Husbandry Guidelines for

Ostrich
Struthio camelus
(Aves: Struthionidae)

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Date of Preparation: July 2016 – November 2017
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WORK HEALTH AND SAFETY RISKS

Workplace Health and Safety (WHS) consists of many points to outline the risks that are associated with working with any animal. All staff and patrons of the park or premises of the animals are covered under the Workplace Health and Safety Act that covers them in case of an injury obtained by these animals. These risks can be broken down into six main points; biological, chemical, environmental, ergonomic, physical and psychological. All these categories of risks have the subtitles of the risks associated with them and all cover different aspects and factors that could affect your work in caring for the animal.

Struthio camelus have many risks associated with, but a majority of them are related to the physical category, as they pose such a threat being a hazardous animal. The strong legs can cause some irreversible damage to limbs and ligaments, and in worst cases, can even lead to death. Being a large and hazardous animal, it is important to use protective equipment, example: rake, shield or shovel to protect yourself from in case of aggression. Keepers that enter the enclosure should be trained in the handling of an ostrich or someone with minimal experience with ostriches should be with a highly experienced keeper. During service of the enclosure, if the bird/s are in the enclosure, a two-keeper policy if heavily encouraged due to the unpredictable nature of these birds, ensuring that the worker is safe and protected from the bird. It is suggested to have the birds locked away in a holding area while you clean to make it safer for all parties involved.

Another important risk to consider when working with *Struthio camelus* is the involvement of sickness that could be hosted by the individual or group. *Struthio camelus* are possible hosts to some very serious zoonotic diseases that could affect a keeper for life or in a short term depending on the disease itself and the severity of the infection. Some of the contractible diseases include salmonella, chlamydia and avian influenza. It is highly important to protect yourself from any of these and to protect your health using PPE (gloves, face mask, goggles) when in proximity or in contact with an animal suspected of illness.

The proper signage should be used to warn off any individual not trained in the behaviour of the animal, such as placing a very noticeable sign warning the public and keepers about the dangers of an ostrich and outlines what qualifications and training that needs to be done before any access is allowed, or if the animal is in quarantine, a sign warning about contamination or the individual's sickness should be placed on the cage card and also as another noticeable sign to let keepers avoid the animal if possible if they have no use for it.

All risks can be very unpredictable and can happen at any time with no form of warning, so it is paramount that attention is paid to your surroundings as well as keeping an eye on the animal for your own safety, and the safety of any members of public and other keepers.

Species Risk Category

Struthio camelus = **Medium Risk** (Hazardous)

The *Struthio camelus* is classed as a medium risk due to their long powerful legs that are usually used for running, at up to speeds of 60-70 km/h, but when fleeing is not an option, ostriches use their legs to deliver powerful kicks. With a 10cm talon on each foot, their downward kicks can cause serious harm to potential predators. They also posses an incredibly strong beak that when used to peck, can cause bruising or damage depending on location of injury. Records of attacks on humans from Ostriches range from simple scratches and bruises, up to fractured skulls and loss of sight from the kicking and pecking and even death.

Workplace Risk Types

Biological

A major biological risk when working with the ostrich is the possibility of contracting any zoonotic diseases that may be hosted by the large bird, such as *salmonellosis*, *chlamydiosis* and *avian influenza*. If any sickness or disease is suspected in the animal, quarantine the birds and the use of personal protective equipment (PPE) if highly advised to lessen the risk of contaminating yourself or any other specimens.

Chemical

A chemical risk could lead to many possible outcomes from rashes to sickness and even irreversible effects to organs. These risks depend on what type and the strength of the chemical and if they are handled properly. The use of Chlorhexadine while cleaning the enclosure, if not wearing the appropriate PPE, could lead to nausea if any is ingested, allergic reactions like rashes, or irritation in the eyes if they are exposed to the chemical. Wearing goggles and gloves should be a must when dealing with all chemicals.

Environmental

Environmental risks cause some of the leading problems with keepers who constantly are working outside. The constant glaring of the sun on sunny days can lead to risks and problems like sun stroke and skin conditions like melanoma. The constant exposure to the suns rays puts the keepers at risk of developing such things. Extreme weather events can also cause a lot of risks, such as big storms can cause a weakness in trees, leading to them dropping their branches in keeper's ways, or even in some cases, on top of the keepers themselves.

Ergonomic

Ergonomic risks occur when the type of work you do, your body position or your working conditions put a strain on your body, these include a poorly set up workstation, not using proper lifting techniques, keeper assistance equipment not properly operational, keeper safety retreats and exits faulty or not at a safe height to avoid injury. One of the main things suffered by Keepers is a strained back from either lots of manual work, heavy lifting, or constantly bending down to retrieve items or clean.

Physical

Physical risks involving the ostrich include manual handling, capture and restraint, injury from close proximity. Their powerful legs can deliver kicks that can cause bruising, fractures and can even break bones if not careful. If an ostrich forces you to the ground, it can easily trample you and cause excess damage. They also possess a strong and powerful beak that, with the assistance of their long necks, can reach a considerable distance and also cause bruising, lacerations and even traumas like loss of sight if a blow to the eye is taken.

Psychological

The psychological risks to working with an ostrich range from personal trauma or causing a ripple effect throughout the entire work group. An effect could be caused by damage or experience to either your own being or witnessing an attack or display be made towards another. Due to their incredibly strong legs and medium danger risk, they could impose a fear amongst those who have less experience working with the ostriches and their defence of a hiss and spread wings might seem intimidating causing a submissive attitude in the keeper. Another psychological effect can happen through the loss of a fellow keeper who suffered a rare fatal injury from the animal, or even the death of the animal itself can be traumatizing to keepers who work with the animal and have invested time into its health, wellbeing and maintenance.

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1 Introduction

This husbandry manual has be compiled by myself for keepers and owners of Ostriches around the world to use as a complete care and guide for providing all needed care for these birds.

The ostrich can stand above 6ft tall and are easily identified with a large body, two long legs with 2 toes and a thin, long neck with a small head and large eyes.

The ostrich was introduced into Australia during the late 1860's and have been used in a variety of industries.

- Used in zoos as part of their collection for education, conservation and recreation
- Kept as pets in Australia
- Kept and bred for the meat farming industry
- Kept and bred for the feather industry
- Classified as pests in some districts in the states of Victoria and South Australia

These birds can be used for education purposes to alert the public about the effects of poaching, trophic cascades, predator requirement, over breeding and always being alert around animals. While these birds are still plenty in number, there are thought to be a species with a declining number, which could soon become an extinction rate. Using the captive populous as ambassadors for their wild family can help improve the knowledge of the general public about conserving a species before they face the issue of extinction.

It is my hope that this manual provides you with all the knowledge required to care and house an Ostrich to the highest standard.

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Taxonomy

1.1 Nomenclature

Class	*Aves*
Order	*Struthioniformes*
Family	*Struthionidae*
Genus	*Struthio*
Species	*camelus*

(Linnaeus, 1758)

1.2 Subspecies

There are five distinct subspecies of *Struthio camelus*

- *Struthio camelus australis* (Gurney, 1868)
- *Struthio camelus camelus* (Linnaeus, 1758)
- *Struthio camelus massaicus* (Neumann, 1898)
- *Struthio camelus syriacus* (Extinct 1966) (Rothschild, 1919)
- *Struthio molybdophanes* (Reichenow, 1883)

1.3 Recent Synonyms

Struthio camelus spatzi is another scientific name for the West African ostrich, but is recognised as an invalid name, unlike its recognised name *Struthio camelus camelus*.

(Stresemann, 1926; Linnaeus, 1758)

1.4 Other Common Names

Within the five subspecies, each has a common name, each mainly based on their primary location or identifying features.

The common names for these subspecies is:

- Southern Ostrich (*Struthio camelus australis*) (Gurney, 1868)
- West African, Red-necked or Common Ostrich (*Struthio camelus camelus*) (Linnaeus, 1758)
- Masai Ostrich (*Struthio camelus massaicus*) (Neumann, 1898)
- Somali Ostrich (*Struthio molybdophanes*) (Rothschild, 1919)
- Middle Eastern or Arabian Ostrich (*Struthio camelus syriacus*) (Reichenow, 1883)
- “Avestruz” in Spanish and Portuguese (Jimenez II, M. and Jimenez, M. 2007)
- “Autruche” in French (Jimenez II, M. and Jimenez, M. 2007)

2 Natural History

The oldest fossil on record that currently represents the earliest ostrich-like species was found within Central Europe and dates back to the middle Eocene period. The species, *Palaeotis*, was an early form of moderately sized bird with features, like the lack of flying, which is shared with modern ratites. Originally, the *Palaeotis* was not considered to be in the same family as the ostrich, but research has shown for it to be an ancestral form. After the documentation of the *Palaeotis* in the Eocene period, it then jumps an approximate 15 million years later to the Miocene period with the ostrich fossil. Many fossils that date back to this period have been found within Africa, Asia and Europe and were characterized to the species *Struthio*, which is represented still today. Popular belief includes that these birds were very distant descendants of dinosaurs from the, specifically the *Dromaeosauridea* family, from the Cretaceous period (D. Smith, 2005). This belief stems from the similarities of the large talon on the dominant toe and their natural ability to produce quick and long strides, averaging around 70 km/h (Animal Fact Guide, 2014), similar to that of the cretaceous Raptors. A large myth that surrounds the ostrich is that they stick their heads in the ground when scared or feeling in danger, but contrary to popular belief, they in fact don't. They instead, have a defensive action of laying low and pressing their long necks to the ground to become less visible at the sense or approach of danger. From a distance, they look like they have buried their head in the sand due to the blending of their plumage with the sandy soil (Animal Fact Guide, 2014, National Geographic, 2011). In countries like Egypt and Mesopotamia, the ostrich has inspired their cultures and civilizations for close to 5,000 years.

2.1 Morphometrics

2.1.1 Mass And Basic Body Measurements

Struthio camelus are large animals and their sizes can range depending on the individual. They can weigh from 93 kg up to 103 kg, although, some rare male cases have been recorded at an astounding 155 kg. They also range in height from anywhere between 1.7 m to 2.7 m depending on the sex and individual itself. At one year of age, chicks can weigh around 45 kg and stand at about 40cm tall. Their unique body structure also provides them with two toes on each foot. The longer inner toe has a 10cm talon used for defence, while the shorter outer toe aids in running fast in long distances.

(Sell, R. 1994)

2.1.2 Sexual Dimorphism

While looking similar in shape and portion, there are clear distinguishing differences between the males and females within *Struthio camelus*. At sexual maturity (2-4 years of age) a male can reach heights between 1.8 and 2.7 metres (6-9ft), while females average between 1.7 and 2 metres (5.5-6.5ft). Like in most avian species, the male is the more decorated in its feathers. They are adorned with primarily black feathers around their body, but the wings are tipped with white, and these are used for the intricate mating display to impress the female. Where as females and chicks are a duller brown and grey.

