in box.

The Emu chick was quite happy to rest in the box once it had some food (Figure 7.8).

Figure 7.9: Slide door down to complete the process.

With the Emu chick inside the box, the side door can then be slid down to enclose it (Figure 7.9).

This form of capture is very effective, easy and involves minimal stress for both the keeper and Emu chick.

Restraint:

Young Emu chicks and juveniles up to 5kg can be handled easily by folding their legs and holding their body next to your own body. The Emu chicks and juveniles may defecate during the process so it is best to aim their vent away from your clothing (Fowler 2008).

Avoid forcing the legs of heavier Emus into the folded position; their legs may dangle while their body is being held (Fowler 2008).

Figure 7.10: Restraining an Emu.

Adult Emus may be grasped with one arm supporting the chest, and the other arm over the body and holding the upper leg.

Lift the Emu off the ground and direct the legs slightly away from your body (Figure 7.10).

It is important to have an understanding of an Emu's nature before attempting any restraint methods. Docile and tame Emus may allow you to walk straight up to them and not even put up a struggle if you lift them off the ground (ensuring they are light enough to do so). Aggressive or unpredictable Emus would require at least two people to restrain them.

Adult Emus may also be restrained by using one arm to grasp the Emu beneath its body and using the free hand to grab hold of one of its wings.

Lift the Emu off the ground so that its legs are pointing away from your body (Figure 7.11).

This form of restraint can be achieved with one person (assuming that the person has the strength to restrain and lift the Emu by themselves).

Figure 7.11: Alternate method of Emu restraint.

Figure 7.12: Standing restraint of an Emu.

For standing restraint of an Emu, approach it from behind, grasp its short wing stubs near the body and straddle the tail (Figure 7.12).

This form of restraint is excellent for determining the sex of Emus. A second keeper is needed to insert their gloved finger through the vent (Fowler 2008).

Restraint of Emu Chicks:

Figure 7.13: Correct restraint of Emu chick using one arm.

Kent Sansom, owner and manager of Oakvale Farm and Fauna World, demonstrates the correct method for restraining an Emu chick (Figures 6.13 and 6.14).

Kent uses one arm to hold the Emu's body against his own and tucks it underneath his armpit.

The Emu's legs are folded and grasped with Kent's hand.

Figure 7.14: Emu chick fits snugly under the arm.

This method of restraint is very effective for Emus of this size.

The main benefit of this technique is that you will have a free arm to carry out other tasks such as examinations.

If necessary, the other arm may be used to support the neck of the Emu (Figure 7.15).

Figure 7.15: Restraint of Emu chick using both arms.

Capture, Restraint and Release of Emu Chick:

Figure 7.16: Herding Emu chick into fence for easier capture.

The three figures on this page (Figures 6.16, 6.17, & 6.18) demonstrate the method that was used for capturing, restraining and releasing an Emu chick at Oakvale Farm and Fauna World.

Firstly, the Emu chick was herded into a fence to trap it and therefore make capture easier (Figure 7.16).

The Emu chick was restrained by using one arm to grasp the top of its legs and the other arm to support its body. The Emus head and neck were poking out from behind the keeper's elbow. The Emu's legs were held away from the keeper's body (Figure 7.17).

The Emus vent was aimed away from the keeper's body as they tend to defecate when being handled.

Figure 7.17: Restraint of Emu chick.

Figure 7.18: Release of Emu chick.

For release of the Emu chick, the keeper slowly crouched down and gently placed the Emu chick in an upright position.

The keeper allowed the Emu chick to feel grounded before releasing its body (Figure 7.18).

Chemical Restraint:

In most circumstances, Emus will respond favourably to the captive environment and allow physical restraint without excessive stress. Certain diagnostic procedures and surgery may however require immobilisation and/or anaesthesia (Fowler 2008).

Emus may be immobilised using isoflurane as an inhalant anaesthetic via a facemask. This provides rapid induction and rapid recovery (Fowler 2008).

7.4 Weighing and Examination

Examinations:

Examinations of Emus can be carried out using most of the restraint techniques that have been discussed.

The standing restraint of Emus (Figure 12) will allow for sexing to be carried out. This form of restraint will also allow for other procedures to be carried out such as visual examinations, and physical examinations of the legs, body, and head.

It may be easier to examine the Emu by lifting it off the ground (Figures 10 & 11). One keeper can restrain the Emu while the other keeper or Vet may carry out the examinations. It may be necessary to use more than one keeper to restrain the bird for easier examinations e.g. another keeper may restrain the head or legs.

Examinations of Emu chicks can be carried out using the form of restraint shown in Figures 13 and 14. The keeper's free arm can be used to carry out the examination or assist the Vet or other keeper with the examination. In most cases, the Emu chick will be a good patient and struggling will be minimal (Figure 7.19).

Figure 7.19: Examination of Emu chick

Figure 7.20: Straddling an Emu for examination or therapy.

If prolonged examinations are required, a keeper may gently ease the Emu to the ground and straddle it in a recumbent position (Figure 7.20) (Fowler 2008).

The keeper should be astride over the pelvis of the Emu with their legs keeping the Emu's feet from pushing out to the side (Fowler 2008).

Weighing:

Emus can be weighed by restraining them using the techniques that were outlined in section *7.3 - Capture and Restraint Techniques.*

Once the Emu is restrained, the keeper can step up onto the scales and take note of the combined keeper and Emu weight (Figure 7.21a). The Emu's weight can be obtained by subtracting the keeper's weight from the combined weight.

Alternatively the Emus could be weighed inside a box (refer to Figure 7.8) and the weight of the box subtracted from the combination weight to obtain the Emus weight.

Emus can also be conditioned with food to step up onto the scales (Figures 21b & c). This method is probably the best because it is easy, stress-free and the Emu is happy to get a feed out of it.

Figure 7.21: Methods for weighing Emus, a – restrain for weighing, b – Entice with food, c – Emu walks onto scales to eat.

7.5 Release

The following suggestions should be taken on board for safe and successful release of Emus back into their enclosure:

- Release should be carried out in the morning because it is cooler and keepers will be able to monitor the Emu throughout the day. The Emu will also have the rest of the day to adjust to its surroundings and gather its bearings before nightfall.

- Release Emu into the designated holding area. Make sure food and water is provided. Remove any unnecessary obstacles from within the enclosure as the Emu may dash off once the door of the box is slid open and run into something. Release should be carried out in the most open position within the holding area.

- When releasing from the box, slide open the door and let the Emu exit at its own will, don't force it out, as this will cause unnecessary stress.

- Monitor Emu closely after release and intermittently throughout the day. Take note of its respiratory rate – is it back to normal? Is it behaving in the same way prior to the capture? Is it showing any signs of stress from the capture?

- Once it is determined that the Emu is healthy through careful monitoring, the door of the holding yard can be opened so that the Emu can chose to join the other Emus within the main enclosure.

- When the Emu has left the holding area, closely monitor it once again to make sure it has settled in well and is getting along with the other Emus.

7.6 Transport Requirements

7.6.1 Box Design

- **Materials:** Wood, non-toxic plastic, fibreglass, synthetics, heavy-duty plastic netting with mesh size of 3cm in diameter.
- **Size:** The normal habits and necessary freedom of movement determine the size. The size of the container must allow the Emu to stand fully erect, turn round, and lie down. Dimensions should not exceed these criteria as too much space could result in the Emu inuring itself. There must be an internal clearance of 10cm above the heads of all Emus when standing.
- **Frame:** solid wood at both ends and base of the container either screwed or nailed and glued with non-toxic glue.
- **Sides**: made out of 2cm plywood or other material of equivalent strength. Netting can be used for the upper part of the container. The height of the sides must reach the upper body level of the Emus when slats or netting is used for the upper part of the container. There should be no sharp protuberances or edges inside the container on which the Emus could injure themselves.
- **Handler Spacer Bars/Handles:** Spacing blocks or bars with a 2.5cm thickness must be provided on all four sides of the container. Forklift spacer bar must be provided in containers with contents totalling more than 60kg.
- **Floor**: solid 2cm plywood with non-slip floor covering.
- **Roof:** solid or netting over a fixed framework. Must be lined with non-destructible padding such as foam rubber as Emus may jump up. If netting is used for young Emus, the mesh must be small enough so that their head cannot become entangled in it if they jump up. A curtain of light material must be placed over the netting when nervous Emus are being shipped.
- **Door:** A sliding door must form one end of the container, which must be secured with screws once closed. Strengthening battens must be present on the door.
- **Ventilation:** When solid containers are used, ventilation openings that are approximately 2.5cm in diameter, must cover at least 20% of the area of all four sides and be spread over the entire surfaces as shown in Figure 7.22. The lower openings must be at least 5cm above the height of the absorbent bedding to prevent spillage. Corners of partitions may be cut away to give improved airflow.

(IATA 2000)

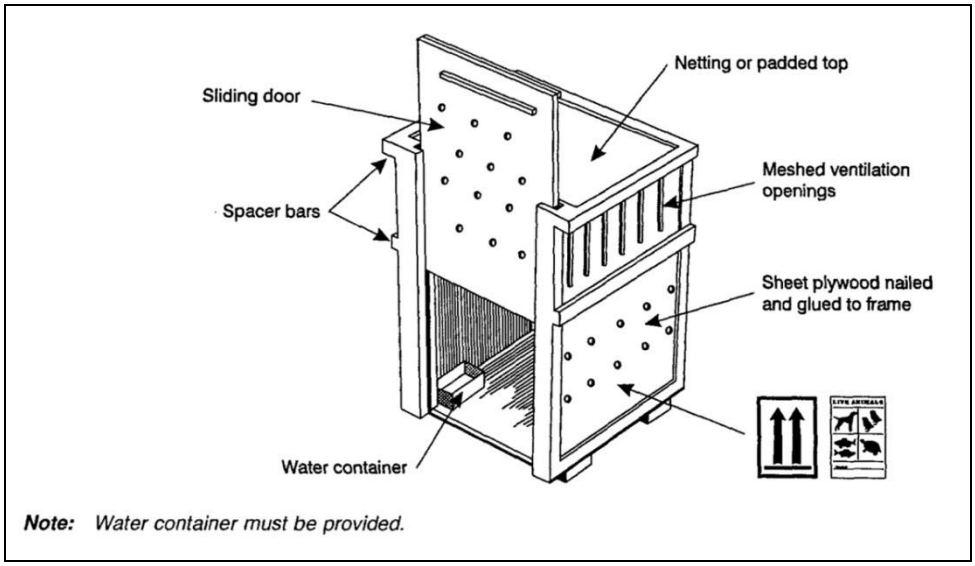


Figure 7.22: Example of Emu transport box. IATA 2000

7.6.2 Furnishings

- Furnishings such as perches are not applicable.
- Wood shavings or similar material for bedding must be placed on top of a 2.5cm thick layer of newspaper or other absorbent material at a depth of 10-15cm.

(IATA 2000)

7.6.3 Water and Food

- Food and water containers must be provided at floor level with outside access for refilling.
- The water container must be wide, with a diameter of 30cm for easy access by the Emu.
- Water container must be flanged.
- Sponge must be inserted into water container to prevent spillage.
- Emus do not usually require additional feeding or watering during 24 hours following the time of dispatch.
- If feeding is required due to an unforseen delay, juicy cut carrots or apples or both must be placed inside each compartment of the container.

(IATA 2000)

7.6.4 Animals per Box

- Emus should be transported in groups with a maximum of six birds per group.

Stocking Density (IATA 2000)

Age of Emu	Floor Space per Bird
1-2 day old chicks	12-13 chicks per box (51 × 45 × 23cm)
Adults	0.44m^2 per bird in communal container

7.6.5 Timing of Transportation

- *For temporary transport:*
  Emus should be transported early in the morning to ensure enough daylight at their destination for them to adjust to their new surroundings.

- *For longer-term transport:*
  Emus should be captured during the cooler parts of the day (morning or afternoon) and given enough time for them to become accustomed to their transport box. The health of the Emus should be monitored during this time. Longer-term transport is best carried out during the night as Emus are often calmer, particularly during the summer months (AWS 2008).