(Murchie, J. 2008, Sell, R. 1994)

Fig. 1.1 Male Ostrich (Dick Daniels)

Fig. 1.2 Female Ostrich (Dick Daniels)

Fig. 2 Visual comparison between sexes (Unknown)

Fig. 3 Ostrich's two toes (Lee Reid)

Fig. 4 Group of assumed females – not sexually mature. Far left showing aggressive male behaviour and darker colouring (National Zoo and Aquarium, Canberra) (Emmalee Murrells)

2.1.3 Distinguishing Features

Struthio camelus is the largest bird on the planet and classed as a ratite, along with Emus, Rheas and Kiwis due to the flat sternum (breastbone) lacking the keel for attachment of wing muscles that is typical of most flying birds. (Shanawany, M and dingle, J. 1999) The Ostrich is easily identifiable by their large bodies and long necks and legs, with a small head but large eyes. The long strong legs lack feathers and are adorned with two toes on each foot, with the nail of the larger, inner toe resembling a hoof. The outer toe lacks the nail, which is believed to be an evolutionary trait to aid in running. The large wings of the ostrich can span around two metres. The feathers of the adult males are mostly black, with white at the ends of the wings and tail, while females and young males are greyish brown and white. The long neck is nearly bare of any feathers and holds high the head that looks small in comparison to the wide, compressed beak and the large limbs and body. The ostrich has the largest eye of any land animal, measuring almost 5cm across allowing long distance sight.

2.2 Distribution and Habitat

Struthio camelus occurs throughout much of Africa, with a range encompassing Mauritania, Mall, Niger, Chad, Sudan, Ethiopia, Kenya, Uganda, Tanzania, Angola, Namibia, South Africa, Botswana, Cambia, Zimbabwe and Mozambique. It is regionally extinct in Libya, but has been introduced to Australia and Swaziland. The subspecies *syriacus* of the Middle East is extinct, probably since around 1966. *Struthio* camelus are non-migratory birds so they generally do not move far from their distributed locations. Although the individual country and global population of the *Struthio camelus* is unknown, the population size has been recorded as declining due to increase of hunting, the plume

trade and extreme loss of habitat. The preferred habitats of the *Struthio camelus* are savannah, scrub, grassland and semi-deserts. They enjoy water and often take baths where water sources are available. (UNEP, 2017, Bradford. A, 2014)

Fig. 5 Screen shot of global distribution map (IUCN Redlist)

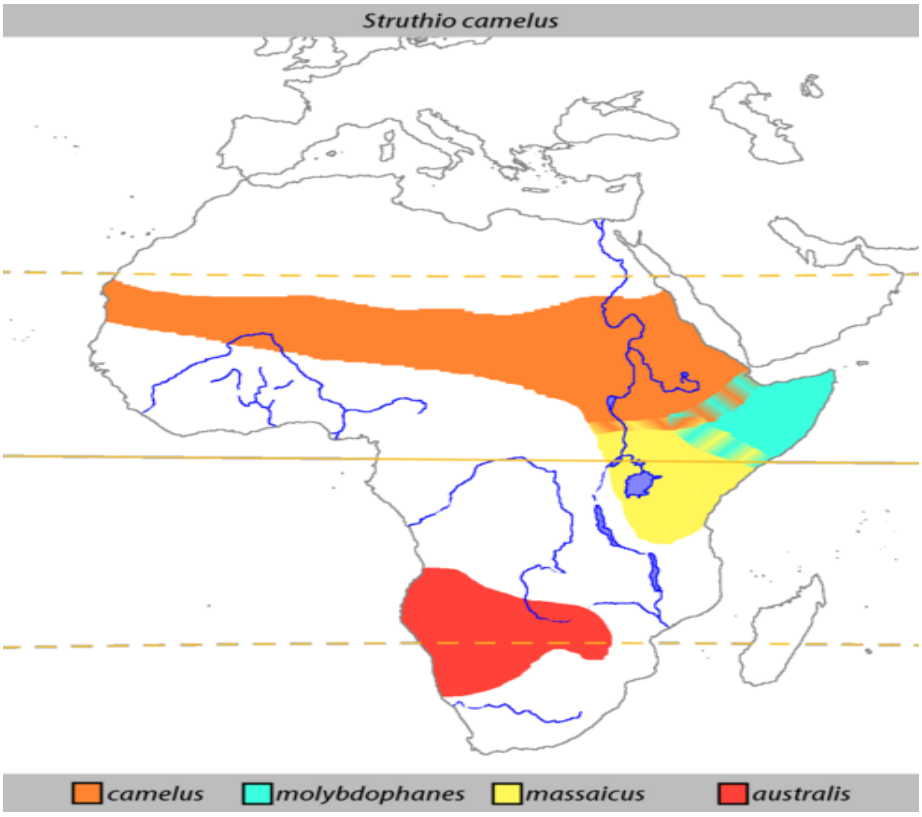


Fig. 6 Species distribution through Africa (New world encyclopaedia)

2.3 Conservation Status

Most ostrich species are not endangered, although population numbers in the wild have been in a steady decline due to hunting. The Somali ostrich has been listed as vulnerable, although their population numbers are not known in specific quantity. It is highly believe that the species is on the rapid decline.

(IUCN Red List, c.)

2.4 Longevity

2.4.1 In the Wild

The ostrich can live anywhere between 30-50 years, with 40 being the averaging age.

(National Geographic, 2011, Jimenez II, M. and Jimenez, M. 2007)

2.4.2 In Captivity

In captivity they can reach 50 years, with some ostrich farmers estimating 70 years.

(Jimenez II, M. and Jimenez, M. 2007)

2.4.3 Techniques Used to Determine Age in Adults

While having no teeth, determining the age of an ostrich can be seen as a difficult task. The use of good and proper record keeping for individuals from hatching could help aid in the age identification due to lack of other methods. However, there is sufficient data available to confirm that feather development and bone ossification may be used as accurate methods to determine bird age at the given time. Since there is a wide variety of rearing methods and nutrition this results in a wide variation of feather development and possibly bone ossification for birds of the same age. Therefore, these methods are lacking in development and need further study and attention. To date, there has only been one study carried out on age identification by bone ossification. More research into these methods needs to be carried out to provide sufficient date to be able to determine the accuracy of this method for age evaluation in Ostriches.

(World Ostrich Association, 2017)

3 Housing Requirements

3.1 Exhibit/Enclosure Design

When creating an exhibit for these birds, there are precautions that should be heard and considered for reasons such as public safety, animal welfare, keeper suitability and easy maintenance. Even though a walk through enclosure is possible, it is heavily suggested against, especially with these birds being as dangerous as they are, you cannot properly gauge their reaction to customers and how they behaviour which can lead to injuries or issues regarding animal welfare.
When designing an enclosure, it should be built with a high fence material (6ft minimum) and the top of the fence should have a protective covering to stop the ostriches accidentally injuring themselves on any protrusions. The corners of the enclosure should also be rounded to allow the bird continuous access to escape and not face the danger of stressing out and being cornered or injuring itself while trapped in a corner. Access gates should have a double door (airlock) system to add extra security and minimise escapes, and not easily accessible to the public. Access runs to a holding area should also be placed and easy to blend with the rest of the exhibit so they can be used as necessary. If there is a plan to place any trees in the exhibit, make sure they have high branches or are made of a softer wood as it can cause some serious injuries. Feed and water containers should remain the same as a change can cause high anxiety and even fatal attempts in individual ostriches. The sand nest should be placed away from the public to allow privacy and lower stress. Appropriate signage should also be placed in easy-to-read areas. Wallows (see 4.9 for further details), Planting long grass sprouts and adding low shrubs.

Exhibits should include:

- Naturalistic settings to resemble natural habitat
- Room and means for enrichment to reduce stereotypic behaviour
- Gives opportunities for recreational and educational opportunities
- Provides covered areas from environmental factors
- Sufficient strength in the structure to withstand force from the animal and time
- Structurally sound and in good repair
- Appliances and plants not in the way to endanger the animals
- Drainage – also should be inaccessible to animals and fitted with wire mesh basket
- Border should exclude predators
- Minimise stressful interactions with plenty of space available
- Keeper access doors that open inward towards the enclosure
- Signs about hazards, keeper notices and about animal
- Easy to maintain and clean

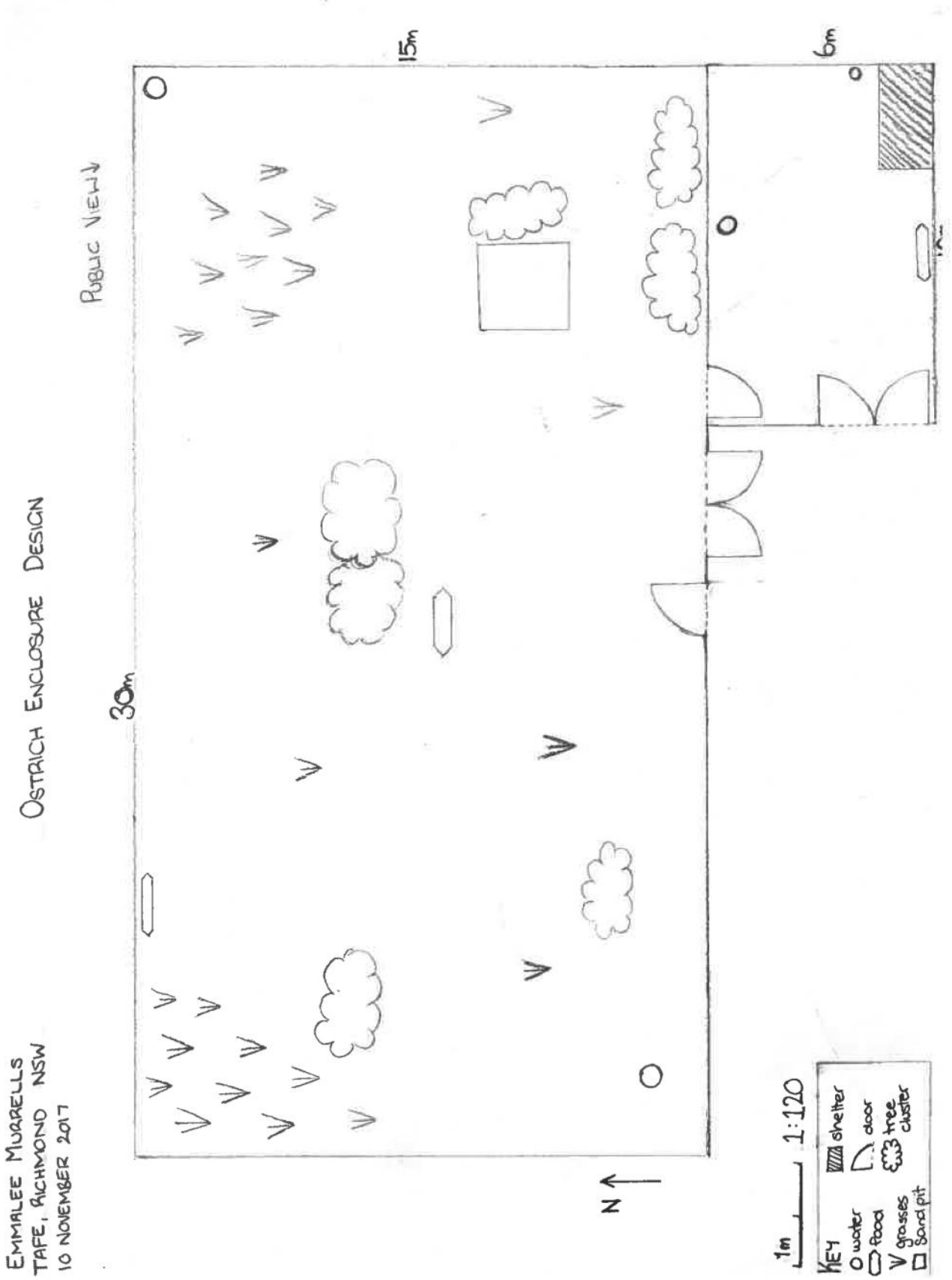


Diagram 1. Example enclosure design without a wallow (E.Murrells)

Fig. 7 Enclosure used as example (National Zoo and Aquarium, Canberra) (Emmalee Murrells)

3.2 Holding Area Design

The holding area for an Ostrich can often be significantly smaller than the exhibited enclosure. The structure should be designed to ensure compliance with animal welfare requirement and to allow for normal mobility. The walls of the holding area must be a minimum of 1.5 meters high and it is highly suggested that the walls are to be made out of solid material to lessen visual stress towards the animal, from personal experience, curved or rounded edges to the holding zone would be ideal for behavioural reasons so they are made to continue around the enclosure and to decrease pacing in a certain section from the animal. The materials used should be designed to be effectively cleaned and to contain the animals. Wood is not a suggested material to be used for posts, railings or partitions as it can easily sustain damage inflicted by the animal/s, and in time it becomes increasingly more difficult to clean and sterilize in the case of a contagious disease outbreak. The floor should be a hard substance that can be easily sterilized between holdings and quickly spot cleaned, for example, concrete flooring for temporary holding areas. The holding area should provide adequate shade to protect the animal from heat, rain, snow and other unfavourable weather. The shade provided should cover an area that can comfortably cover the number of animals that the pen is designed to hold. The holding area should also have feeding and watering tools that are well positioned off the ground with enough space to avoid aggression between birds. I, based upon the recommendations of the holding area design, create the following example.

Example of holding area:

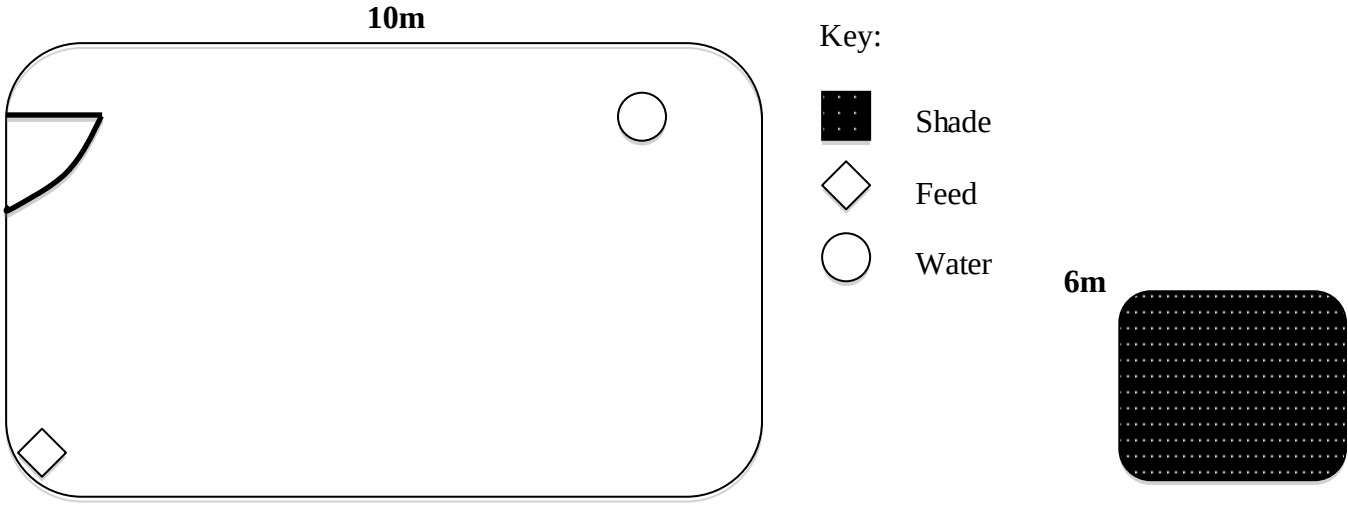


Fig.8 Holding area at The Curaçao Ostrich farm (Unknown)

Fig. 9 Ostrich holding yard (Johor, Malaysia) (Unknown)

3.3 Spatial Requirements

Due to the Ostrich being a natural roamer, a large space is required to supply the bird its natural habit to freely wander around a large space with minimal obstacles to obscure the path of the bird. The *Australian Animal Welfare Standards and Guidelines* state a required space the must be met if permanently exhibiting an Ostrich in a captive facility. I wasn't able to find any state specific spatial guidelines so I have used the nationally set standards. I have done research into these measurements and the most suitable design to allow for maximum movement while still adhering to the requirements set forth for Australia.

(Exhibited Animals-Ratites, 2011)

The minimum housing requirements to hold an Ostrich are:

Spatial Requirements	
Up to 2 individuals	400 sq. metres
Every additional adult	15 sq. metres

Table 1.

(Australian Animal Welfare Standards and Guidelines minimum)

3.4 Position of Enclosures

I wasn't able to find any research done or any suggestions to a preferred position for this particular bird, but it was mentioned that a large open space with plenty of access to sunlight is the most suitable positioning for the ostrich, as this allows for the weather to replicate a natural sunlight regime and to replicate, to the best ability available, the heat and humidity that is endured by ostriches in the wild.

3.5 Weather Protection

The area of the enclosure should be a wide-open area with minimal obstacles, allowing for the animal to roam, however, protection from weather is required to keep the animal stress-free and safe. A covered section of the enclosure is required to shelter the animal from mild and extreme weather conditions, for example, high temperatures, heavy rain, snow, hail and strong winds. The shelter needs to be able to sufficiently shelter all animals within the enclosure, with enough room to allow for movement and to minimize aggression between the birds. It is suggested that 20% of the enclosure should have some variation of cover, whether it is a physical structure constructed to withstand the heat, rain and other weather conditions or some over laying trees to provide shade form the sun and heat and light rainfall.

Fig. 10 Temporary shelter and weather protection (Riverside County Fair Ground) (Unknown)

3.6 Temperature Requirements

There are no set temperature requirements that I have come across in my research, but due to the ostrich being a large and endothermic bird, they don't require a constant temperature to keep them active and alive. Due to the large size of the ostrich, they need to be housed outside to be in a healthy state, although that leaves them susceptible to the outside temperature that can be unpredictable. Extreme heats and cold temperatures are harmful to these animals as they can suffer severe heat stress, so it is important to keep in mind the wellbeing of the ostrich/s in their pens when on hot and humid days or days that are extreme cold.

In my experience, on days that have had high temperatures, I have retrieved a hose multiple times and mist sprayed the Ostrich at my workplace to keep her cool and to make sure she does not suffer from heat stress. To save time, a sprinkler or misting system could be set up inside the enclosure so it sprays into the enclosure with a control panel outside of the enclosure for the keepers to adjust as needed or required.

3.7 Substrate

The most suggested substrates for the ostrich are sand and soil. Grass substrate of a variety of grasses that are suitable for the animal should cover a majority of the enclosure, although a compacted dirt floor with loose soil or sand on top in parts of the enclosure is preferred as their substrate as it can be easily clumped and cleaned, while also allowing for the ostrich to have a 'dust-bath' whenever they wish to. The sand and dirt replicates, to the best ability, the natural ground on the African continent, which the ostrich originates from. Floors and substrates of enclosures for ratites of all ages must be designed, constructed and maintained so that they are non-slip, provide support and minimize the risk of injury and disease. The use of concrete should be very minimal to none. Concrete shouldn't be used in a display enclosure, instead it should just be the loose substrate on top of the compacted floor, although in temporary holding pens and enclosures, a concrete flooring with loose substrate on top can be used (but if possible avoided) so it may be easily and effectively cleaned or sterilized in between birds and uses. Pebbles should also be within the substrate spread about sporadically as ostriches, to help with their digestive system, swallow pebbles. The pebbles will not harm the ostrich's feet, which is the main concern when considering substrate for the ostrich.

3.8 Nest boxes and/or Bedding Material

The ostrich creates a nest out of a shallow decline in the ground, and uses that to lie their eggs in, so no nest boxes are required for the animal as it would take up too much space within their enclosure. A nesting pit should be supplied within the enclosure though and situated away from the public accessible fence; otherwise the ostrich can easily take the public's proximity as a threat to the egg and could lead to aggression towards the visitors. The nests are generally a shallow depression in the ground and made out of a soft substance like sand. It is possible to enhance the nest by digging a small hole, next to the nest, and filling it with course sand. Placing short shrubs around the nest or even placing straw around the nest pit can act as a bank for the nest to clearly indicate where it is and also acts as a barrier against excessive moisture and water flow.

(Bertram, R.C.B. 1992.)

Fig. 11 Female sitting on communal nest (Paul Guillet)

Although, the eggs that I have witnessed in my workplace have not been put into any sort of nest form or in the same location, they were infertile eggs, so it is possible that the nature of the egg (fertile or infertile) could possibly determine the care given to the egg and whether it is discarded or cared for. I also have not witnessed this ostrich sitting on the eggs. If housing a singular ostrich, depending on the behaviour of the animal, a nest may not be necessary to have in the enclosure as a ostrich nest is generally communal.

Fig. 12 Egg laid in enclosure (Emmalee Murrells)

3.9 Enclosure Furnishings

The most important and must have furnishing for the ostrich besides the nest (as seen in 4.8), is the inclusion of a wallow inside of the enclosure. These wallows can consist of, but not limited to, dust baths, shallow water ponds and mud pools. These wallows should cover 2.3 metres squared, by 15.24 cm deep, and this is important as it allows the bird to undertake natural and behavioural cleaning to replicate it's wild habits. Planting long grass sprouts allow the bird to pick at the grass and to graze through out the day and in the enclosure. Adding pebbles to the enclosure has the same furnishing effect as stated in 4.7 because it adds enrichment. Adding low shrubs into the enclosure adds some natural foliage for the animal to pick at, while also adding aesthetic to the enclosure. Adding pebbles into the enclosure encourages a natural part of an ostrich's behaviour, they swallow the pebbles (a condition called *Pica*) to help them digest their food, although, care must be taken that they are not consuming too many that it could lead to serious health issues.

(Exhibited Animals-Ratites, 2014)

3.10 Sustainability

Creating a sustainable and eco-friendly zoo environment can be done with easy changes. Ways to introduce a sustainable environment include introducing solar powering, recycling goods, mulching old browse and introducing the use of water tanks.

Using **solar powered** lighting in yards, amenities and guest paths can significantly cut the use of electricity and instead of mainly using the main electrical grid, and it is fed off a reusable energy source. Connecting these lights to timers and manual modes to adjust when the lights are needed, if at all, reduces the need for dependability and allows keepers to create an appropriate 24hr light cycle.