7.6.6 Release from Box

- For interstate or overseas transport, the Emus will need to be released into quarantine for a certain length of time to prevent the spread of disease.

- For release into an empty enclosure, place the transport container in the enclosure early in the morning and leave the door to the container open. The Emu can then leave the container and enter the new enclosure when it is ready. The Emu will have the rest of the day to adjust to its new surroundings (become familiar with new smells, sounds and sights), and find where the food is. Keepers can monitor their progress throughout the day.

- For release into an inhabited enclosure, follow the same procedure for release into an empty enclosure (mentioned previously); however place the transport container in the holding yard adjoining the main enclosure. The Emu can once again leave the opened container when it is ready and enter the holding yard. Monitor the Emu once it has exited the transport box, noting any signs of stress such as increased respiratory rate. If the Emu seems to be behaving normally, the door of the holding yard can be opened so that the Emu can chose to enter the main enclosure. Once again monitor the Emu after it has entered the main enclosure to make sure it has settled in well and is getting along with the other Emus or different species altogether.

(Reeve-Parker 2007)

8 Health Requirements

8.1 Daily Health Checks

Distant examinations of Emus should be carried out daily in order to check their health status (generally this will be at the time of feeding). Questions you should be asking yourself when carrying out these distant examinations include:

- Are they moving about freely? Are all of their legs working well with no signs of lacerations, bumps or swelling?
- Are they feeding normally, not overeating? Is the food they swallow easily sliding down their throats?
- Are they drinking normal amounts of water, not excessively?
- Are their eyes clear, bright, fully open and of a normal colour?
- Are their plumages all intact with no feathers missing in patches or knotted up (e.g. with faeces)?
- Are their droppings of a normal consistency and colour with no spots of blood?
- Are no abnormal discharges present around their beaks, eyes, or cloacal regions?
- Are their necks moving freely and easily with no lacerations or bumps?
- Is their overall behaviour normal? Has anything which is out of character been observed?

8.2 Detailed Physical Examination

8.2.1 Chemical Restraint

Due to the often docile nature of Emus, chemical restraint for detailed physical examinations is normally not required. Detailed physical examinations can be carried out using physical restraint and are best carried out using two or more people.

Chemical restraint may be required for surgical procedures in which case a veterinarian must be present. “If an emu must be sedated in the field, ketamine or tiletamine/zolazepam may be given by injection. However, without an accurate means of weighing an emu in the field, it is possible that the vet may inadvertently give the incorrect dose of injectable medications” (Wissman 2006).

During procedures where Emus have been chemically restrained, and if time permits, it may be a good idea to take these opportunities to carry out physical examinations which would otherwise be too difficult or dangerous to achieve under normal circumstances. Examples of what may be looked at during chemical restraint include the vent, ears, and oral cavity.

8.2.2 Physical Examination

Once an Emu is physically restrained, it will be easier to carry out a more thorough health examination (refer to section *7.3 Capture & Restraint Techniques*). Examples of key things that should be checked during physical examinations include:

Weight

Weigh the Emu on a set scales while it is being restrained by someone and then subtract the weight of that person to attain the weight of the bird (refer to chapter 7 for alternative ways to weigh Emus). Check records to determine whether the Emu has lost weight, gained weight or remained at the same weight. Feel the body to ensure that no bones are significantly protruding and that there is plenty of meat on the Emu.

Eyes

Make sure the eyes are bright and alert, and that there is no abnormal ocular discharge. Take note if there are any discolourations, scars, or accumulations. Also ensure there are no scabs or blood around the eye and that the Emu can see out of them. The Emu's sight could be tested by waving a shiny object in front its eyes and observing its response – if it reacts to the object, say by trying to peck at it or avoid it, it is very likely that it has good eyesight.

Figure 8.1: Healthy Emu eyes - bright and alert, no discharges.

Beak

Take a close look at the beak and check for any discharges, accumulations or crusty build-ups around the nostrils. Also check for lesions and any cracking. Take note if the beak is of an unusual shape (i.e. any deformities). Smell the nostrils for any unpleasant odours and listen for any abnormal sounds from the nostrils.

Oral Cavity

Check the oral cavity for accumulations, disolourations, discharges, unpleasant odours, and growths (Clark n.d.). Also check for any lesions and make sure that the mucous membrane is a normal colour. “In addition, it is important to check the cleft in the upper palate of the oral cavity. This cleft is the choana, and it is a direct communication with the respiratory tract. Thus, any accumulations, discharges, etc., in this region may be from the respiratory tract” (Clark n.d.).

Respiration

Check that the respiration rate is normal and that the Emu is not making any abnormal sounds such as wheezing or crackling. Watch out for any coughing or sneezing. A stethoscope should be used during such examinations.

Skin and Feathers

Ensure the skin is of a normal colour and that there are no lesions or swellings present. Take note if there are any scabs, inflammations, or dry, flaky skin. Check skin and plumage for ectoparasites such as lice and mites or are there any signs that they have recently been present. Observe plumage for missing patches of feathers. Run fingers through plumage to check for any breakages or bleeding feathers.

Body

Check the whole body for any lesions, bumps, or abnormalities. Check for tenderness of the legs and neck by running your hand over these areas while lightly applying pressure – observe closely for any signs of discomfort. Take a close look at the wings to check for any fractures or wing paralysis. Make sure the wings can move freely about. Have a look at the feet and note whether all the claws are intact, or if there are any lesions or bumps present.

Figure 8.2: Healthy plumage and body of an Emu.

Vent

Take a close look at the vent to make an assessment of the health of the GI tract. Check for parasites, soiling of the feathers, evidence of egg laying, diarrhoea, swelling, reddening, blood from the vent, and any abnormalities (Clark n.d.). Check for dryness, cracking, smelly discharges, and dried faeces. Note whether it is of a normal colour and size.

8.3 Routine Treatments

Routine treatments are very important and it is essential that these treatments are carried out at the correct intervals. Health problems can be prevented with routine treatments and good hygienic practices (refer to section 5.1 – Hygiene and Cleaning).

Emus should be wormed with a broad spectrum wormer every three months or as directed by a Veterinarian. Worming products containing the active ingredient Levamisole have been prescribed by Veterinarians for worming Emus. The Free Range Emu Farm (Toodyay Emu Farm) in Western Australia use 'WSD Levamisole for Sheep and Lambs' to worm their Emus (Appendix E). Since this product is registered for worming sheep, they were directed by a Veterinarian to use half the recommended dose rate for worming their Emus (Kip Venn 2009). It is very important to contact a Veterinarian before using a product that has not been registered for use in Emus. Manufacturers of worming products can also be contacted for off-label use. Either Veterinarians or Manufacturers will advise how much worming product should be administered in the drinking water.

Faecals should be checked at least every six months for both parasitic worm eggs and protozoa. Testing for *Chlamydophila*, *Salmonella,* and other organisms should be carried out periodically. Prior to breeding season, Emus should undergo a complete blood count (CBC) and chemistry panel for detection of any present infections or other conditions (Wissman 2006).

The right jugular vein is easily accessible (and much larger than the left jugular vein). The vein can be occluded in a similar way to that of other species however it is advisable to not stand directly in front of the Emu when performing venipuncture, as they kick straight forward and can cause a serious injury. The wing can be cannulated for small blood samples, and in chicks or recumbent birds the medial metatarsal vein can also be used (runs along the medial side of the hock) (Wissman 2006).

Emus can be sprayed with mice and lice spray periodically to prevent infestations.

Coccidiosis is common in chicks and may also be observed in adults therefore a coccidiocide (such as Baycox – Appendix F) should be administered to Emus at an early age. Once again, it is very important that the manufacturer's directions are followed. "Large numbers of coccidia may cause some intestinal problems, including diarrhoea, but the birds tend to develop a resistance and tolerance to these parasites as they age (Wissman 2006).

8.4 Known Health Problems

Common medical problems of Emus are outlined in the following tables. These tables may be used as a guide for diagnosing illnesses or conditions, however veterinary treatment and advice should always be sought after if a health problem has been displayed in an Emu.

It is important to pay attention to the 'prevention' sections of these tables as prevention is always better than cure! As a general rule, most diseases or other health problems can be prevented with good hygiene, good management practices and common sense.
It is also important to become familiar with the signs of common health problems in Emus, because if an Emu does become sick, early detection may mean the difference between life and death.

Heavy Metal Poisoning

Cause	Ingestion of metal scraps (e.g. zinc, lead).
Signs	Signs of Metal Poisoning may include: • Constant thirst. • Regurgitation of water. • Vomiting. • Listlessness. • Weakness. • Depression. • Tremors. • Loss of coordinated movements. • Seizures. • Inappetence (lack of appetite). • Liver and renal involvement. • Reddish urates and droppings. • Bright green droppings. **Diagnostic Tests:** • Radiographic evidence of metallic fragments along with a rapid response to parenteral fluids and calcium EDTA treatment are diagnostic. • Blood lead and zinc concentrations can also be measured. Serum lead concentrations of >0.5ppm and zinc concentrations of >2ppm are suggestive of toxicosis. (Raidal n.d.)
Treatment	Chelates (an organic compound used to detoxify poisonous metal agents) are used to treat this metal toxicosis. Chelating agents are continually injected into the poisoned bird's muscles until its blood levels return to normal. (PetMD 2008)
Prevention	Clear any consumable heavy metal scraps from within the enclosure (e.g. unused fencing materials). Use fencing made from non-toxic materials, such as stainless steel and welded wires. Lead can be found in old paint and soldering therefore it is important to ensure the enclosure is free of these substances.

	(PetMD 2008)

Obstruction/ Perforation of the GI Tract

Cause	Ingestion of loose nails or other larger objects.
Signs	The clinical signs might be intermittent depending on the size of the object and the nature of the Emus diet. Signs of Obstruction/Perforation of the GI Tract may include: • Regurgitation. • Gasping. • Choking. • Physical lump in throat where object is stuck. • Abnormal sounds. • Inappetence. • Depression. • Lethargy. • Weakness. • Continuous swallowing. **Diagnostic Tests:** • Radiographs of GI tract. • Endoscopy (Raidal n.d.)
Treatment	"Most foreign bodies are small enough to be removed orally either with the aid of general anaesthesia, surgical instruments and endoscopy or by palpation (examining by touch)" (Raidal n.d.) .
Prevention	Make sure nails that are used in enclosures are hammered in tightly and that there are no loose nails lying around on the ground or other sharp objects that the Emus may consume.

Leg and Wing Fractures

Cause	Leg fractures are common in ratites and occur for a number of reasons: e.g. fighting with other Emus, kicking fences, inappropriate enclosure design or incorrect capture and handling techniques. Wing fractures may occur if the Emu is restrained using the vestigial wings during procedures or due to incorrect handling (Wissman 2006).
Signs	Signs of leg fractures include: • Inability to walk. • Unsuccessful attempts to stand – e.g. the Emu may be lying on the ground and scrambling around in an attempt to stand. • Falling over due to loss of balance. Emus may appear to be sitting normally even if they have broken their leg, unless they have broken it in a way that it looks twisted. Generally they cannot walk and flop to the ground when they attempt to do so. (Keenan 2009). Signs of wing fractures include: • Wing hangs abnormally from body. Emus may show signs of pain when they fracture a leg or wing including depression, listlessness, weakness and lack of appetite. **Diagnostic Tests:** • Radiographs, ultrasounds.
Treatment	"Fractures of the leg are usually easy to repair surgically, but are rarely successful long-term because of problems in managing these large, fractious, bipedal patients" (Stewart n.d.). Emus tolerate long-term use of slings. Plates may be used if bone quality is normal. Fractures of the phalanges, fractures of the distal metaphysis of the tarsometatarsus and luxations of the metatarsal-phalangeal or interphalangeal joints can be stabilised with fibreglass casts, to which most Emus readily adapt (Stewart n.d.). Leg fractures are always very serious and often result in the decision to euthanase the bird (Wissman 2006). Most wings will heal without intervention unless the fracture is compound.
Prevention	Take care during capturing and handling procedures. Separate Emus that continually fight. Make sure the enclosure is 'Emu friendly' e.g. no large holes in ground or unnecessary objects that are potential trip hazards. Take extra care during handling, especially when a restraint method involves handling the wings.