Fig. 13 Solar Powered streetlights, BTreeShop Online

Setting up a manageable **recycling system** adds a great benefit for a sustainable workplace as well. Recycling goods (eg. cardboard and plastic bottles) can be used as enrichment for the animals as well as being sent to a recycling plant to allow the reuse and recreation. Choosing to reuse these items can also save the institute money instead of needing to buy new plastic toys, these recycled objects are cheap, mostly free, and easy to obtain while having multiple purposes. In my experience, a lot of plastic waste can from the produce suppliers who used a lot of plastic bags, to reduce this, we organised for multiple reusable carry crates to be used to transport the food back and forth, and for easy storage which cut out the need for those plastic bags and led to a cleaner and more organised food preparation area. Introducing a system similar to this into your own organisation can save a lot of room in your garbage wastage as well. Old browse and tree trimmings can also be recycled through mulching. Once mulched, they can be used in enclosures and garden beds to add to plant stability and water retainment.

Introducing **water tanks** into your institute creates an always-ready water supply that is easily sourced and can be filtered with a proper filter and irrigation system. This reduces the dependence on the main water supply, saves money and provides an alternate supply during water restrictions. This water can be attached to any tap and used as drinking water for the animals, fill ponds, wallows, streams and watering the plants, as rainwater contains natural organisms that are healthy for animals. At Werribee Open Range Zoo, they use recycled water from the Western Treatment Plant. This water is used exclusively for irrigation, animal exhibit washing, public toilets, and to fill and top up water bodies (such as those at the hippo and core river) and the bus shelter doubles as an effective water collection agent. (Zoological Parks and Gardens Board)

Fig. 14 Rain tanks and bus shelter, Werribee Open Range Zoo

Compose piles are also a really clever way to recycle animal waste, lawn and tree trimmings, food scraps (excluding meat) and bedding material (if it can be easily broken down). Creating a compose pile should be approved by the council and abide by their individual regulations and should always be monitored. These piles create a great, easy and cheap way to ethically source fertilising material that is great for keeping healthy gardens within your institute. As an alternative to an outside/exposed pile, there are machines, such as the 'HotRot' used by Melbourne zoo. The product from the HotRot is blended to create ZooGro, which conditions the soil, and improve water and nutrient retention. The HotRot saves Melbourne Zoo two tonnes of organic material from going to the waste bin every day.
(Zoological Parks and Gardens Board)

Fig. 5 HotRot machine, Melbourne Zoo

4 General Husbandry

4.1 Hygiene and Cleaning

Unless unavoidable, these jobs should be done in the morning before the facility opens, to save face and to ensure full focus on the task and animals in case of an emergency or an unforeseeable event, for example the death of an animal. Ensuring these tasks are done in the morning also means the husbandry task can be done in the cooler hours of the day, as not to exhaust yourself or the animals during the heat of the day.

Cleaning Regime for Enclosures	
Daily	Due to the hazardous nature of the ostrich, a daily clean can be a dangerous job. A head count should be taken daily to ensure no escapes, deaths and to report any hatching, followed by a general health check before entering the enclosure and/or putting the birds away. A daily cleaning can consist of placing the animal away in a temporary holding pen to assure your safety and giving a quick and effective rake of the yard and picking up and removing waste matter (old food or faeces). Emptying water holders and refilling to sufficient level to last through the day with contingency in case of extra thirst. A fence check should be commenced for any damage, holes or weaknesses so it can be addressed appropriately. Quick water and spray of grass and shrubs to maintain health of the plants. Removing weeds that have grown in the enclosure as some might contain toxins or harmful substances if ingested, make sure to remove roots as well.
Weekly	Furniture cleaning should happen once a week; this includes a scrub of any artificial furniture with high-grade disinfectant (eg. F10) to remove any matter that could cause sickness or harm to prevent the growth of bacteria or fungi. If necessary then a small substrate change should be undertaken as well (mainly nest material if spoilt by rain or use). Scrubbing of any cement or solid areas.
Monthly	A substrate change of the nest and dust bath should be done in monthly or bi-monthly sectors. A pond scrubbing should be commenced with high-grade disinfectant (eg. F10) to clear out any bacteria or fungi particles that can cause harm to the bird by growing on its skin or feathers. If required, replanting grass or shrubs in the enclosure should be done if it is worn down or looking dead.
Yearly	Small amount of organic fertilization of grassed area to help grass growth. If budget or facility allows, relaying of grass turf.

NOTE: Before using any chemical, make sure that is registered with the APVMA (Australian Pesticides and Veterinary Medicines) and displays the registration number, if the product is unregistered, it could be illegal, dangerous and harmful to the animal.

CLEANING AGENTS

Note: Details provided in *Appedicies 1 and 2*.

SAFE:
Chlorhexadine – cleaning artificial furnishings and for disinfecting thoroughly
F10 is great to use for cleaning furniture and equipment (needs to be thoroughly rinsed)
Animal safe non-toxic hand wash that is safe to come into contact with animals
Virex 2 – hospital grade disinfectant
Animal house – feed bowls or feed platforms
WD-40 – used to remove and fix rusted hinges of gates
Emerald disinfectant - a general and quick clean of feed trays

UNSAFE:
Bleach – if ingested it can cause fatalities if not washed away properly
Chlorines – toxic and corrosive, which will lead to fatalities if not properly, washed away
Weed sprays – can cause poisoning with in the bird
Disinfectants that are not approved by hospitals or vets are best to be avoided, as there are possibilities of harmful affects to the bird due to the presence of harmful chemicals.

4.1.1 Annual cycle of Activity

Timeline for Maintenance Scheduling

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
BREEDING SEASON	■	■	■					■	■	■	■	■
ENCLOSURE REPAIRS			■	■								
ENCLOSURE RENOVATIONS			■	■	■							
FULL CLEANING OF ENCLOSURES					■							■
ROUTINE HEALTH CHECKS	■	■	■	■	■	■	■	■	■	■	■	■
ANNUAL VET VISIT						■						

- Breeding season can start from end of July (although normally within August) to mid March all depending on environment
- Enclosure repairs done over March/April when breeding season is over and the young are parent reared or ready for removal, depending on when they hatched. This way breeding season isn't disturbed when intending to breed.
- Enclosure renovations done from March to May before the breeding season starts again to allow the birds enough time to recover from the stress of renovations. These should be completed as

quickly as possible in order to not disturb or stress the birds and preventing them from breeding (if intended).
- Full cleans of the enclosure should be done on a 6 monthly (June/December) schedule to keep the invasion to a minimum. December clean should only be done if it is not interfering with breeding or the raising of the chicks. Assess the enclosure before proceeding or remove the ostriches first.
- Health checks done every month throughout the year to monitor each bird and make appropriate adjustments based on health
- Annual vet visit should be done in June just before breeding season so ensure their vaccinations are up to date, individuals health is at a high standard and any treatments are planned out (e.g. worming)

4.2 Record Keeping

Keeping records is highly important to the care of the Ostrich. Records should always be kept to aid every carer in the activities, abnormalities and changes to the ostrich. These records keep all keepers on the same information level and can even be shared with other institutes to compare and create plans that work best for the ostrich needs. Records also allow for proper identification of individuals, especially in ages, as it is so hard to determine their age.

Daily:	The physical condition of the animals and their behaviours should be recorded on a daily basis to aid in identification of patterned behaviours and for the general wellbeing of each animal as well. If any health problems are identified in an individual or group it should be recorded on the daily record to keep track of how it changes day by day and any following treatment from the vet must be recorded to keep track of the progress. Eating habits (uneaten or particular food items), behaviour (pacing, hissing, aggression, lameness, sexual displays, etc.) also needs to be recorded.
Weekly:	Due to the nature of the female ostrich averaging an egg every 10 days, even if infertile this reproductive event should be recorded weekly as it happens to ensure that the female is producing the eggs properly without any abnormalities along with reporting any missed cycles.
Monthly:	If there is a weekly diet for these animals, it must be recorded on its respective date, but if the diet is changed, it should be recorded on the monthly schedule in case it must be changed around the same time the following month. A quick veterinary check-up is advised every month and to be put onto the monthly records. Individuals should be weighed and measured monthly to check for health (underweight, overweight or desired weight for species and age), this is done monthly due to the hazardous nature of these animals.
Yearly:	As the seasons change, so does the sexual behaviour of these large birds. Any records on observations like mating and nest development should be kept in accordance to the time of year that they happened depending on the conditions and environment. Veterinary treatment for annual check-ups on general health and any vaccinations must be recorded yearly to insure an annual pattern occurs to avoid missing any important days.

4.3 Methods of Identification

The most effective method of identification on *Struthio camelus* is the use of **identification tags on the neck**, this allows for an easier read through up close inspection or through binoculars, although this method does have a few negative points. On most cases, the neck tag requires for you to be up close to the animals neck and head area, which puts you in the position to be pecked at, and it could also be caught on things like furniture and the fence and be ripped out, loosing the identification of the individual. If there are multiple, fighting could also cause the tag to be ripped out of the skin. Application of the tag also requires for you to be next to the animal and in a dangerous zone, even if the animal is sedated, it could wear off quickly, putting you back into danger. For domestic or zoo kept ostriches, the use of a microchip can be highly useful as it can assist for crushes and runs, encasing them in as soon as the desired microchip is read through the scanner, but due to most captive ostriches being a part of the farming industry, it would be costly and time consuming to microchip individuals and therefore, easier for clear markers like neck tags to be able to readily identify which bird you need without damaging the meat production. Also, having a microchip requires close contact to allow a scanner to read the chip was found in the body, and this can also be time consuming and placing the animal under stress and the keepers/care takers in greater danger.

Fig.16 Identification neck tag (Emmalee Murrells)

4.4 Routine Data Collection

Anything that is registered, as an important event should be recorded and the data collected and reported to the appropriate data base. These events include deaths, births, weights, age, measurements, behaviour, and breeding, egg laying, if there is any feather loss, injuries, and changes in diet, incidents or attacks. All these things should be recorded on the day they happen and should be placed into an orderly check to make sure they do happen and the proper updates are happening. This helps maintain the animal's health and also updates about any abnormalities that may be present, the proper practice of routine collection also keeps other keepers up to date about the animals along with collection management sites and organisations.

5 Feeding Requirements

5.1 Diet in the Wild

Ostriches are omnivores, but with a predominately herbivorous diet they can survive and eat mostly only plant matter, but they occasionally eat the remains of various animals left from a carnivorous predators feed. They are known to be very selective feeders, taking the seed heads of grasses and certain flowers when provided the opportunity, otherwise they can eat a variety **wild leaves and bushes, shrubs, grasses, roots of a plant, plant seeds, fauna and sprouts**. The carnivorous side of their diet can include small chunks of meat like **mice, remnants of various species of animals, lizards, little rodents and frogs**. They have also been known to eat locusts and crickets. In the wild, access to water on the dry plains of Africa is hard to come by at a regular interval if sharing that same source with other species, so Ostriches, much like Camels, can survive long periods of time without water in the wild. (Bradford, A, 2014)

5.2 Captive Diet

The diet of the Ostrich in captivity should be made up of a combination of ingredients to maximize the adequate daily nutrient intake the birds should receive and within the weight ratio that the bird should consume in a single day. Feed conversion ratios (FCR) for ostriches are higher than that of poultry species during early growth.

According to Cillers (1995), the following FCRs can be expected for ostriches

Age	Ratio*
Hatching - 2 months	2:1
2 - 4 months	2:1
4 - 6 months	3.8:1
6 - 10 months	5.5:1
10 - 14 months	10:1

Table 2. Captive diet food ratio

*The ratio shown represents the weight of food compared to the weight of the youngling.

Table 3. **Calculated requirements for maintenance and growth in Ostriches at various intervals**

Age (day)	Body mass (kg)	Body mass for period (kg)	Feed intake (kg/bird)
30	3.3	1.8	0.25
60	9.1	6.6	0.49
90	16.6	14.6	0.75
120	25.0	23.6	0.91
150	36.2	33.6	1.35
180	47.9	45.4	1.65
210	58.2	57.5	1.81
240	67.4	68.1	1.90
270	75.8	77.6	1.95
300	83.7	86.5	2.00
330	88.6	93.6	2.40
360	91.9	96.0	2.45
390	95.2	101.6	2.50
420	98.4	105.2	2.50
450	101.2	108.4	2.50
480	103.2	111.1	2.50
510	105.1	113.2	2.50
540	106.7	115.0	2.50
570	109.1	117.2	2.50
600	110.7	119.4	2.50

(Cillers, 2000)

There are two main type of habits that link with their diet and habits, including 1) foraging (feeding) and 2) pecking (not feeding). (Miao, Z., Glatz, P. and Ru, Y. 2003)

Foraging is commenced for long periods of time for wild ostriches, and the time is normally increased when the ostriches are feeding in groups. For example, a single bird can spend up to 65% of their day foraging, but when congressed in groups of three or more, this time can be increased to up to 85%. The time these wild bird spend foraging could be influenced due to these birds needing a 5-6 kg of fresh material mass daily (containing 70% water), or when feeding on natural forage (Milton et al., 1994). Although, an ostrich held in captivity only requires an average of 3.5kg per day, which is preferable is providing a mixed diet, like in the example of Mogo Zoo provided, each ostrich is provided with 3.5kg each per day through a mixture of pellets, grain, roughage and greens, along with the grass within their enclosure. (Miao, Z., Glatz, P. and Ru, Y. 2003)

Example:

MOGO ZOO OSTRICH DIET

Mogo zoo has 7 female ostrich, housed in a large grassed paddock (allowing them to graze all the time).

They still receive a made diet of:

Greens (Twice daily)

Chopped up apple, carrot, pear and leafy greens

Grain mix (Twice daily)

1. Supercool pellets (Ambos stockfeeds) 2 ½ scoops (3125 grams)
2. GG Grain mix (Grenfell commodities) 1 ¼ scoops (1250 grams)
3. Lucerne chaff 2 ½ heaped scoops
4. Shell grit 2 scoops (600 grams)

Disclaimer

The information in this document is specific to Mogo Zoo and is not provided to others as a recommendation for adoption. In providing this information, Mogo Zoo accepts no liability arising from use of this material. It is recommended that use by others be subject to their own assessments.

Diet supplied by A. Mifsud

Foods an ostrich CAN eat:

Apples	Grapes
Pears	Brown bread (in small portion)
Squash	Tomato (in small proportions)
Parsnip	Leafy greens (Choy sum, Bok Choy, Broccolini, etc.)
Grasses/Tussocks	Mango
Seeds	Bali seed
Capsicum	Cauliflower
Carrot	Wild leaves/shrubs/bushes/roots of plants/sprouts
Crickets/locusts	Small bits of meat (DOC, rodents, frogs)
Farm approved pellets	

(pers.comm. A.Doel)

Preparing a diet depends on how many ostrich you have in your care and your access to certain materials. Personally, I have prepared diets of fruit, vegetable, roughage, and grain and combined mixes and a supply of grass for a singular female ostrich.

Preparing a diet:

Each individual bird should be fed twice a day (am and pm feeding times) and roughly 3-3.5kg in total should be provided every day. A feeding of grass or tussocks should be supplied when possible, this stops over grazing of the paddock and offers a variety.

To consider:

NEVER feed an ostrich onion or avocado. These are highly toxic to ostriches.

When preparing a fruit diet, make sure that all the food is appropriate for the animal to be able to eat without causing any issues or complications, for instance, the fruit is not rotten, pellets and grain isn't spoiled or nothing sharp is present.

Regularly, I personally have to provide a mixed feed with roughage, pellets, fruit and vegetables, due to my workplace being donation based with fruit. Normally by my work day, we are low on fruit to feed out as the fruit run is the following morning due to the supply of the local produce store, occasionally a collection is made Thursday morning and a full fresh produce feed is given and recorded.

Mixed Feed Diet:
(Based on feeding x1 female (0.1.0)

Utensils:

Bucket to carry the food
Silver bowl
Measuring cup (2 cups)
Chopping board
Knife

How to:

1. Using the scoop, place 1/3 scoop using measuring cup of poultry pellets and barely mix (approx. 450 grams) and 1/3 scoop of chaff into the feed bucket you have.
2. Select and get your fruit ready on the chopping board. A variety of fruit and vegetables is best.
3. Cut the fruit into the pieces compared to the size guide. Cut till 1 kg of fruit.
4. Place into the silver bowl and feed out when required.
5. Repeat for next feed

Size guide.
Preferable size.

Fig.17 Fresh feed (E.Murrells)

Fig.18 Mixed feed (E.Murrells)

Fig.19 Roughage feed (E.Murrells)

In the pictures above are examples of feeds made by myself and another keeper. The first picture is of a fruit and vegetable mixture made by myself and another keeper (A.Doel), the middle is a vegetable and bread mixture made by another keeper (L. Bartley) and the last is an example of a roughage feed prepared by myself.

Fig. 20 and 21 Grass feed during the middle of the day as enrichment (Emmalee Murrells)

Providing a variety in food should be highly considered to keep an interest in the birds eating habit, if the bird has a preference of a particular food, a suggestion of using it for conditioning to motivate it, as well as enrichment to encourage it to keep moving and activating it's mind to find a way to access that food. Patty, the ostrich I work with enjoys tomatoes, so I used that to help build a relationship and gain trust.

Due to my workplace being based on a donated fruit and vegetable matter from local markets and stores and only collected every Monday and Thursday/Friday, ensuring enough is available throughout the whole week is difficult. The weekly diet (see below) is an example of our desired feed out, but sometimes, due to lack of available fruit and vegetables, they sometimes have to be changed around and/or substituted until the next available fruit delivery.

Example of a weekly diet rotation plan:

MONDAY	Fruit and vegetable mix
TUESDAY	Fruit, vegetable, roughage and grain mix
WEDNESDAY	Roughage and grain mix with fruit enrichment w/ weaner rat or DOC
THURSDAY	Fruit and vegetable mix
FRIDAY	Fruit, vegetable, roughage and grain mix
SATURDAY	Roughage and grain mix with fruit enrichment w/ weaner rat or DOC
SUNDAY	Roughage and grain mix

5.3 Supplements

Dehydrated molasses powder should be added to the feed as it improves the feeds taste. It is necessary to add vitamin premix to the rations in order to meet the birds' requirements. (Aganga, A. A., Aganga, A. O., Omphile, U. J.)

Electroguard can also be given to ostriches, as it is a water-soluble gel that assists in treatment of symptoms associate with stress, diarrhoeas and dehydration. (Prophylactic adult dosage: 1L gel/100 l water). (Afrivet)

5.4 Presentation of Food

Giving the food to the ostriches in a half-barrel bin or strong feed buckets attached to the fence line is a great way to keep the food off the ground and to reduce the incidence of pests to hang around for the food, although it halts the birds natural instinct to forage for the food. Feeding in barrels can also be beneficial as it can stop the food from spoiling on wet ground and is an easy surface to clean and sterilize. The best way to present the food to the ostrich is a scatter feed, although this can be hard with some roughage like lucerne chaff as it is small flakes and harder to lay around, the chaff should be the dominate thing placed in the feeding barrels or buckets, while pellets, seeds, grass, tussocks, fruit and vegetable matter should be scatter to encourage natural behaviour. This scattering also acts as a behavioural enrichment as it allows them to wander around searching for the food for a few hours, rather than the same repetitive action of going to the same spot to eat. Through my observations of these feeding techniques, I have noticed a significant difference in behaviour. When we were originally only placing the feed into a feed bucket securely attached to the fence, I noticed by the next round of feeding, either PM feed or the next morning, there was still a significant amount of food remaining in the bucket, although when I introduced scatter feed, first starting with some fruit both scattered and some in the bucket, the ostrich went for the feed on the ground, rather than what was in the bucket. Over the next couple of weeks I started introducing this more but adding more to the scatter pile, e.g. more fruit, veg and even adding pellets when the ground wasn't damp, and she continued to choose the scatter over the bucket.

Fig.22 Feed trough design, RELN.

Fig.23 D Feeder suspended on fence (E. Murrells)

5.5 Sustainability aspects of feeding including food security

Creating a sustainable food source for the ostrich can be difficult if in an isolated environment, but that are alternatives. Ways to obtain a sustainable food supply can include obtaining your fresh produce from local farmers/markets, using local produce stores for pellets, creating your own garden, plantations and breeding small mice for the purpose of feeding.

As the ostrich mostly has a fresh food diet, fresh food can be quite easy to come by. Making deals with local farmers, markets or stores can save in money, transport cost and fuel emissions and also aid in local community support. Actively seek out stores that need to get rid of food before spoil dates, farmers who have extra produce and markets who can cut great deals. In my experience, my institute received its fruit and vegetable matter from Woolworths and Aldi during the week when they did produce turn over. This meant we got a lot of fruit to feed in one trip, cutting down the use of fuel. We also used reusable crates the transport the food, meaning we had no use for plastic bags and it reduced out rubbish load.

Bulk ordering your pellets, barley, hay, chaff and other roughage needs can lessen the amount of time you need to place a delivery order cutting fuel and transport use and saving extra money on the delivery cost, if being transported long distances. For the use of browse (pecking, enrichment and environmental display), sourcing out a plantation that has access to your necessary plants can be sustainable by not affecting the local habitat and removing another animals food. Cutting enough browse to last half the week is ideal and storing it in bins with water to hold and keep them moisturised.

Developing a worm farm, like such at Healesville Sanctuary, can help with your left over food scraps from animals or food preparations by eating and processing the food down. Foods that should not be placed into these worm farms include meat products or highly acid fruit/vegetables as it hurts the worms and can kill off the colony. These worm farms also produce high quality fertiliser, which is great for garden beds.

Fig.24 Worm farm at Healesville Sanctuary, Victoria

More detailed and sustainable options are available in section 4.10.

6 Handling and Transport

6.1 Timing of Capture and Handling

The best time for capture and handling the animal is early morning, before the park opens and before morning feed, this way the light is still bright enough but the heat of the day hasn't begun, this saves the catcher and the bird from heat stress. Attempting the capture or handling early in the morning also allows time in the rest of the day to attempt again further in the day, in case of an unsuccessful attempt at first. Attempting the capture at night or in darker hours can be dangerous due to the birds high fight or flight response, and with the lack of vision for the human, makes it harder to do the examination and also makes it harder to see if the animal is going to react with aggression.