Skin Lacerations

Cause	Many things could cause skin lacerations in Emus e.g. scraping against sharp objects in the enclosure such as metal wire poking out of a fence, or fighting with other Emus in the group.
Signs	Signs of skin lacerations include: • The most obvious sign is blood that may be running or seeping from the laceration. • Dried blood may be found around the laceration. Flies may congregate in the area of the wound. • Depending on how deep the cut is, Emus may also show signs of listlessness, depression, and lameness.
Treatment	"Do not apply clotting powder or flour to a cut in the skin. Cleanse the area gently with a 3% hydrogen peroxide solution, Nolvasan, or Betadine, and apply pressure for 3-5 minutes. If the laceration is less than ¼ inch, the wound can be cleaned with hydrogen peroxide twice daily until healed" (AvianWeb 2006). If the laceration is greater than ¼ inch, the wound may need to be sutured by a vet (AvianWeb 2006). "Skin lacerations are usually easy to suture or staple, however, using local anaesthetic is not recommended" (Wissman 2006). "Never apply first aid ointments - or any ointment - to any part of a bird without checking with an avian veterinarian. Most ointments will do irreparable damage to feathers, and many may have serious health effects as well" (AvianWeb 2006). During the healing process, an antiseptic powder may be applied to the wound (if recommended by the veterinarian) as well as a powder or spray to deter flies (as long as the treatment does not irritate the injury).
Prevention	• Remove sharp, protruding objects from within enclosure (including any items on the ground that could cut the feet of an Emu). • Make sure there is no wire sticking out of the fence. • Separate Emus that fight.

Endoparasitic Infestations

Cause	Internal Parasites such as: • Nematodes (roundworms) • Trematodes (flukes) • Cestodes (tapeworms)
Signs	Signs of Endoparasitic infestations include: • Diarrhoea • Inappetence • Anorexia • Excessive hunger • Pneumonia • Dyspnoea (difficulty breathing) • Anaemia • Hepatitis • Neoplasia (tumour formation) **Diagnostic Tests:** • Faecal examination, faecal smears and faecal flotation will allow identification of certain internal parasites and their eggs.
Treatment	Broad spectrum anthelmintic treatment. Seek Veterinary Treatment.
Prevention	The parasitic load of a group of Emus should be checked regularly by faecal examinations. A regular worming program should be instigated. Parasitic burdens can be reduced by regular cleaning, daily removal of faeces, off ground, anti-spill feeders, the provision of clean drinking water. Waterers should ideally be raised off the ground so that the birds cannot stand or sit in them.

(Spielman n.d.)

Ectoparasites

Cause	Exposure to lice, mites, flies and ticks
Signs	Signs of Ectoparasitic infestations may include:- • Itching. • Feather loss. • Visible parasites. • Inappetence. • Anaemia (in the case of heavy tick infestations).
Treatment	Powders and sprays will combat lice, mites and flies whereas ticks will require manual removal.
Prevention	Ectoparsites such as lice, mites, flies and ticks need to be kept under control with regular physical examinations, and by following the same preventative measures for endoparasites (outlined above).

Bacterial Infections

Cause	Infection with bacterial agents such as *E. Coli, Salmonella* spp., *Mycoplasma* spp., *Mycobacterium avium* (tuberculosis) and *Clostridium perfringens* (Stewart n.d.). Bacterial infections are more prevalent in situations where there is overcrowding, poor nutrition, poor hygiene, and high stress.
Signs	Signs of bacterial infections may include: • Diarrhoea. • Weakness. • Lethargy. • Inappetence. • Vomiting. • Depression (sometimes the only sign of avian tuberculosis) • Sudden death. • Conjunctivitis. • Sinusitis. • Pneumonia. • Air Sacculitis (inflammation of the air sacs). • Gastroenteritis (inflammation of stomach and bowel). • Omphalitis (infection of the umbilical cord stump in the neonate). • Septicaemia (bacterial infection in the blood stream). • Lameness, accompanied by swollen joints – may be a sign of mycoplasmosis. **Diagnostic Tests:** • Bacterial infections can be detected by faecal analysis. • Blood tests and radiographs may also be used to diagnose bacterial infections. (Spielman n.d., Stewart n.d.)
Treatment	Seek veterinary advice. Some bacterial infections may be combated with antibiotics (the antibiotic required will depend on the results of the culture tests). For some bacterial infections there are no treatments currently available therefore it is imperative to adopt preventative measures.
Prevention	Adopt good husbandry practices e.g. remove faeces daily, avoid overcrowding, raise feeding stations, provide quality feed, clean and disinfect enclosures on a regular basis (Spielman n.d.). Isolate diseased Emus to prevent spread of disease.

Chlamydophilosis

Cause	Infection with the bacterium *Chlamydophila* spp. (Wissman 2006).
Signs	Signs of infection with *Chlamydophila* spp. include: • Conjunctivitis, • Respiratory signs - watery eyes, nasal discharge, and moist respiratory noises. Sneezing and coughing is also a feature. • Biliverdinuria (deposition of greenish pigments in the urine). • Weight loss. • Depression. • Lethargy. (Bird Care and Conservation Society 1999, Wissman 2006) **Diagnostic Tests:** • Faecal testing (requires viable organisms). • A swab of the choana and cloaca can be submitted for PCR (Polymerase Chain Reaction) testing or alternatively tested using a Clearview kit. This can be performed in house, but may be inaccurate resulting in both false negatives and false positives. • Blood can be tested using the Immunocomb test kit. This test measures antibody rather than antigen and a positive result is indicative of exposure but not necessarily of current disease. However, a high antibody level coupled with appropriate clinical signs is strongly suggestive of chlamydophilosis. (AWHN 2009)
Treatment	Clinical signs may be resolved with treatment however the infection itself may not necessarily be cleared. Emus may remain as carriers that can shed organisms again at a future point. Seek veterinary advice. Treatment options include injectable doxycycline administered at 50 mg/kg once a week for seven weeks, or oral doxycycline 25-30 mg/kg daily for a month. (AWHN 2009)
Prevention	• Quarantine all new birds and isolate infected birds. • Good hygiene is essential. *Chlamydophila* are susceptible to most disinfectants including quaternary ammonium compounds, alcohol, benzalkonium chloride, bleach and hydrogen peroxide. • Avoid stress. (AWHN 2009, Bird Care and Conservation Society 1999)

Fungal Diseases – Aspergillosis

Cause	Infection with *Aspergilla spp.* Emus raised on wet, mouldy hay or contaminated feed are at high risk of contracting aspergillosis. Immunosuppression, bacterial infection and over-use of antibiotics may predispose a bird to aspergillosis. (Wissman 2006)
Signs	Signs of Aspergillosis include: • Respiratory signs (e.g. gagging, coughing, choking, wheezing). • Depression and weakness is often all you will see. (Bird Care and Conservation Society 1999) **Diagnostic Tests:** • Microbial culture and isolation of the organism within lesions are required for definitive diagnosis. • Clinical signs and the presence of leucocytosis may also be suggestive of aspergillosis. • Endoscopic examinations are used to visualise fungal plaques within the air sac, lung or trachea. • Cytologic examination of oculonasal discharges, or infraorbital lavage fluid may be useful in the diagnosis of mycotic sinusitis. • Serology for the detection of aspergillosis is available at commercial veterinary laboratories. • Radiographs may reveal multifocal densities within the lungs, trachea, or air sacs that reflect the presence of fungal plaques. (Rose 2005)
Treatment	Accessible lesions can be removed with surgery. Antifungal drugs may be administered orally, topically, by injection, or nebulising (more than one drug may be used). Therapy needs to be continued for weeks to months. Oxygen, supplemental heat, tube feeding, treatment of underlying conditions and other forms of supportive care are often needed. Aspergillosis is very hard to treat (Coleman 2007).
Prevention	Strict standards of hygiene are a must for preventing aspergillosis. Bedding materials should be kept clean and dry. Try to avoid using straw, hay, and other agricultural products for bedding or nesting material. Feed should be stored appropriately and regularly examined for the presence of fungi. Any husbandry technique that minimises stress is likely to reduce the risk of aspergillosis. Make sure hay that is fed to Emus is dry and mould-free. Emus may also be given preventative treatments with antifungal agents (Rose 2005).

Candidiasis

Cause	Infection with the yeast *Candida albicans*
Signs	Signs of Candidiasis include: • Depression. • Ruffled feathers. • They continue to eat but fail to thrive. • Whitish ulcers, scabs or plaques at the commissures of the mouth (where upper and lower beaks meet) and on the tongue. • Bad breath. • The proventriculus often has whitish thickened areas of mucosa. Erosions of the koilin lining of the ventriculus and the proventriculus are also commonly seen. • Weight loss. • Vomiting. • Diarrhoea. • Malnutrition. • In the respiratory tract, *Candida* may cause nasal discharge, a change in the voice, difficulty breathing, rapid breathing, and inability to exercise. (Raidal n.d., Nash 2009) **Diagnostic Tests:** • "Gram-stained impression smears from the oral cavity, crop and faeces are useful for diagnosis as is histopathology and culture of the ventriculus at necropsy" (Raidal n.d.).
Treatment	Antifungal medications. Elimination of risk factors, such as poor diet, poor sanitation, or the presence of other diseases. Antifungal medications commonly include nystatin, flucytosine, ketoconazole, fluconazole, and itraconazole. Ointments containing amphotericin B may be applied for treatment of oral or skin infections (Nash 2009).
Prevention	Candidiasis occurs when some other factor negatively influences the health of the bird. The risk of candidiasis can be greatly decreased by providing a clean environment and proper nutrition, reducing or eliminating any causes of stress, and preventing contact with any potentially sick bird. Antifungal medications may be used for birds on prolonged antibiotics. Nystatin may be added to the hand-rearing formulas in nurseries. Any nursery items should be cleaned and disinfected after use on each bird. Any left-over formula from baby birds should be discarded (Nash 2009).

Protozoal Diseases – Coccidiosis

Cause	Infection with *Eimeria* spp.
Signs	Signs of Coccidiosis may include: • Listlessness. • Lethargy. • Weight loss. • Blood in the droppings or elsewhere in the body. • Diarrhoea. • Dehydration. • Death. (Markley 2004) **Diagnostic Tests:** • Definite diagnosis can be established only by laboratory examination. Intestinal smears are examined under a microscope. The coccidia are identified based on their shape, size and location in the gut (Wright 2005).
Treatment	Seek Veterinary Treatment. Once coccidiosis is diagnosed in an Emu, treatment with an anticoccidial drug (e.g. Baycox – toltrazuril) should begin immediately. Follow the manufacturer's instructions. Coccidiosis will often react to treatment using coccidiostats delivered in the drinking water (available from veterinarians, chemists or produce merchants). (Wright 2005).
Prevention	Vaccination – effective live vaccines are available. These ensure that the Emus are exposed early in life and develop immunity to the most virulent species of coccidia. It is essential to follow the manufacturer´s recommendations for effective vaccination. Coccidia require moisture to become infective; therefore substrate within enclosures must be kept as dry as possible. Ventilation must be good and the Emus should not be overcrowded. It is best to house Emus on dry, well drained, sunny, sandy, north facing, sloping yards in order to prevent high exposure to coccidiosis. If the Emus are only exposed to a low level of infection, they will gradually become immune but clinical disease will occur if the coccidiosis challenge is too great. Immunity to one species of coccidia does not protect Emus against other coccidial species. It is very risky to rely on hygiene alone to produce satisfactory control, therefore vaccination or coccidiostats delivered in the drinking water is recommended. (Wright 2005).