6.2 Catching Equipment

Equipment used to aid in capturing and restrain a ratite may include:

- Capture bag and/or hoods/pillowcases
- Deep hoop nets
- Race made of hessian
- Pole syringe or dart administration under direction of a veterinarian

(Exhibited Animals – Ratites, 2014)

When using equipment such as a capture bag, hood or deep neck hood, you need to consider how big the individual ostrich is. They need to be thick enough that once you place it over the birds' head, it will sit far enough down their neck that they cannot flick it or having it falling off if the animal tries to struggle or during movement.

6.3 Capture and Restraint Techniques

NOTE: Ostrich have strong, powerful and long legs; they can kick out at any time, avoid being within kicking distance if bird seems distraught or aggressive.

When trying to capture an ostrich, it should never been done alone, a minimum of two keepers is required. Birds that have been trained, may be led into a partition with hessian walls to block vision of others or surroundings. Other birds would need to be manually handled. To capture those birds, you need to isolate the desired individual near the fence and use a step ladder to reach over the fence and place a capture bag/deep hoop net/pillowcase over the animals head and down its neck far enough that it can't easily fall off. You can then enter the enclosure, if the bird is in an enclosure with multiple other ostriches, you will need a third keeper with you to act as a watch and a barrier between you and the other birds. If the ostrich is being walked (e.g. to another enclosure or into a transport box), two keepers are to hold onto the ostrich and help walk the ostrich by guiding it, hug the bird around the chest and back. If walking the bird, it must be walked backwards to avoid the animal bolting and always stand at the side of the bird, while the second and a second handler keeps the bird from moving backwards by upward and forward pressure to the pelvis. If a veterinarian is available, the use of a light-calming agent, such as Valium, can be used to lessen the stress of the animal.

Ostriches can attack at any time with little to no warning before hand. It is suggested that the best way to enter an enclosure is with a large shepherd hooks to gently steer away any approaching bird and keeping your distance from it. The hook can even been used to gently grab the bird you are after while hooking the pole in the most gentle way around the upper third of the neck while letting the

bird pull back as you move with it. Never use strong force of hard movements with the hook around the ostriches neck cause it can serious injury or even fatality to the bird. Once the bird is hooked, gently pull the hook to reach for the head to hood the bird. If the ostrich is grabbed by the head or neck they can jump and kick forward, leading to possible injuries of the keepers but holding the base of the tail, and pulling it back at the same time as the head of the ostrich is pulled to hood the bird, will reduce the tendency of the bird to jump. Make sure that your person and the ostrich's head is away from the legs of the bird, while holding the bird's head below the level of its chest until it is properly hooded and secured. (Wade, 1996; P.Glatz, 2011) (pers.comm. A. Doel, November 2016)

6.4 Weighing and Examination

Weighing an ostrich can be a difficult task at the best of time. The animal needs to first be isolated into a holding area, and then a sock/block-out bag placed over the ostrich's head (pers. comm. A. Doel). You can then proceed to lead them onto a set of scales for weight measurements. Weights are required for the transport process to transfer to the receiver. Examining every bird before transportation is crucial to assure that each transported bird is in a healthy state, fit for travel. The examination should start from the head and work it's was down to the tail, making sure to check the wings, and then on to the feet and toes for a close examination for abnormalities. These examinations should take place before travelling and after the birds arrive, and after the settle in period, to ensure no injuries were sustained during transportation. (pers.comm A. Doel) To minimise the risk to keepers and stress on the bird, the use of target training and conditioning can benefit the keepers to make it and easy task to record the weights necessary.

6.5 Transport Requirements

6.5.1 Box Design

The size of the transport box should be determined by the normal habits and necessary need and freedom of movement. The container must be larger enough for the birds to turn around, lie down and stand to full height with an internal clearance of 10cm above the head of all birds. The joints of the container should be made so that it cannot damage the birds beak or claw from the inside, so have the inside edges smooth and round can help to avoid injury from movement during loading and transport. The container must keep the bird inside and safe from unauthorized access from outside and the door must be made so it will not be able to accidentally open, from either inside or outside. There must be no sharp projections, such as nails, which the bird can injure itself. It is highly recommended that dimensions do NOT exceed these criteria as too much room can lead to accidental injury. The container should be made and constructed with wood, non-toxic plastics, fiberglass, synthetics and heavy-duty plastic netting with a mesh size of 3cm diameter. (IATA Live Animal Regulations, 2012)

"A person in charge must ensure that the vehicles and handling facilities are constructed, maintained and operated in a way that minimizes risk to the welfare of the birds." (AAWS, Land Transport of Emus and Ostriches, 2017)

Vehicles and facilities must:

i. Be appropriate to contain emus and ostriches; and
ii. Have effective airflow; and
iii. Have flooring that minimizes the likelihood of injury or of birds slipping or falling; and
iv. Be free from internal protrusions and other objects that could cause injury; and
v. Has sufficient vertical clearance for emus and ostriches to minimize the risk of injury.

Separate troughs for food and water need to be provided. They should be made of non-toxic materials with rounded edges and should be attached to the inside of the container so they can be easily accessed for replenishing purposes. The troughs must have a lip to avoid spillage as much as possible and need to be wide with a 30cm diameter for easy access by the bird. Do not use soldered tin, as it can be poisonous.

Example from IATA regulations:

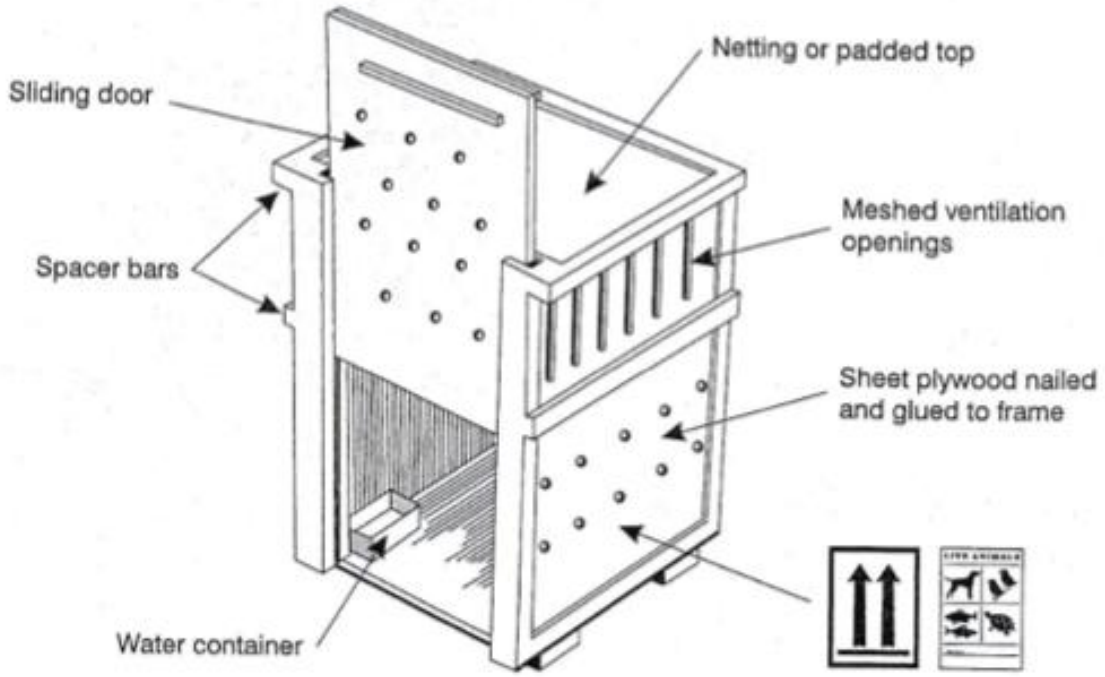


Fig. 25 (IATA Ostrich transport regulations)

Example of transportation truck:

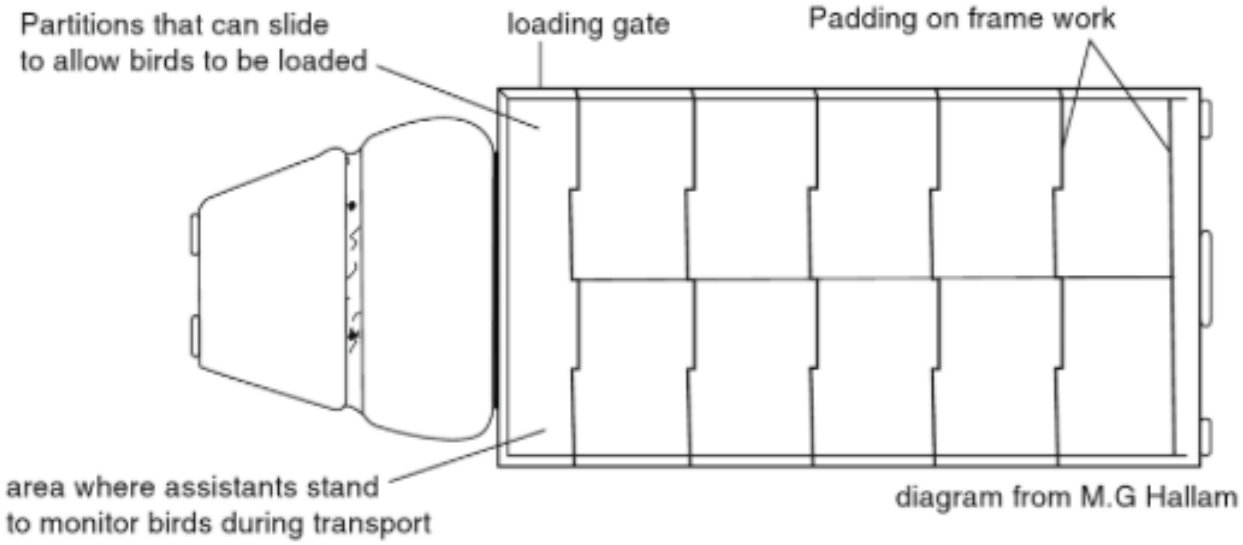


Fig. 26 (P.Glatz, 2011, The Welfare of Farmed Ratites)

6.5.2 Furnishings

Bedding of wood shavings is required to assist with padding the feet of the bird and to minimise, although, within some states of Australia (Western Australia and Tasmania), transport of organic matter is not allowed, and will be burned to stop contamination or transfer of diseases or sicknesses, so when transporting, check each state regulations and have a replacement ready to go when required.

6.5.3 Water and Food

Class Maximum time off water (hours)

Adult ostriches:	36	
Ostriches 5–90 days old:	24	
Ostrich chicks up to 4 days old	60	A* following take off B**

A* Normal allowable time off water is 72 hours, allowing 12 hours for hatching time before removal (take off) from the hatchery.
B** Water-deprivation time allowed can be up to 72 hours following take-off if provided with hydrating material in the transport container.

The person in charge needs to ensure that ostriches over the age of five days old are fed within 24 hours before assembly for transport and that those between 5 and 90 days old are fed every 12 hours. These young chicks should also not be held in containers for longer than 12 hours, unless adequate access to water, feed and shelter has been provided. If the adults have been without water for 36 hours, the person in charge is responsible for ensuring that they have access to water and food for 24 hours before commencing another journey. Food must be provided by the shipper, but it should be checked that is doesn't not break restrictions or regulations of the countries/states that the birds are shipped to. (IATA Ostrich Transportation Regulations)

With young chicks, precaution must be taken with the provided water troughs (see 7.5.3), in cases of drowning. Floating a sponge or other suitable material on the water surface can minimize this.