Reproductive Problems in Hens

Cause	There can be many causes of reproductive problems including hypocalcaemia, oviductal infection and ruptured oviduct (Wissman 2006). Determining the exact cause of egg binding can be difficult. Some of the factors thought to cause egg binding include genetic factors, malnutrition, cold weather, infection, trauma to the reproductive tract, inadequate nesting area, excessive egg laying, obesity, or lack of exercise. Those with an inadequate calcium intake are particularly prone (LBAH 2007, Stewart n.d.).
Signs	Emus may show no outward signs of reproductive problems. Visible signs of reproductive problems may include: • Excessive ventrodrosal movement of the cloaca when a hen is running may be an early sign of egg-related problems. • Prolapse of the vagina will indicate reproductive problems. • Large pericloacal swelling may indicate peritoneal hernias. • Signs of illness such as depression, lack of appetite, weight loss, weakness, constant sitting. **Diagnostic Tests:** • Diagnostic tests include haematology and serum biochemistry, oviduct cultures, abdominocentesis, radiology and ultrasonography. Diagnosis of reproductive problems may be reached via physical examination (including cloacal palpation and eversion of the phallus), by looking at the reproductive history of the Emu, and diagnostic tests such as those mentioned above. (Stewart n.d.).
Treatment	Seek Veterinary Treatment. Surgery may be required to correct reproductive problems in hens (Wissman 2006). Egg binding and dystocia may be treated with lubrication, calcium injections and possibly vitamins A, D, E and selenium. The bird's ambient temperature may need to be increased. Fluids and dextrose would most likely need to be administered. Contraction of the reproductive tract (and hopefully passing of the egg) may be caused by injections of oxytocin or arginine vasotocin, or application of a prostaglandin gel. These medications should not be used if an obstruction is present (Nash 2009).
Prevention	Reproductive problems may be prevented with proper nutrition, good hygiene practices and good management. Adequate exercise and proper breeding techniques may also prevent common reproductive problems.

Environmental Diseases

Cause	Hyperthermia – excessive elevation of body temperature. May be caused by inadequate shelter, capture, restraint and transport of Emus. Hypothermia – subnormal body temperature. May be caused by inadequate heating, inadequate facilities, advanced disease states. Extreme feather loss during cold weather may also bring on hypothermia.
Signs	Signs of Hyperthermia may include: • Increased respiratory rate. • Weakness. • Unconsciousness. • Panting. Signs of Hypothermia may include: • Decreased heart rate. • Lethargy. • Weakness. • Cold to touch.
Treatment	Hyperthermia – remove from heat source, cool slowly with fans and water. Seek veterinary treatment. Hypothermia – warm slowly in 37°C environment (e.g. use electric blankets, wrap in large blankets, rub with hands if possible). Minimise heat loss. Treat underlying diseases.
Prevention	Provide appropriate shelter, heating/cooling. Ensure facilities are adequate for housing Emus. Reduce stress. Practice correct capture and handling techniques.

(Spielman n.d.)

Nutritional Diseases

Cause	Insufficient or inappropriate total nutrients, bad management, inability to obtain correct feed. Vitamin deficiencies.
Signs	Signs of nutritional disease may include: • Weight loss. • Poor to emaciated condition. • Weakness. • Lethargy. • Abnormal growth – failure to grow, stunted growth, deformities. • Depression. • Inappetence. • Increased thirst. • Increased urination. • Vulnerability to disease.
Treatment	Provision of a well balanced nutritional diet. Increase total food intake for underweight birds. Vitamin supplementations. Seek veterinary advice.
Prevention	Provide a well balanced nutritional diet. Ensure quantities of food appropriately reflect group numbers. Make sure Emus have adequate exposure to the sun and plenty of room to exercise.

(Spielman n.d.)

8.5 Quarantine Requirements

As soon as illness has been detected in an Emu, it must be moved to a designated quarantine area. This quarantine area should be in an area which isolates the Emu from *all* other animals, including those in its own group. The quarantine area may be a smaller paddock that is separate from all other enclosures and out of the public view. The quarantine area should also be as free from stress as possible, ideally in a quiet area with appropriate shelter, warmth and easily accessible.

It is advisable that Emus are quarantined for a minimum of 30 days and under the supervision of a veterinarian. The veterinarian will monitor the progress of the Emu's health and once treatment has been successful and the Emu is no longer considered contagious, the veterinarian will give consent to move it back to its original enclosure.
Under no circumstances should Emus be moved back to their original group before appropriate testing has been carried out to confirm they are disease free.

Newly acquired Emus from different locations must also be quarantined for a minimum of 30 days before they are introduced to the main collection. This time period should be sufficient for detection of disease. Quarantine should always be carried out on an "all in, all out" basis. Should an Emu within a group that are undergoing quarantine contract or test positive to an infectious disease, it must be placed in isolation. The whole group must then undergo a further 30 days of quarantine or even longer, with appropriate testing. The length of the quarantine period is dependable on the incubation period of the disease concerned (Woodford 2000).

It is advisable that the person who is looking after the Emus in quarantine should not visit or work with animals of a similar taxonomic group. If this is not possible, the Emus in quarantine should be serviced last. Equipment for feeding and cleaning should be kept separate from equipment that is used for all other animals within the wildlife park. Equipment that is used for quarantine should be regularly disinfected with a disinfectant recommended by the veterinarian. All soiled bedding and uneaten food should be disposed of in a hygienic manner, preferably by burning (Woodford 2000).

Precautions must be taken in order to minimise the risk of exposure to zoonotic diseases. Precautions should include the use of disinfectant foot baths, wearing appropriate protective clothing, masks and gloves (Woodford 2000).

Before the release of newly acquired Emus after quarantine, it is a good idea to check their plumage for any seeds that are exotic to the release area. Similarly, they should be checked for tick infestations, which could potentially be vectors of diseases that are also exotic to the release area (Woodford 2000).

9 Behaviour

9.1 Activity

Emus are diurnal meaning they are most active during the day and sleep at night. Emus are nomadic in the wild, following the rain to feed. They walk significant distances at a steady pace of 7km per hour, covering 9 feet (270cm) in a single stride. If being chased by a predator, Emus can reach speeds of up to 50km per hour. Within a season, it is not unusual for an Emu to walk 1000km, with 10 to 25km a day being normal (male with chicks move more slowly) (Wikipedia 2008, Animal Life Resource 2009).

Through spring and summer, Emus consume between 3kg to 4kg of food every day, doubling their body weight. Once breeding commences, this reduces to an average of less than 100 grams per day (Australian Calliope 2009). The amount of time Emus spend foraging each day depends on the time of year, however they will feed throughout the day until they meet their requirements.

During the day, Emus may carry out a range of tasks such as feeding, swimming, walking, running, and playing. They are very curious and inquisitive birds and are easily fascinated by the simplest of things.

9.2 Social Behaviour

Emus are mostly solitary creatures and do not require company or mutual grooming which many other birds do. They can be seen in enormous flocks in the wild when they are roaming the continent in search for the best feeding areas however this is not considered truly social behaviour, simply a matter of going where the food is (Wikipedia 2008).

Emus can be found in pairs in open country and occupy home ranges of about 30km^2. They defend significant parts of these areas, but generally try to avoid other Emus. When confronted with an unwelcome Emu they use their powerful legs to kick as a defence (Davies 2009).

Members of a brood may remain together for some months after being deserted by their father but will eventually break up and form pairs rather than stay together as a flock (Davies 2009).

Emus communicate with two basic calls: the grunt and the drum (or boom). The grunt, which is given mainly by the male, has an aggressive message yet is far less intense than the drum (or boom). The drum or boom is mainly given by the female and is used for courtship and to make territorial claims. To make the drum or boom call, Emus use their tracheal pouch as a resonating chamber, and the low frequency call can carry 1km. Emus display by fluffing out their neck while drumming and at other times, by stretching themselves up to their full height and grunting with vigour. Chicks have a piping call until about five months old when their voice breaks. A hole opens up in their trachea and communication with their air sac is established (Davies 2009).

Emus generally tolerate each other fairly well however they may become quite aggressive during certain times of the year. Females fight vigorously amongst themselves for access to unpaired males (Coddington & Cockburn 1995). Males that are broody will also become very aggressive towards other Emus, including their mates.

9.3 Reproductive Behaviour

Emus form pairs around December to January and it is the female that initiates courtship (refer to section *10.1 Mating System* for a detailed explanation on the four acts of mating).

9.4 Bathing

Emus love the water and are expert swimmers. When bathing they do not use their wings to splash themselves as other birds do; they flop down into the water, rolling from side to side until their feathers are fully soaked. It can be quite comical watching them do their water aerobics – splashing, jumping, running, and rolling around. Upon exiting the water they shake themselves off like a wet dog (and smell like one too!) (*Billabong Sanctuary 2007)*.

Within the enclosure, if there is no dam, creek or other means for the Emus to swim in, sprinklers are the next best thing – and a good form of behavioural enrichment.

Figure 9.1: Emus enjoying themsleves in dams at Oakvale Farm & Fauna World.

9.5 Behavioural Problems

Generally, Emus behave very well and because of this, juveniles are sometimes found roaming free throughout zoos and wildlife parks. Emus may however become too confident with the public, especially if they are continually provided with food. They may start hassling people for food and can easily scare children. Emus are extremely curious birds, and are known to peck at shiny and brightly coloured objects such as watches or other jewellery. While their beaks generally would not inflict any serious harm, pecking can be intimidating to those who are not conditioned to it.

"Emus, particularly those in semi-open captivity, who have little fear of humans, are also prone to pecking at hairy human heads and wooly clothing, which can be distressing for small children and tourists" (Chemistry Daily 2007).

Due to being fed by the public, Emus may also peck at people through fences or over fences if they are not high enough in an attempt to get food. Free roaming Emus may also become quite thrifty at stealing food especially food that is provided by the institution as they become very familiar with the packaging.

From experience Emus are pleasurable to work with as they are pretty docile creatures. They can become aggressive towards keepers during the breeding season and appropriate measures should be undertaken such as having two keepers enter the enclosure at all times.

9.6 Signs of Stress

Signs of stress in the Emu may include feather loss (especially in males that are nesting), running fence lines, or jumping at fences in an attempt to escape. Emus are generally relaxed and do not get stressed easily.

Other signs of stress may include:

- Depression
- Moodiness or irritability
- Excessive activity
- Feather picking
- Increased pecking
- Increased elimination
- Inactivity or sluggishness
- Lack of desire to socialise
- Abnormal vocalisation (University of Minnesota 2007)

9.7 Behavioural Enrichment

Due to the curious nature of Emus, behavioural enrichment can easily be provided as they would be interested in almost anything (apart from sharp objects which could cause damage if swallowed).

Some suggestions for enrichment include:

- Sticks with rags tied to the end that can be dangled over the enclosure fence.
- Shiny disco balls hung up in trees (refer to section *4.9 Enclosure Furnishings* for picture).

- Large plastic 2L milk bottles filled with shiny objects such as marbles – be sure to fix lid tightly so that Emus cannot swallow anything inside.
- Reflective surfaces in which they can see themselves.
- Fake Emus made from materials such as brooms and mop ends to look like their shaggy feathers.
- Sprinklers, hoses or running water of any sort e.g. man-made waterfalls.
- Food items hidden around the enclosure e.g. fruits hung in trees (within reach of course). Fresh browse provided on a regular basis.
- Inflatable toys in the dam.

9.8 Introductions and Removals

Even if you believe you know your Emus very well, they can still be unpredictable. When introducing new Emus into an already established flock of Emus it is best to do so via slow release (refer to section *8.5 Quarantine Requirements* for proper procedures when introducing new Emus).

After quarantine, the new Emu or Emus could either be placed in a holding area adjacent to the main enclosure or fenced off within a section of the enclosure. This will allow the new and old Emus to meet however if their initial reaction is unfavourable, there is no way for them to get at each other and fight. The behaviours of both groups of Emus should be closely monitored.

Once it has been established that there is a good chance the Emus will get along, the newly acquired Emus can be let through to the main enclosure. Once again, it is vital that close monitoring is carried out and if there are any signs of aggression between the two groups, they should be separated for a longer amount of time (signs of aggression may be kicking out, grunts or standing tall).

When introducing Emus that have been removed from their group temporarily, say for treatment, the same protocols which have been mentioned above should be followed. With Emus it is very unlikely that there would be any problems with reintroductions but monitoring should be carried out in all circumstances. At Oakvale Farm & Fauna World, a male Emu was removed from the main exhibit for some time due to extreme feather loss as a result of nesting stress. Once all feathers grew back, this Emu was released back into the enclosure without using slow release and there were no problems as a result.

9.9 Intraspecific Compatibility

Both male and female Emus can be housed together as pairs or in large groups without any major problems occurring as long as there is plenty of space for them to roam within the enclosure. The space within the enclosure should be sufficient so that Emus can avoid each other if they wish (refer to section *4.3 Spatial Requirements*). It may be necessary to remove female Emus from the enclosure when the males start incubating the eggs as the males can become aggressive.

9.10 Interspecific Compatibility

Emus can be housed with different species as long as they are compatible, i.e. of a docile nature as well. Macropods are often seen housed with Emus because they are placid and non-threatening. The free roaming juveniles at Oakvale Farm & Fauna World mixed rather well with several different animal species such as goats, sheep, ducks, chickens, and kangaroos.

Figure 9.2: Young Emus often mix with different species (goats on left kangaroos on right).

Figure 9.3: Kangaroos lazing in Emu enclosure at Featherdale Wildlife Park.

Emus that have been housed as a separate species within their enclosure for a long time may become territorial. This was shown to be true by the Emus at Oakvale Farm & Fauna World when a Darter, *Anhinga novaehollandiae*, was introduced into their enclosure. Upon introduction of this Darter, the Emus all ran over to it and stood over it in a threatening manner. At one stage they all cornered him and started stomping on him, luckily he was saved by two keepers who were monitoring him. The Darter worked out that if he dove into the dam he would be safe (the Emus surprisingly chose to leave him alone once he did). After a couple of days, the Emus' curiosity and aggression wore off and the Darter was able to venture out further into the enclosure. Slow release may have prevented this negative interaction between the two species.

Figure 9.4: Emus showing aggression towards newly introduced Darter.

It is possible that when Emus are housed with other species that they could contract diseases from them (some of which would be listed in section *8.4 Known Health Problems*). Good hygiene practices and regular worming treatments should help prevent transmission of such diseases.

9.11 Suitability to Captivity

Emus are very well suited to a captive life and this can be proven by the number of zoos and wildlife parks that keep them not only in Australia but also worldwide. Emus are easy to care for in captivity as very few resources are needed to be poured into them. They are an interesting display animal and enjoyable to work with.

10 Breeding

10.1 Mating System

Female Emus are *polygamous*, which means they may mate with several males after their first partner (Simpson & Day 2004). This type of mating system is called successive or sequential polyandry (Philadelphia Zoo 2009). Once pairing has occurred in the summer, females and males may remain together for five months. The female dominates the male during pair formation and initiates courtship however once incubation begins, the male becomes aggressive towards other Emus, including the female. Females take no part in incubating the eggs or caring for the young, this is done by the males (AMO 2001).

The act of mating has four phases: 1) courtship; 2) mounting and partial evagination of the phallus; 3) intromission and ejaculation (Figure 10.1); and 4) postcoital display (Malecki *et al.* 1997).

Courtship:

The females produce a 'booming' sound, which can be heard hundreds of metres away. Feathers are fluffed and there is a lot of "dipping, ducking, grunting and bobbing around" (Parker 2000). Males may also fight with one another, chasing each other away from females using their powerful frontal kicks (Parker 2000). Once a strong bond has been formed in a pair, the male and female Emus will raise their heads and may also circle each other. "The male puts his head over the female's head and back, touches her with his breast and pushes forward. The female usually walks a short distance, closely followed by the male, then crouches for him" (Malecki *et al.* 1997).

Mounting and Partial Evagination of the Phallus:

The male Emu places himself behind the crouched Emu, sitting almost at the right angles, and then gradually moves towards her tail. With a leg either side of the female and in a sitting position, the male moves forwards and partially evaginates the phallus (everts his penis). The male raises his body, brings his phallus close to the female's cloaca and touches it. The female is pressed by the male's breast and lowers her neck. She then pushes her abdomen back and everts her cloaca (Malecki *et al.* 1997).

Intromission and Ejaculation:

The male Emu contacts the female's cloaca by moving further forward and raising the front of his body. The phallus becomes erect when it gains intromission. The male grabs the back of the female's neck and ejaculates (Malecki *et al.* 1997).

Figure 10.1: Emus mating.

Postcoital Display (after sexual intercourse):

After ejaculating, the male dismounts, stands up and fluffs his feathers. Gradually the erect penis is withdrawn within the male's body. The male preens himself and then walks away. This is accompanied by signs which resemble nesting behaviour: "The male lowers his head until it is just above the ground, grunts frequently, and picks up and replaces leaves, small sticks, grass, or feathers". The female Emu stands after the male, keeping her body higher than in a normal standing (Malecki *et al.* 1997).

10.2 Ease of Breeding

Emus breed readily in captivity (Parliament of Victoria 2002).

Decreased daylight hours trigger breeding in Emus. Short days (photoperiod) have been found to depress appetites, particularly in the males, and trigger hormones that stimulate their breeding (Parker 2000).

10.3 Reproductive Condition

Prior to the breeding season, male and female Emus in good reproductive condition almost double their body weight by putting on a layer of fat between their gut cavity and muscle groups (Australian Calliope 2009). Other signs of good reproductive condition include courtship displays (mentioned above, section 10.1) as well as the following changes that females and males uniquely experience:

10.3.1 Females

Ahead of the breeding season, thick, black feathers will cover the female's head and neck and her body plumage will become darker, indicating her willingness to mate (*Billabong Sanctuary 2007*). Before mating the female will make dull, rattling sounds (sounding like drum beats) (Ivory 1999).

10.3.2 Males

During the breeding season, male Emus experience hormonal changes. There is an increase in luteinizing hormone and testosterone levels and their testicles double in size. Males lose their appetite and construct a nest for the female to lay her eggs (Wikipedia 2008).

10.4 Techniques Used to Control Breeding

The best method for controlling breeding is to separate the sexes into different enclosures. If this is not possible, there are other means for controlling breeding including removal of eggs, and removal of nests or nesting materials within the enclosure. Males and females may also be separated by dispositions (moving one of the sexes to other institutions). Quantities of food should be decreased and a change in diet may be necessary (avoid providing a high fat diet). Mating behaviour may be discouraged by interrupting any courtship displays, and providing the Emus with plenty of forms of enrichment.

10.5 Occurrence of Hybrids

There are no known occurrences of hybrids.

10.6 Timing of Breeding

Emus are seasonal breeders. They will begin pairing in December/January each year (Kent & Bewg 2008).

Emus breed during decreasing daylight periods (around April when the days get noticeably shorter) (Parker 2000).

Hens will begin laying eggs from mid to late April each year. Most females will have finished laying eggs by October/November (Kent & Bewg 2008). Chicks hatch from as early as June, to as late as December (July and August are generally the peak times) (Parker 2000).

10.7 Age at First Breeding and Last Breeding

Emus usually begin breeding when they are two years old however those that do not hatch until late in the season may not start breeding until they are three years of age (Wissman 2006).

Emus may live for about 30 years or so in captivity and may produce eggs for more than 16 years (Jeffrey 2001).

10.8 Ability to Breed Every Year

Emus have the ability to breed every year. Females may mate with several partners during each breeding season.

10.9 Ability to Breed More than Once Per Year

In a good season, a female Emu may lay three complete clutches (San Diego Zoo 2008).

10.10 Nesting, Hollow or Other Requirements

Male Emus will make rough nests on the ground out of sticks, leaves, grass, and bark (Figure 10.2). It is therefore important that these materials are either present in the enclosure or provided during the breeding season. Emus prefer building nests behind visual barriers such as large rocks, shrubs, and trees for safety and protection. So it is advisable to have such barriers in the enclosure.

Figure 10.2: Emu nest.

10.11 Breeding Diet

An increasing proportion of an emu's live-weight gain as it approaches sexual maturity is body fat.

By ensuring only a very limited gain in body fat beyond 12 months of age, the reproductive fitness of females can be enhanced.

This can be achieved by providing the Emus with unrestricted access to a maintenance diet (Table 1) supplemented with lucerne pellets, hay or pasture.

(Mannion & Kent 2008)

Table 10.1: Nutrient requirements of adult Emus.

Nutrient	Breeder	Maintenance
Metabolisable energy (MJ/kg)	11.0	10.5
Lysine % of diet	0.81	0.63
Methionine % of diet	0.38	0.25
Methionine + cystine % of diet	0.67	0.47
Tryptophan % of diet	0.18	0.12
Isoleucine % of diet	0.58	0.41
Threonine % of diet	0.60	0.38
Calcium % of diet	3.0	1.6
Available phosphorus % of diet	0.6	0.6
Sodium % of diet	0.2	0.2

Table 10.2: Example of breeder diet (% composition).

Diet	Breeder	Maintenance
Sorghum	31.6	30.0
Wheat	30.0	34.2
Meat and bone meal (55%)	10.3	5.7
Soyabean meal (45%)	4.9	-
Sunflower meal (32%)	6.5	-
Millrun	10.0	10.0
Lucerne meal	-	16.4
Limestone	5.7	2.0
Dicalcium phosphate	-	0.7
Salt	0.22	0.29
DL methionine	0.17	0.09
L Lysine HCl	0.07	0.10
Mineral and vitamin premix	0.50	0.50

As the mature breeding female Emu approaches the egg-laying season, she will require a more highly nutritious diet than the maintenance diet. This higher plane of nutrition is necessary for the female to meet her needs for egg formation.

It is recommended that a breeder diet is provided six weeks prior to the first egg being laid because it takes approximately five weeks for an egg to develop.

This highly nutritious diet is also required by breeding males to make sure they achieve good fertility and increase their body reserves before incubation. An example of a breeder diet has been provided (Table 2).

(Mannion & Kent 2008)

10.12Incubation Period

The male Emu incubates the eggs for a period of eight weeks. During this time he will rarely leave the nest, not even to drink, eat, or defecate. He rests his neck on the ground and becomes torpid, dropping his body temperature by about four degrees (Figure 10.3) (van den Beld 1992). The male Emu will stand only to turn the eggs, which he does about ten times a day (Wikipedia 2008).

Over the eight weeks of incubation, males will survive on stored body-fat and on morning dew which they can reach from the nest. Male Emus will lose one-third of their body weight during the incubation period (Wikipedia 2008).

Figure 10.3: An exhausted looking male sitting

on **(**most of) his eggs.

10.13 Clutch Size

Females will lay 6 – 14 large, dark green eggs (with an average clutch size of around 10 eggs) (Simpson & Day 2004). The eggs are on average 130mm × 90mm and weigh about 500 to 700 grams (AMO 2001, *Billabong Sanctuary 2007*). The rate of lay is initially slow, with several days between the early eggs. The rate increases to one egg every couple of days or so towards the end of the clutch (Kent & Bewg 2008).


Herbert 2009

Figure 10.4: Size of Emu egg.

In some cases the clutch size can be much higher than typical clutch sizes (e.g. 25 eggs) simply because the female may lay eggs in the nest which have been fertilised by other males. Females will also go off and mate with other males which form their own nest, so in one year the female can lay multiple clutches (Wikipedia 2008).

Older hens usually lay more eggs than first year layers and young hens (Wissman 2006).

A male Emu will adopt lost chicks from other broods, provided that they are no bigger than his own offspring (Ivory 1999).

10.14Age at Fledging

Newly hatched chicks are active and can leave the nest at about three days old (San Diego Zoo 2008)

10.15Age of Removal from Parents

Male Emus will raise their chicks until they are about 18 months of age however chicks can be pulled from their parents soon after they hatch (after a few days). Emu chicks are *precocial* which means they are well developed and capable of locomotion soon after hatching (Pough *et al.* 2002), and can feed themselves.

10.16Growth and Development

The weights and heights of eight individual Emu chicks from 1 week to 11 weeks old have been provided below (Table 3). This table can be used as a guide to help determine the unknown age of a chick. The height measurements were taken from the ground to the top of the chicks' heads while they were standing in an upright position with their necks fully extended (Henderson 1999).

Table 10.3: Individual growth rates of eight Emu chicks (from 1-11 weeks) (Henderson 1999).