6.5.4 Animals per Box

Aggressive birds must be boxed individually. The driver must assess the loading density for each pen or division in the live stock crate or each container, with the exception of emus and ostriches in containers. The assessment is based on average live weight of the intended loading, and must be managed to minimise risk to the welfare of the birds. Determination of loading density must consider all of the following factors:

i) Class
ii) Size and body condition
iii) Predicted climatic conditions
iv) Nature of the intended journey
v) Design and capacity of the vehicle.

The driver must segregate birds by sufficient internal partitions to minimise risk to the welfare of other birds.

(IATA Ostrich Transport Regulations)

Loading density

The following minimum space allowances should be provided:

Ostrich (weight in kg)	Minimum space per bird (m2)
A day old	0.10
35	0.19
95	0.41
+110	0.48

Note: General standards apply to ratites to ensure that the loading density is appropriate and to minimise the risk to the welfare of birds. Chicks up to 12 weeks old should be transported in groups of no more than 30 birds with partitions placed between adjacent groups.

6.5.5 Timing of Transportation

When transporting ostriches, it should be preferably done during the morning to avoid the heat of the day to minimize heat related illnesses or stress from the animals. Keeping the trailer or transporter at a cool temperature keeps the animals cooler and makes the unloading easier and allowing time during the rest of the day for the birds to adapt to their new surrounding. When transporting, the transporter must take responsible action to minimize the risk to the birds welfare. In chicks less than 5 days old, it is the transporters responsibility to ensure they do not over chill or heat during the period of transportation.

6.6 Release from Box

Inspect the receiving yard immediately before unloading, to ensure that there is free access and sufficient space for the birds intended to be unloaded; and take reasonable steps to notify a receiver of the arrival of the birds at the destination. The receiver must place ostriches less than five days old in a suitable brooding environment after arrival and within 72 hours of removal from the incubator. When releasing the bird, you must consider your safety first. If the bird has been walked into an enclosure, you can lead it back into the enclosure with the hood still over the head and over to the fence line, using the same three keeper technique in 7.3 with two leading the animal and a defence line between you and other keepers, then exit the enclosure and remove the bag. The animal may bolt so it is essential that all keepers are safe before the hood is removed. If using the fence line, make sure that the bird is placed in an area with no obstacles near it so it doesn't collide or trip on them if it is in a state of panic as it could lead to serious injury. Inspect the receiving yard immediately before unloading, to ensure that there is free access and sufficient space for the birds intended to be unloaded; and take reasonable steps to notify a receiver of the arrival of the birds at the destination. The receiver must place ostriches less than five days old in a suitable brooding environment after arrival and within 72 hours of removal from the incubator. (IATA Ostrich Transport Regulations)

Unloading ostriches:
Before unloading, the driver should check the condition of the receiving area and make sure appropriate pens and water supplies are available. When inspecting the yard at night or where light is insufficient, a portable source of lighting should be available. At the unloading, if the facility is unmanned or out-of-hours arrangements are to be followed, drivers should make sure that unloaded birds have access to water. Birds (including ostriches in containers) should be unloaded promptly on arrival at the destination. Ostriches (except those in containers) should be allowed to walk quietly and calmly off the vehicle to minimise stress and injury. Particular care should be taken during unloading,

as birds will be fatigued from the journey. At night, lighting should be positioned to give even illumination over ramps, races, yards and inside the transport vehicle, and should not shine into the eyes of birds moving in the desired direction.

Note: Requirements relating to handling, loading facilities and inspections apply to the unloading of ostriches.

6.7 Sustainability

Transporting multiple birds at once allows a cut in carbon costs for operating a transport truck and allows for less resources to be used for all of them at once rather than splitting it into multiple trips.

Making a conscious effort to use a fuel efficient car or truck and low emission fuel can help create a sustainable workplace by reducing the carbon footprint left on the world.

7 Health Requirements

7.1 Daily Health Checks

Daily health checks are often performed by a distant examination during cleaning/feeding from what you can see on the outside. When commencing a daily health check, make sure that you start from the head and work all the way down to the feet/toes and record/report any abnormalities, also making sure to record which exact animal, such as ID tags or specific markings ***(eg. Y265 = Yellow tag no. 265)***

Head:
Eyes – discharges, wounds, closed or abnormalities
Beak – discharges, breakages, chipping, discolouration inside mouth
Scalp – wounds, scabs, sores
Neck: wounds, scabs, sores, parasites, skin irritation
Body: feather loss, patches, cloaca redness/deformities
Wings: feather loss, properly formed
Legs: wounds, scabs, sores, parasites
Feet/toes: breakage, formations, missing, clarity
Faecal: discolouration, foreign objects, contains blood
General: gait, movement, response, concentration, behaviour (extra skittish, aggression in a usually non-aggressive individual), in an abnormal spot, lack of response, pacing, feeding level (what they have eaten, not eating and records) and discharges.

7.2 Detailed Physical Examination

To conduct a detailed physical examination, you need to have the animal restrained, or even trained in some instances, to be able to be touched and felt to notice any abnormalities that aren't visible during a distant examination. Due to the ostrich being a hazardous animal, a detailed examination can be hard or even impossible to perform without the use of chemical restraint. You can train the ostrich to enter a crush or holding zone and allow you to touch and handle to ostrich without a negative reaction from the bird.

7.2.1 Chemical Restraint

Because of their hazardous nature, closer examination is best to be done under a general anaesthetic. Having the ostrich under the anaesthesia means you can check under the feathers for any abnormalities that are not visible during a distant examination (example: wounds, parasites, ticks, lumps, irritated skin breakages in bone, malnutrition and prominent bones from weight loss). You can even collect blood for samples and testing while the bird is unconscious. (Ostrich Manual, 2014)

7.2.2 Physical Examination

A physical examination can be very risky for the keepers with the adults of these birds, so make sure to exercise a minimum of two-keeper policy. This physical examination should be taken with great care with trained keepers. The animal needs to first be isolated into a holding area, and then a sock/block-out bag placed over the ostriches head. (A. Doel, pers.comm.) You can then proceed to lead them onto a set of scales for weight measurements. Because of the nature of these birds, there is not much that can be done with the ostrich while they are conscious. Stationing can be beneficial to help keep the bird in place while the physical examination is performed. A stanchion can be useful but should only be used for difficult birds. For easier handled birds, the black out bag should be

effective enough to do a full physical examination, draw blood or perform minor surgical procedures like small biopsy sampling or stitching.
A physical examination is based on a visual and manual examination of the bird to evaluate its physical condition and aid in diagnosis of some medical problems. While performing physical examination, it is important that it is thorough to avoid missing and abnormalities and avoid having to capture the bird again. Examinations of the eyes, nostrils, mouth and throat are important for the diagnosis of nutritional deficiencies and well as infections, especially in young ostriches. Monitoring the urine and faecal matter of the birds can lead to detection of dehydration (Skaghauge and Dawson, Chapter 3, The Ostrich), intestinal disorders or liver damage with a green colouration, which diseases such as influenza may cause. (Unknown, The Ostrich)

7.3 Routine Treatments

Always read the label about dosage rates.

Monthly:

Lice and ticks prevention – topically
Worming treatment – Panacur 25: 15mL/50kg bodyweight *
Fenbendazole: 15 mg/kg orally
Ivermectin: 0.2 mg/kg orally (0.2 mg/kg subcutaneously)
*based upon cattle recommendation
Methods of administration: orally, topically, subcutaneous

Presentation of medication in feed or water is quite common against certain poultry diseases, but with ostriches this procedure is less accepted. It is necessary to establish a medication protocol based on the risk of exposure to an agent and the resulting costs following infection. Preventative medication in ostriches can be applied against bacterial, fungal, protozoa and parasitic diseases. (The Ostrich, Ch 12, Unknown)

7.4 Known Health Problems

"Ostriches are susceptible to a wide range of bacterial diseases, some of which are common in poultry (Huchzermeyer). As with other infectious diseases, the best method for prevention of disease is by the application of biosecurity measures…."

NOTE: Medication listed is only a suggestion. No mediation should be provided without consulting a vet first.

In Australia:

Capture Myopathy (Rath, 1993):

Zoonotic status: Non-contagious.
Aetiology: Over exertion, heat, recovery after anaesthesia and entrapment
Signs: High body temp, muscle spasms, stiffness, lameness, lying down or stumbling and anorexia. Dark coloured urine
Treatment: Treatment is rarely successful, but there is a record in rheas with the use of IV fluids, esophagostomy-tube feeding, long-term sedation, muscle relaxants and antibiotics, sling anf physiotherapy all resulting in resolution after 23 days

Prevention: Proper management, restrain, transport, and capture techniques are important preventative measures.

Salmonellosis, *Salmonella Typhimurium and Salmonella Enteritidis*

Zoonotic status: Contagious to humans through inhalation.

Aetiology: A bacterial infection caused by salmonella microbes, usually through rodent contaminated feed or raw materials. Feral pigeons, doves, sparrows and other free-flying species of birds with access to the chick runs can also cause a spread of the disease. The use of open water reservoirs or direct piping from surface water can also lead to an infection.

Signs: There are no externally signs, but tests should be run to check the spleen and inside organs for inflammation during a monthly health check.

Treatment: Effective antibiotics, as determined through antibiograms combined with complex probiotics in a so-called 'tandem programme' (morning/evening alternation), followed by constant exposure to probiotics for a period of one week, have been successful in most of these outbreaks.

Prevention: During the critical first few weeks of life, the use of complex carbohydrates at an inclusion rate of 2 kg/ton with attention to disinfection and biosecurity issues when dealing with feed and water.

Notes: Older animals are typically able to carry and intermittently shed salmonellae for an extended period. (Verwoerd, D. 2000)

Campylobacteriosis, *Campylobacter jejuni*:

Zoonotic status: Contagious to humans through ingestion.

Aetiology: Can be associated with outbreak on enteritis and hepatitis in chicks from 2 weeks to two months in age. Contaminated water can also be a key distributer for this disease.

Signs: Lack of appetite, dehydration, green colouration of urine (young chicks) and depressive behaviour.

Treatment: A dose of Furaltadone (250 mg/1 drinking water) in the younger birds, and with norfloxacin (30 mg/kg live weight) in the older birds reduces mortality. Antibiotics (danofloxacin at 5 mg/kg) coupled with complex probiotics in the food.

Prevention: An experimental autogenously inactivated *Campylobacter* bacterin vaccine in an oil emulsion adjuvant enriched with vitamin E, given to all chicks on arrival, seemed to assist in preventing further outbreaks in this specific operation. Changing management-related stressful procedures. (Verwoerd, D. 2000)

http://www.who.int/mediacentre/factsheets/fs255/en/

Chlamydiosis, *chlamydia psittaci*:

Zoonotic status: Contagious to humans through inhalation.