	BIRD ME0930		BIRD ME0932		BIRD ME0932		BIRD ME0933		BIRD ME0975		BIRD ME1019		BIRD ME1020		BIRD ME1021	
AGE OF BIRD WEEKS	W gm	H mm	W gm	H mm	W gm	H mm	W gm	Hmm	W gm	H mm	W gm	H mm	W gm	H mm	W gm	H mm
1	455	320	416	320	420	320	450	320								
3	1035	430	735	390	775	420	895	410			1000	450	1100	450	1000	400
5	2250	500	1500	510	1250	480	1750	510	2250	560	1750	540	1750	470	1500	460
7	3250	630	2250	590	2000	530	2750	630	4000	650						
9	5000	720	3750	730	3500	650	4750	770	5750	780						
11									6000	940						

The best way to determine the age of chicks is through good record keeping. Hatch dates should be recorded as well as height and weight measurements to ensure the Emu chicks are growing at the correct rate.

As a guide only, the important weights of growing Emus are as follows:

- Hatch 420 g
- Three months 8 kg
- Six months 19 kg
- 1 year 30 kg
- 2 years 50 kg (Kent 2008)

"Emus can achieve mature body weights of 49.5 kg, grow at an average growth rate of 68.4 g/d from birth to maturity, and reach maximum velocity of growth at 105 d of age when they weigh 9.8 kg" (Dunk *et al.* 2003).
The following photographs represent the physical changes that two Emus underwent during their growth and development to twelve months of age. 'Bip' and 'Bop' are residents at Oakvale Farm and Fauna World. Photos taken 2008 (Kelly Swarbrick).

2 Weeks Old

3 Weeks Old



4 Weeks Old

5 Weeks Old


9 Weeks Old

10 Weeks Old

1

18 Weeks Old

Photos of Emus at six months of age were taken by *Jasmine Anderson* (February 2009), at Oakvale Farm & Fauna World.

12 Months Old

11 Artificial Rearing

11.1 Incubator Type

Specific Emu egg incubators are available however poultry incubators have been converted to hold Emu eggs with good results (Kent & Bewg 2008).

The *GQF Sportsman Incubator Model 1536* is specifically designed for incubating and hatching Emu eggs (Figure 11.1). This incubator can hold 3 turning racks or 3 hatching racks, or any combination of the two. Horizontal rotation incubators turn the Emu eggs 180° automatically and can set and hatch eggs in the one cabinet. The eggs are secured and therefore there is no walking or tumbling of the eggs. This model has a high volume fan for dryer conditions (GQF Manufacturing 2009).

Figure 11.1: No. 1536 Incubator containing two No. 1511 Emu Rotational Racks (top right) and one No. 3072 Hatching Basket (bottom left).

GQF Manufacturing is an American company and distribute to Australia through Brookfield Poultry Equipment, QLD. GQF Sportsman Incubators need to be altered to comply with Australian standards and therefore, brass wafer technology will be incorporated into the machines. This means that temperatures will need to be set manually (Brookfield Poultry Equipment 2008).

11.2 Incubation Temperatures and Humidity

Kent and Bewg (2008) have reported that as a guide, the incubator will need to be run at a constant temperature of 35.25°C-35.5°C (dry bulb) and a relative humidity of 45-50% (26°C-27°C) (wet bulb) throughout the first 50 days of incubation.

The Environmental Protection Agency, QLD reported similar incubation settings:

Temperature	35.25-36. °C
Relative humidity incubation	50%

Prior to incubation, eggs would need to be collected daily to reduce pre-incubation problems and disinfected using a recognised egg sanitation process (refer to section *11.13 Hygiene* for details). After cleaning the eggs, they will need to be stored in a cool room at a temperature of 10°C – 16°C for up to 10 days. Eggs should be taken out of cold storage and left for 12-18 hours so they return to room temperature, before placing them in the incubator (Kent & Bewg 2008).

Eggs will require either manual or automatic turning a minimum of three times a day. The eggs should always be turned an odd number of times per day when turned manually to ensure the embryo does not end up in the same position every night with the risk of it becoming stuck to the side of the shell and subsequently dying (Kent & Bewg 2008).

11.3 Desired % Egg Mass Loss

The optimum weight loss for the emu egg is believed to be between 13% and 17% from the time the egg is laid until internal pipping occurs (Davis 2007).

The following formula can be used to determine how much weight an Emu egg should lose each day in order to achieve the desired % egg mass loss.

$$\textit{Daily weight Loss Target Aim} = \frac{\textit{Fresh Laid Weight x Desired \% Loss to Pip}}{\textit{Number of Days to Pip}}$$

(Gowland 2004)

Example of Daily Weight Loss Target Aim:

Fresh Laid Weight = **600g**
Desired % Loss to Pip = **15%** (ideal % egg weight loss)
Number of Days to Pip = **49**

= (**600g** × **15%**) / **49**
= 90 / **49**

= **1.84g**

In this example, the 600g egg would need to lose 1.84g in weight each day to achieve the desired % egg weight loss (15%).

11.4 Hatching Temperature and Humidity

Kent and Bewg (2008) state that the hatcher should be operated at a slightly lower temperature than the incubator; 35°C, and higher humidity, 28°C – 29°C (wet bulb).

The Environmental Protection Agency, QLD reported similar hatching settings:

Temperature	35.25-36. °C
Relative humidity hatching	75-80%

The higher humidity helps to moisten the internal membranes and soften the shell to assist in the hatching process. Eggs are not turned during the hatching period (Kent & Bewg 2008).

11.5 Normal Pip to Hatch Interval

"The average hatchery sequence for the chick to break into air cell is at 47 days of incubation while to pip the eggshell is at 49 days and to complete hatching at 50 days. However, the time interval is subject to normal biological variations" (Adewumi *et al.* 2008).

Emu eggs are opaque so candling is not an effective means of determining whether an egg has internally pipped. A method called tapping replaces the candling procedure. Tapping the egg with a small cylindrical metal rod produces particular sounds that can be used to identify an egg that has internally pipped and needs to be moved to the hatcher (Jeffrey 2001).

11.6 Brooder Types/Design

There are two basic types of brooding system:

1. Localised Heat Type;
2. Whole Space Type;

Localised Heat Type

Several brooders of this type exist, including ones heated by infra-red lamps, gas heaters or electrical bar heaters.

Infra-red Brooders

Infra-red lamps are suspended 450 to 600mm above the chicks. Two 100 watt bulbs are adequate to brood small numbers. Two lamps should be used in case one lamp fails. It is recommended that each globe is provided with a reflector to transfer the light and heat down to the chicks. This system may however not provide enough heat to young chicks in cold areas.

Infra-red brooding units are often surrounded by a solid partition at least 300-450 mm high to eliminate draughts. A number of feeding and watering stations are included within this surround.

This system was used to rear two Emu chicks at Oakvale Farm and Fauna World and was very successful. The chicks were taken outside on a daily basis for exercise.

Gas Brooders and Electrical Bar Heaters

Provide radiant heat to the immediate area under the heating elements. Gas brooders and electrical bar heaters vary in size and heating ability, and are used in a similar way to infra-red lamps. Existing gas and electric poultry brooders have been found to be satisfactory for brooding, and superior to infra-red and porcelain globes.

(Kent & Trappett 2003).

Whole Space Type

The whole brooding shed is enclosed, insulated and heated to a uniform temperature. Heat sources may include gas, electricity, oil, or kerosene, and are either portable or fixed to the brooding shed. Heat has to be evenly distributed throughout the whole area. This brooding system is only practical and economical if large numbers of similarly aged chicks need to be reared. The atmosphere within the shed needs to be assessed on a regular basis. If the air becomes stuffy or levels of ammonia can be detected, the shed should be flushed with fresh air.

11.7 Brooder Temperatures

The following table provides a guide to what temperatures are required by Emu chicks at different stages during brooding.

Table 11.1: Temperatures Required by Emu Chicks at Different Ages.

Age (days)	Temperature at Chick Level (°C)
1-7	30+
7-14	28
14-21	26
21-28	24

It is important that Emu chicks are brooded at the correct temperature in draught-free, suitably sized areas. The chicks' thermal comfort behaviour is the best guide to whether or not the temperature is correct; if they huddle close to the heat source they are cold, if they are well dispersed they could be too hot. To assist your management, it is best to put a minimum-maximum thermometer near the chicks to obtain valuable information on temperature fluctuations (especially during the colder parts of the night). As the chicks grow older, the temperature can be reduced.

(Kent & Trappett 2003)

11.8 Diet and Feeding Routine

Hand reared chicks require a high light intensity on the food and water for the first few days after hatching to learn to find food and water (Figure 11.2).

Figure 11.2: Light source above food at Oakvale Farm.

Emu chicks will have to be taught to peck at the food as the father normally does this. Young turkeys or chickens have been successfully used as teachers and once some of the chicks have learned they can teach younger birds that may come into care.

At Oakvale Farm and Fauna World, the two young Emu chicks were housed with two chickens in the early stages of the rearing process to teach them how to peck at food. This method was proven to be very successful (Figure 11.3).

Figure 11.3: Emus taught by chickens how to peck at food (Oakvale Farm & Fauna World).

If you do not have access to surrogate fathers, you can teach the chicks to feed by using a bright coloured stick or pen and tapping the dish. The chicks' inquisitive nature will start them pecking at the same place. Patience is required.

Note: No bedding which might possibly be eaten should be used during this training phase which could last one to two weeks.

For the first three weeks the water dish should be no more than 50mm deep so that the young chicks do not drown.

The following diet has been provided to rear Emu chicks:

Equal amounts of:

- Turkey crumbles

- Milled wheat
- Milled barley
- Milled corn

To each kilo of mix add:

- 1 tablespoon of calcium
- ½ teaspoon of lucerne meal if available*
- 1 tablespoon of fine gravel – fine sand must *NEVER* be used as it could impact in the stomach, build up and cause eventual death.

*if Lucerne meal is not available, give the chicks **finely chopped** greens.

Examples of greens that could be provided include:

- Various grasses
- Lettuce leaves
- Spinach leaves
- Fresh lucerne

Food is offered dry so the chicks start off as they would in the wild where no moist food is available. It is also essential that the chicks learn to identify water and offering dry food makes water all the more important.
The following table provides the recommended quantities of dry feed to be offered to chicks each day to obtain their recommended weight gain. Plenty of chopped greens were also provided.

Table 11.2: Quantity of Dry Feed/Day Required by Emu Chicks at Different Ages.

Age	Quantity of Dry Feed/Day
Up to 1 week of age	250g
Up to 2 weeks of age	375g
Up to 2 weeks of age	400g
Up to 4 weeks of age	525g

Each week continue to increase the dry feed offered each day by 125g up to the age of 8 weeks. From 9 weeks of age allow free access to the dry feed mix for two hours twice a day until the chicks reach 12 weeks of age. After that, free access to feed can be allowed with no time restriction provided there has been no signs of leg weakness and PROVIDED the chicks have a large exercise area.

Table 11.3 can be used as a guide to determine whether hand reared chicks are receiving the correct quantities of food. The weights of the eight Emu chicks were achieved by following the recommendations in the table above. It is very important to weigh Emu chicks on a weekly basis and regularly check them for any signs of leg weakness or deformities. The heights of the chicks in **Table 11.3** were obtained by measuring them from the ground to the top of their head while they were standing in an upright position with their necks fully extended.

Table 11.3: Individual growth rates of eight Emu chicks (from 1-11 weeks old).

	BIRD ME0930		BIRD ME0931		BIRD ME0932		BIRD ME0933		BIRD ME0975		BIRD ME1019		BIRD ME1020		BIRD ME1021	
AGE OF BIRD WEEKS	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)	W (gm)	H (mm)
1	455	320	416	320	420	320	450	320								
3	1035	430	735	390	775	420	895	410			1000	450	1100	450	1000	400
5	2250	500	1500	510	1250	480	1750	510	2250	560	1750	540	1750	470	1500	460
7	3250	630	2250	590	2000	530	2750	630	4000	650						
9	5000	720	3750	730	3500	650	4750	770	5750	780						
11									6000	940						

(Henderson 1999)

Juvenile Emus (3 months to 6 months): The same diet which is provided to Emu chicks can be used for juveniles, however larger stones can be added (approximately 12mm to 25mm in diameter). Greens can be coarsely chopped and if possible live food should be added to their diet e.g. grass hoppers, meal worms, beetles etc. A small quantity of whole grains can also be offered.

Note: *the above information for section 11.8 Diet and Feeding Regime was obtained from the* ***Australian Bird Rehabilitation Manual (Norma Henderson 1999).***

11.9 Specific Requirements

Water

Death of young chicks can often be due to their failure to find water. To prevent such deaths, chicks must learn very early in life where to find water. Cool, clean water must be provided in small, readily accessible drinkers at a number of food and water stations. Chicks can be attracted to the waterers by placing shiny or coloured objects in the water containers – ensuring that they cannot swallow the objects (Kent & Trappett 2003).

Food

Refer to section above *11.8 Diet and Feeding Regime*.

Enclosure Substrate

It is important to use a substrate that the Emu chicks will not try to consume. Substrates should be clean, chemical free, soft, and absorbent, has good insulation properties and dust free. Pine shavings and sawdust satisfy these requirements (Kent & Trappett 2003).

Sawdust was used as the substrate within the Emu chick enclosure at Oakvale Farm & Fauna World. Faeces were easily removed on a daily basis and the substrate was completely changed on a weekly basis to maintain a high quality of hygiene.

Ventilation

Emu chicks require a constant supply of fresh, clean air to grow and remain healthy therefore it is important that areas in which they are housed provide this. Draughts should be prevented at all costs as Emu chicks chill quickly (Kent & Trappett 2003).

Light

Emu chicks respond and grow better when a constant light source is provided. This enables them to move around their enclosure to find food and water throughout an extended period. A program of "23 hours of light at an intensity of 20 lux has provided excellent growth rates while intensities equivalent to a 40W bulb have also been found satisfactory" (Kent & Trappett 2003).

It is important that chicks have a period of darkness to prevent young chicks huddling together which may result in suffocation if a blackout should occur (Kent & Trappett 2003).

Exercise

Emu chicks should be taken out of their penned area to an appropriate outside grassed area for daily exercise. This is vital for their health and leg formation. They will also use this time to peck at the grass. It is important to keep a close eye on chicks that are exercising as they panic easily and to watch out for predators.

11.10 Pinioning Requirements

N/A – (Emus cannot fly).

11.11 Data Recording

For good management, it is essential to keep records on all aspects of artificially rearing Emus. Records can begin with lay and collection dates. It is very important that the fresh laid weights of eggs are recorded because this information will be required to work out the weight loss that each egg requires on a daily basis to achieve the desired % egg weight loss (refer to section *11.3 Desired % Egg Mass Loss*.)

Keep daily records on the incubator environment (temperature and humidity). Regular egg weighing (e.g. every 3 days) is essential for determining whether desired egg mass loss has been achieved. Weighing the eggs and keeping good accurate records on the incubator environment will provide the information needed to set the optimum humidity level. In addition, these records will provide you with a good reference on the performance of the incubator, particularly if problems are noted in hatchability. Some eggs do not lose weight as readily as others and therefore records can be referred to for determining what action may be taken to compensate, such as raising or lowering humidity or increasing or decreasing length of storage (Davis 2007).

Records should also be kept on percent hatchability, percentage of infertility, and embryo deaths. Records can be used to detect malfunctions before a disaster develops. Records of fertility and embryo deaths may alert the person in charge of hatching to production, storage, or incubator problems so that adjustments can be corrected before major losses occur (OGPBB n.d.).

Records would need to be kept on number of turns per day if this is done manually. Results of tapping eggs to determine whether they have internally pipped should also be recorded (Jeffrey 2001).

Good records must also be kept once the chicks have hatched from their shells. Examples of what could be recorded include weekly weights, quantities and types of food consumed, changes in diet, body condition, faecal output, behaviours, response to surrogate fathers, ability to feed themselves, illnesses, deformities, and deaths.

11.12Identification Methods

All individual Emus should be clearly identified. Approved methods of identification include wing tags and microchips. Microchips should be placed sub-cutaneous at the back of the neck or in the left lateral thigh when the bird is at least three months of age. Wing tags may not be aesthetically pleasing for Emus on exhibit (EPA QLD).

Dye was used to distinguish the two Emu chicks at Oakvale Farm & Fauna World when they were of a young age. Blue dye was painted onto the head of one chick so they could be told apart when weighing them each week. Different colours can be used if there are a number of chicks and once they reach 3 months of age, microchipping is a good means of identification.

Refer to section *5.3 Methods of Identification* for further information.

11.13Hygiene

A high standard of hygiene is vital during the artificial rearing of Emu chicks. Good hygiene is important from the very start i.e. from collecting eggs for incubation to adulthood and throughout the entire lives of the Emus.

Soiled or heavily contaminated eggs should not be placed into an incubator. These eggs should either be culled or disinfected as soon as possible after collecting them from the nest site (EPA QLD). Emu eggs are susceptible to bacterial contamination and should therefore be sanitised by using a recommended fumigant or egg washing product. Incubators and hatchers should also be thoroughly disinfected between batches using the same products. A recommended disinfectant is Avisafe™, by Vetafarm. Hatchery waste, including unhatched embryos, should not be stored or allowed to accumulate in the vicinity of the incubators (Kent & Trappett 2003).

Water needs to be changed on a daily basis and topped up with fresh, clean water. Water containers should also be scrubbed daily and disinfected on a regular basis. Water may need to be changed more than once throughout the day, especially if Emu chicks have defecated in the water.

Food dishes should also be cleaned on a daily basis and uneaten food should be removed at the end of every day. Faeces should be removed daily from within chick enclosures to prevent harbouring of diseases. Substrates should be completely changed on a weekly basis or more if required.

Chick enclosures should be thoroughly cleaned and disinfected after every use and fresh, clean sawdust or similar substrate should be provided each time.

It is also extremely important to wash your hands before and after handling chicks and cleaning so that the chance of spreading disease is minimised.

Refer to section *5.1 Hygiene and Cleaning* for further information.

11.14Behavioural Considerations

There are not many major behavioural problems that occur as a result from hand rearing Emus. They are naturally inquisitive birds and even without hand rearing will often approach the public and appear quite tame. Hand reared Emus may have a lesser degree of human fear and in order to reduce this it is important to allow the Emu chicks to spend as much time as possible with their surrogate fathers e.g. chickens, turkeys, and ducks so they pick up on their behaviours and react to situations as naturally as possible.

The juvenile Emus (Bip and Bop) at Oakvale Farm & Fauna World grew to love the public when they were free range – mainly because they were offered food throughout the day. Due to their lack of fear, they did however become too boisterous and regularly stole food from the public. They were also perceived to be threatening by young children when the Emus approached them and as a result they had to be moved to a fenced-off enclosure. Now they can still approach the public but the fence allows the public to walk away if they feel hassled. The Emus are friendly enough to allow the public to pat their heads and necks and this is a positive outcome of hand rearing them.

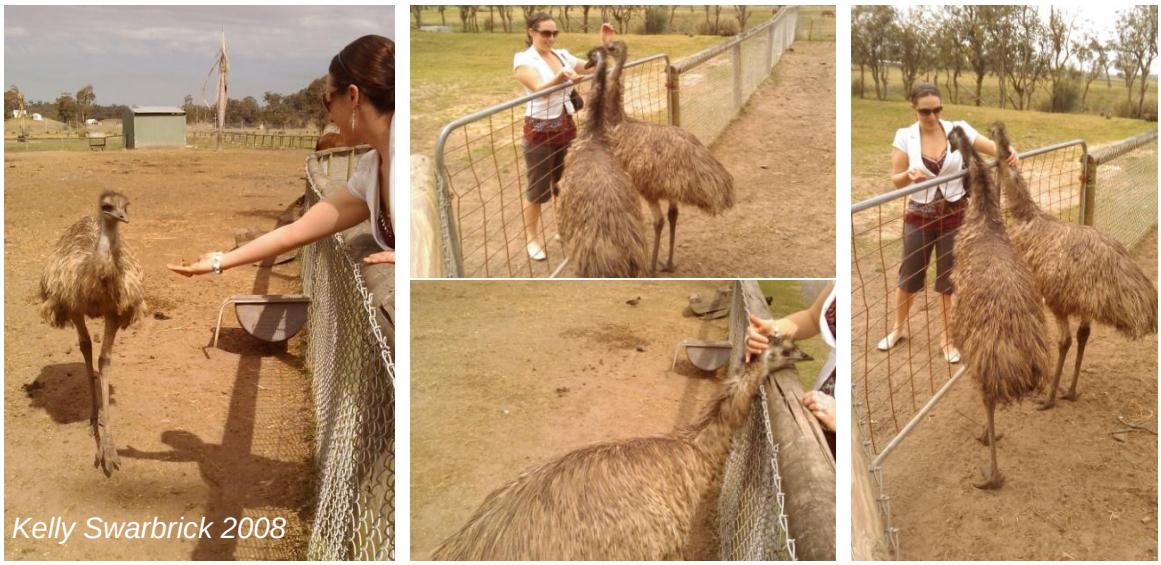


Figure 11.3: Feeding /patting the two juveniles in their new enclosure at Oakvale Farm & Fauna World.

11.15Use of Foster Species

Emus are precocial which means they have the ability to walk and feed themselves after hatching, therefore the only foster parents they require are either chickens or young turkeys to teach them how to drink water and peck at food.

11.16Weaning

N/A – Emus are precocial and therefore do not require weaning.

11.17Rehabilitation Procedures

Throughout all stages of rehabilitation, it is important to remember the Emu's final destination – back to the wild. All care should be provided whilst keeping this in mind. Emus need to stay fearful of humans if they are to survive in the wild. The housing, cleaning and feeding should therefore be done quickly, with a minimum amount of disturbance (Walraven 2004).

If Emus learn to associate humans with food during the rehabilitation process, they may approach humans once released in the wild. To avoid this, the Emu in care could be familiarised with a certain shape and colour – one that it is unlikely to ever see in the wild. For example the keeper who cares for the Emu during rehabilitation could always wear a white lab coat when dealing with it. Once released in the wild, the Emu is unlikely to encounter someone in a white lab coat and the sight of people minus the white lab coats is less likely to trigger an association with food (Walraven 2004).

Ideally Emus should be rehabilitated at the release site. Chicks should also be raised at the release site however if this is not possible, transfer to pre-release by 6 months of age should be considered (Henderson 1999).

During rehabilitation, Emus should be provided with clean dry bedding daily, and clean fresh water – which should be available at all times. Straw or hay should not be used with birds as it may predispose respiratory illness. Most birds require privacy to feel secure - this can be provided by screening off the enclosure or by using natural barriers such as trees or large rocks. All measures should be undertaken to minimise stress during rehabilitation. This can be achieved by replicating the Emu's wild environment as much as possible, providing the appropriate temperature, suitable company, somewhere comfortable to sleep, and an enclosure that is quiet (Walraven 2004).

Rehabilitation procedures and treatment measures would depend on individual cases i.e. what the Emu's illness/ injury is. Refer to *8.4 Known Health Problems* for treatment on common Emu health problems.

If injuries are severe it may be necessary to seek veterinary attention. Rehabilitation procedures would therefore be based on veterinary advice. It may be necessary to contact a wildlife carer (such as a member of WIRES) to rehabilitate wild Emus if appropriate licensing is not held.

Licensing

The legal requirements for holding native fauna vary from State to State. A permit to hold an injured native animal, even temporarily, will be needed in most cases. The National Parks and Wildlife Service of NSW (NPWS) will need to be contacted for obtaining a licence for holding native fauna for rehabilitation in NSW. Government authorities such as NPWS will also provide general advice on wildlife and refer you to a local veterinarian or wildlife rescue group for further assistance. Contact details of the relevant wildlife authorities in each State are as follows (Walraven 2004):

Table 11.4: Government Authorities in States of Australia

State	*Government Authority*	*Contact Details*
NSW	National Parks & Wildlife Service of NSW	Telephone: (02) 9585 6444 www.npws.nsw.gov.au
ACT	Environment ACT	Telephone: (02) 6207 9777 www.environment.act.gov.au
NT	Parks and Wildlife Commission of the Northern Territory	Telephone: (08) 8999 4536 www.nt.gov.au/ipe/pwent
QLD	Queensland Parks and Wildlife Service	Telephone: (07) 3202 0200 www.epa.qld.gov.au
SA	Department of Environment and Natural Resources	Telephone: (08) 8124 4700 www.denr.sa.gov.au
TAS	Department of Primary Industry, Water and Environment	Telephone: (03) 6233 6556 www.dtpha.tas.gov.au/parkswildlife.htm
VIC	Department Sustainability and Environment	Telephone: (03) 9412 4011 www.dse.vic.gov.au
WA	Department of Conservation and Land Management (CALM)	Telephone: (08) 9334 0333 www.calm.wa.gov.au

Housing for Rehabilitating Emus

Emus must be protected from fox predation, and electric fences are recommended to discourage predators (Henderson 1999). For information on setting up Emu housing for rehabilitation purposes, refer to sections *4 Housing Requirements* and *11.9 Special Requirements*. It is important to construct the enclosure in a way to reflect natural surroundings as much as possible. This will make the transition from captivity to the wild much easier.

Rehabilitation Diet

It is important to provide Emus being rehabilitated with a diet that closely resembles what they would find in the wild. If feeding Emus from a young age it may be necessary to provide a more captive diet (see section *11.8 Diet and Feeding Regime*), however as they approach release age (i.e. 18 months) it is best to replace the captive diet with a more naturalistic diet. This can be done by reducing the amounts of pellet or dry food with natural browse (refer to *6.1 Diet in the Wild*). It is essential that by release age the Emu can recognise natural food sources, and feed independently.

Human Interaction during Rehabilitation

Human interaction during rehabilitation should be kept to a minimum. It is very important to not tame the birds (e.g. by petting them), or to have them associate humans with food, or become desensitised to human presence. Emus that are being rehabilitated would most likely benefit from being left undisturbed as much as possible.

Release Considerations

Indications that an Emu is ready for release may include:-

- The Emu can move freely;
- It is in a good condition i.e. fit.
- It is socially adapted to survive in its natural state;
- It can recognise its own species;
- Displays appropriate Emu behaviour;
- It recognises its natural food sources;
- Feeds independently;
- It is used to exposure to natural elements, and is acclimatised to the release conditions;
- Displays normal physical features;
- Is dehumanised.

Readiness for release will also depend on weather conditions, timing of release, availability for a suitable release site, other habitat considerations, and the practicality of releasing Emus back into the area where they were originally found. When possible Emus older that 13 months should not be transported between December and June each year – this may vary depending on the location and sexual maturity of the Emus (Henderson 1999).

Wild Emus at or near the release site should be observed prior to the release of rehabilitated Emus. The climatic conditions of the release site should be investigated, and where possible release should be timed following good rain in the area. This will ensure that the emus will have sufficient food to maintain them through the first few difficult weeks of adjustment (Henderson 1999).

Emus should be released as close as possible to the area in which they came from bearing in mind that they are a nomadic species (Henderson 1999). Early morning would be the most suitable time to release Emus because that will give them plenty of time to settle in to their surroundings (Walraven 2004).

Permission from the relevant State wildlife authority must be sought prior to the release of Emus (see Table 11.4 for contacts) (Walraven 2004).

Soft or Hard Release

Two release methods are recognised:

- Hard release – release without support, mostly used for rehabilitated adults that have spent only a short time in captivity.

- Soft release – support provided.

In most cases, soft release is the appropriate technique. The support given during soft release substitutes, to a degree, for the support the Emu may have had from its parent

or family group. Support given during soft release may consist of a release paddock. This should be located in a suitable habitat for the Emu and near its original encounter site. The Emu would spend some time here prior to release. The Emu would become as used to the area at the time of release as would local resident animals at the release site (Walraven 2004).

The release paddock is left open for the Emu to come and go as it pleases. In the soft release site, the Emu will continue to find food and shelter for as long as it needs it. Most released Emus will decrease the amount of food taken from the soft release site after a few weeks. It is then time to reduce the amount of food provided for the Emu so it learns to be fully self-sufficient (Walraven 2004).

Stick around and watch the Emu that was rescued take its freedom. It is wonderful and satisfying to watch the Emu return to where it belongs. Enjoy the experience! (Walraven 2004).

Capture and Restraint during Rehabilitation

Refer to section *7.3 Capture and Restraint Techniques.* Bear in mind that some of these techniques may not be acceptable for wild Emus during rehabilitation, depending on the extent/nature of their injuries.

Transport

For chicks up to 3 months of age the transport vehicle should be dimly lit and provide fresh air, but the chicks must be protected from chilling and extremes in temperature (Henderson 1999).

It is very important that the birds cannot see out or they may try to escape, causing injuries. A transport vehicle or compartment should have smooth sides with no projections or footholds. A solid non-see-through barrier should be presented to the Emus and they will behave in a more orderly manner when placed in such an environment for transport (Henderson 1999). Refer to *7.6 Transport Requirements* for further information.

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Glossary

Abdominocentesis: Insertion of a trocar (sharp pointed instrument) through a small incision in the abdominal wall into the abdominal cavity to collect abdominal fluid for evaluation (Mid-Atlantic Equine Medical Center 2009).

Anthelmintic: Any drug or agent used to destroy parasitic, especially intestinal, worms e.g. tapeworms, roundworms, and flukes (Oxford 2008).

Brood: The young of an animal (especially a bird) produced at one hatching or birth (Oxford 2008).

Brooder: A heated house for chicks (Oxford 2008).

Broody: Of a hen (or in this case male Emu) wanting to brood i.e. sit on eggs to hatch them (Oxford 2008).

Browse: Feed in the form of twigs, young shoots, branches of leaves (Oxford 2008). Browse may also be used for enrichment purposes.

Candling: Test an egg for freshness or fertility by holding it to the light (Oxford 2008).

Capture Myopathy: It is associated with the stress of capture, restraint and transportation. An animal suffers capture myopathy when its muscles break down because of reduced blood supply. The early signs are a stiff walk and swollen, hard, hot muscles that progress to paresis. It will eventually result in death. Affected animals may have red urine, trouble breathing and a very fast heart rate (Queensland Government 2009).

Cloaca: The genital and excretory cavity at the end of the intestinal canal in birds (Oxford 2008).

Clutch size: A set of eggs for hatching, a brood of chickens (Oxford 2008).

Conditioning: Teach or accustom animals to adopt certain habits (Oxford 2008).

Cytologic: Study of cells (Oxford 2008).

Defecate: Discharge faeces from the body (Oxford 2008).

Distal metaphysis: The *metaphysis* is the growing part near the end of a long bone. (the *distal* end is the end situated farthest from the midline of the body or point of attachment). (Oxford 2008).

Dystocia: Difficult or prolonged birth (Oxford 2008).

Ectoparasites: Parasites that live on the body surface of their hosts (Oxford 2008).

EDTA: Ethylenediaminetetraacetic acid. A common chelating agent (Oxford 2008).

Emaciated: Abnormally thin or feeble (Oxford 2008).

Endemic: Regularly or only found among a certain region (Oxford 2008).

Endoparasitic: Parasites that live on the insides of their hosts (Oxford 2008).

Endoscopic: Instrument for viewing the internal parts of the body (Oxford 2008).

Enrichment: The practice of providing animals under managed care with stimuli such as natural and artificial objects. Enrichment involves animal management techniques which allow the animal in captivity to express a range of natural behaviours and provides stimulation. Animal holders provide animals with the choices to interact with conspecifics, to interact with other species, to search for food and browse, to manipulate food (complete fruits, branches), to manipulate novel objects (anything suitable), to interact with humans (training, feeding), to change their daily routine (ZooLex 2008)

Evaginate: To evert a body organ inside surface to outside. To cause a body organ or part to become inside-out (enwik).

Extant: Still existing, surviving. Opposite to extinct (Oxford 2008).

Histopathology: **1**. Changes in tissues caused by disease. **2**. The study of these (Oxford 2008).

Hybrids: The offspring of two animals of different species or varieties (Oxford 2008).

Hypocalcaemia: Deficiency of calcium in the bloodstream (Oxford 2008).

Immunosuppression: The partial or complete suppression of the immune response of an individual (Oxford 2008).

Incubation: Sit on (brood) or artificially heat eggs to bring forth young birds (i.e. eggs hatch) (Oxford 2008).

Inappetence: Lack of appetite (TFD 2009).

Infraorbital: Below or under the area around the eye of a bird (Oxford 2008).

Interphalangeal: Between phalanges (toe or finger bones), as with an interphalangeal joint (Wiktionary 2008).

Interspecific: Pertaining to phenomena occurring between members of different species (Pough *et al.* 2002).

Intraspecific: Pertaining to phenomena occurring between members of the same species (Pough *et al.* 2002).

Intromission: The act of sending, letting, or putting something in, especially the introduction of one organ or part into another (e.g. the penis into the vagina) (Oxford 2008).

Laceration: Mangle or tear (especially flesh or tissue) e.g. cut to skin.

Lameness: Disabled, especially in the foot or leg; limping; unable to walk normally (Oxford 2008).

Leucocytosis: An increase in the number of white cells in the blood, especially during an infection (Oxford 2008).

Metatarsal-phalangeal joint: Referring to the joint between the metatarsus (*a group of five long bones in the foot*) and the phalanges of the toes (*toe bones*) (Wikipedia 2009).

Morphometrics: Morphometry, especially of living organisms (Oxford 2008).

Morphometry: The process of measuring the external shape and dimensions of living organisms (Oxford 2008).

Mycotic: Disease caused by a fungus (Oxford 2008).

Necropsy: The process of dissecting a dead animal to determine the cause of death (DQU 2009).

Nomadic: Roam from place to place e.g. in search for food. No specific territory (Oxford 2008).

Oculonasal: Referring to the eyes and nose (Oxford 2008).

Palpation: The process of examining by touch (Oxford 2008).

Pericloacal: Around or surrounding the cloaca (Oxford 2008).

Phallus: The (especially erect) penis (Oxford 2008).

Pinioning: To cut off the outer part of a bird's wing, usually including the flight feathers to permanently prevent flight (Oxford 2008).

Pipping: The *Pip* is the hole a newly formed chick makes in its shell when it is ready to hatch. *Pipping* is the act of making the hole (BackYard Chickens 2009).

PPE: Personal Protective Equipment e.g. gloves, safety glasses, boots.

Prolapse: The forward or downward displacement of a part or organ (Oxford 2008).

Proventriculus: The narrow glandular first region of a bird's stomach (Oxford 2008). The proventriculus is quite large with the function of mixing food with digestive fluid prior to the ingesta being propelled into the ventriculus (the gizzard) where grinding occurs (Wissman 2006).

Quarantine: Isolation imposed on animals that have arrived from elsewhere or been exposed to, and might spread, infectious or contagious disease (Oxford 2008).

Serology: The scientific study or diagnostic examination of blood serum, especially with regard to the response of the immune system to pathogens or introduced substances (Oxford 2008).

Sexual Dimorphism: Distinct difference in size or appearance between the sexes of an animal in addition to the sexual organs themselves (Oxford 2008).

Sinusitis: Inflammation of a nasal sinus (cavity of bone or tissue, especially in the skull connecting with the nostrils (Oxford 2008).

Substrate: The ground covering within an enclosure e.g. grass, dirt, sand, gravel.

Tarsometatarsus: A long bone in the lower leg of birds, formed by fusion of tarsal and metatarsal structures (ankle and foot) (Oxford 2008).

Taxonomy: The science of the classification of living and extinct organisms (Oxford 2008).

Tibiotarsus: The bone in a bird equivalent to the tibia fused at the lower end with some bones of the tarsus (Oxford 2008).

Tridactyl: Having three fingers or toes (Oxford 2008).

Ventriculus: The gizzard (Wissman 2006).

Ventrodorsal: Both ventral and dorsal; extending from a ventral to a dorsal surface. Ventral – pertaining to the underside, or bottom of animal. Dorsal – pertaining to the back (TFD 2009).

Weaning: The process of gradually introducing a young bird to what will be its adult diet.

Zoonoses: Disease which can be transmitted to humans from animals or vice versa (Oxford 2008).

APPENDIX A

ANIMAL HOUSE MSDS