Aetiology: High levels of stress and the natural immunity level being undeveloped can lead to an infection. This disease will occur mostly in younger birds, as they have not lived long enough to for immunity strong enough to fend off the infection. Over crowding, poor hygiene and poor environment control are common causes. Introducing new birds into your collection without proper quarantine routine can lead to an infection of your collection.

Signs: Respiratory problems are a common sign. This includes upper respiratory infections, difficulty in breathing (dyspnea), sinus issues, upper windpipe and cases of pneumonia. Conjunctivitis can also be linked into the respiratory infection as a secondary infection as well as depressed behaviour and a 'penguin-like' gait.

Treatment: Recommended treatment for chlamydiosis is constant tetracycline treatment for a period

of forty-five days
Prevention: No vaccine available. Wild birds should be excluded from the facility, and wild rodents, which might act as mechanical vectors, should be controlled. (Verwoerd, D. 2000)

Anthrax, *Bacillus anthracis*:

Zoonotic status: Contagious to humans by touching contaminated substances.
Aetiology: *Bacillus anthracis,* which forms highly resistant spores upon exposure to air, extending the infectivity of a contaminated environment. The disease occurs worldwide, mainly in poorly drained alkaline soils
Signs: Lack of appetite and fatigue. Exudation of tarry blood from the body orifices of the body.
Treatment: Administration of penicillin
Prevention: The disease was controlled in cattle in the early part of this century in South Africa and most parts of the world with the advent of effective vaccines. These vaccines also successfully protect ostriches from the disease (Verwoerd, D. (2000)

Bird flu, *Avian influenza*:

Zoonotic: Contagious to humans through direct contact of infected bird.
Aetiology: The migrations and movements of wild waterfowl, has lead to the development of avian influenza and has been indirectly related via the use of untreated surface water, as the virus can survive in such environments for up to 200 days.
Signs: Colouration of urine (cases of bright green), depressed behaviour, respiratory issues and discharges from the eyes.
Treatment: It is reported to have protected against morbidity and mortality, but it did not however, prevent the shedding of virus (Huchzermeyer, 1998). Inactivated vaccines may also promote selection of more pathogenic variants (Shane and Tully, 1996). All avian influenza viruses have the ability and tendency to mutate and recombine (Huchzermeyer, 1998).
Prevention: Due to the existence of a large number of virus subtypes together with the known variation of strains, vaccination cannot be used as a routine tool for the disease control. The best solution is to eliminate or reduce contact of wild birds and ostriches.
(Verwoerd, D. 2000, Mfaume, A. and Agab, H., n.d.)

Osteomyelitis:

Zoonotic status: Non-contagious.
Aetiology: An infection contained through an injury or wound.
Signs: Unusual gait, swelling around bone in infected area favouring a leg or unusual position.
Treatment: A course of antibiotics during a designated period (authorized by a veterinarian) should reverse the infection.
Prevention: There are no vaccines available. The only way to try and prevent this disease is to keep monitoring any wounds the birds might have and attending to them as any sign of infection.
(pers.comm. Whitten, C, 2017)

Pica:

Zoonotic status: Non-contagious
Aetiology: In mammals it can be caused from PTSD or stress induced illness, but in Ostriches it is common and used to help break down and digest their food. Although caution must be taken to observe how many they ingest or it can cause an impaction.
Signs: Eating strange and unusual objects (pebbles)
Treatment: As it is normal for an ostrich, monitoring the amount of pebbles is the most efficient treatment to make sure they cannot cause themselves harm.
Prevention: Only having a small amount of pebbles in the enclosure.

7.5 Quarantine Requirements

Quarantine: The operator must ensure newly acquired ratites undergo a minimum 30-day period of quarantine unless advised otherwise by a veterinarian. (Exhibited Animals –Ratites, 2014)

To protect the animals already within your collection, it is advisable to do multiple faecal samples weeks apart to make sure the animal is parasite free, and along with having them within the quarantine, doing blood tests to ensure that no infectious diseases that remain within the animal, and then methods of eradication of those disease/illnesses or the animal must be considered.

If the bird is showing signs of having any illness, making sure the bird stays in quarantine for the incubation period of that particular illness.

8 Behaviour

8.1 Activity

The ostrich is a diurnal species that spends its time foraging and active during the day. They are predominately foragers while maintaining a constant awareness to approaching dangers or predators. The ostrich is also a highly nervous animal due to have a lot of natural predators. They have a natural gait that involves a bob to their head and body with unhindered movement. Their wings are flattened to their body unless in a defensive or mating display. They can run up to 70 km/h in longer spurts than most predators. They regularly preen their feathers to keep themselves clean and mite free. The territorial range of a singular male ostrich and small harem can range from 2 – 20km squared and they can be violently protective of their territory, resulting in male dominance battles.

Positive:	**Negative:**
Preening	Antisocial (can be excluded
Foraging	Unusual gait (limping)
Pecking	Favouring one leg
Dust bathing	Overly aggressive
Breeding	Loss of appetite
Normal locomotion	Lethargic
Social behaviour	Self-mutilation
Alert	Pacing

8.2 Social Behaviour

Ostrich behaviour allows for them to socially operate in a harem formation. Although, in captivity, this can be slightly altered with most institutes have a group of only females, or sometimes even house a group with up to one male. Although, for safety reasons, for keepers and animals, you should never have more than one male as dominance displays can end with serious injuries. (Amado, M., Xavier, D., Boere, V., Torres-Pereira, C., McManus, C. and Bernal, F.)

Fig.27 Ostrich flock in South Africa (Unknown)

8.3 Reproductive Behaviour

WARNING: Extra caution must be taken around the males during breeding season. They are extra dangerous and protective with their chicks.

During breeding season, males perform an intricate display, also known as 'the breeding dance' to the female of interest. The male usually starts presenting to the dominant female and making his way through the harem. The dance consists of the male crouching and using his wings to swing and shudder in hopes to attract the female for breeding. (Mating habits of Ostriches, Breeding Behaviour Pattern…2015, Shanawany, M. and dingle, J. 1999)

Fig. 28 Male mating display and breeding.
Samburu National Reserve, East Africa
(Susan Roehl)

During the early stages of raising the chicks, the males care for the hatchlings and become extra aggressive. In the case of a predator, to protect to chicks, an adult will pretend to be injured and drawing the predator away from the vulnerable chicks. As another form of parental protection, they can also charge towards the potential predator with open wings, lowered head and kicking out the legs as an attack.

8.4 Behavioural Problems

Males flare and charge at intruders, normally keepers, when entering the enclosure. The use of a protection barrier/board should be used to protect against the aggression of the male.

8.5 Signs of Stress

Ostriches are naturally highly stressed animals. The show signs by pacing, excessive running, and even in extreme cases, they will decide to hit their head onto the ground in an attempt of a fatal injury.

8.6 Behavioural Enrichment

Conditioning – getting the animal used to behaviours on a command or cue.
Scattering – scattering the food allows for natural behaviours like pecking and foraging.
Presenting a male to a female for social/breeding enrichment (natural behaviour)
Due to the high stress levels in these birds, it is hard to stimulate these animals through toys or other enrichment ideas as it can lead to a self inflicted fatality.
Providing plenty of space for the birds to peck through out the day allows them the natural enrichment of behaviours they would practice in the wild.

(Exhibited Animal – Rartites, 2014)

8.7 Introductions and Removals

When introducing a new bird to the collection, it is very important that they are introduced in a safe environment with a barrier separating the current collection and those being introduced otherwise dominance can lead to injuries in individuals.

8.8 Intraspecific Compatibility

They can mix with other ostrich species quite well.

8.9 Interspecific Compatibility

Determining compatible species can be difficult, depending on the species and activity level. Mogo Zoo housed their ostriches with Giraffes until injuries began, generally accidental, to the ostriches and they were then separated except for a singular young giraffe. I am not aware of other institutes housing their birds with other species, but in my experience, our individual female was housed separately. It could be of benefit to try and house ostriches with other animals belonging to the African continent (eg. Zebras and Antelope) to create a mixed species African wildlife display.

Fig.29 Mixed exhibit. Contains one Giraffe and five female ostriches. Giraffe not pictured. Mogo Zoo, Mogo. (E.Murrells)

8.10 Suitability to Captivity

Ostriches are easy to keep in captivity, as they require a lower level of maintenance or social interaction. Exhibits for these birds are easy to maintain, as they don't require a lot of high maintenance vegetation due to a natural arid climate. With work and bonding with the animals, they can be conditioned to enter yards with the keepers being safely behind a protective barrier. They are fairly low maintenance animals, although they can be dangerous.

9 Breeding

9.1 Mating System

One male holds a territory and mates with up to four females (i.e. he is polygamous). The females each have home ranges that they do not defend and which overlap with one another. The male will bow his head, and then begin to wave and shake the feathers on his alternating wings. The whole time his wings are moving, his tail feathers are moving up and down. Depending on what the female does- accepts or decline- he will be able to move towards her. A male shows a female the nests in his territory. If the female accepts a scrape, she lies in it and she is termed the 'major' female if she is the first to do so. Their home ranges do not coincide with the male territories and are larger. A territorial male drives other males out of his territory but displays to females that he encounters. Successful displaying can be followed by copulation. The female ostrich holds her wings out from her sides, shaking the tips. She bobs her head, holding it low while opening and closing her beak. She crouches, telling the male she's ready. He approaches her with a rapid footwork dance and then mounts her while crouching with one foot on the ground and the other on her back. While mating, the male groans and the female snaps her beak and shakes her head. A mating session can last 30 to 90 seconds, with the male mating several times a day with any one female. A male mounts a female from behind. The male will search for a suitable place to create a nest for the female, normally after the first mating has occurred. The hen usually lays her egg in the early morning (before 8am) and late afternoon (after 4pm). Both cock and hen sometimes display broody behaviour next to a nest; it is usually associated with the presence of eggs or the male's solicitation towards the female to produce an egg. (Shanawany, M. and Dingle, J. 1999)

9.2 Ease of Breeding

It is easy to breed an ostrich pair with successful eggs; due to the amount of females mated with increases the chance of hatchlings emerging. Although they will have a more successful rate of breeding during their peak season rather than during the colder months.

9.3 Reproductive Condition

9.3.1 Females

Broody behaviour displayed by the female ostrich demonstrates her readiness to mate. Walking with her wings stretched out alongside her body and shaking them gently, keeping her head close to the ground and pecking at the soil aimlessly.

9.3.2 Males

Males become more aggressive, with typical territorial behaviour displayed. His beak and shins will change in colour from pale pink to deep red – this is a sign for farmers that the male breeding birds are getting ready for the coming breeding season.

9.4 Techniques Used to Control Breeding

If you want to stop breeding, you will have to separate the genders into different pens. The females will still lay eggs but they will be infertile. In captivity the farming owners are often very selective about whom the males mate with. They want to be able to offer overall quality in terms of the hide for leather, the feathers for hats and other items, and the tenderness of the meat. Selective breeding often involves a complex process of DNA profiling.

9.5 Occurrence of Hybrids

No hybrids possible, but intergrades (between subspecies) is highly possible if sub-species are house together.

9.6 Timing of Breeding

Northern hemi-sphere	March - august/ september	(leuthold, 1977)
Southern hemi-sphere	July/august - end of march	(jarvis, jarvis and kef-fen, 1985)

Fig. 30 (Breeding Behavioural Pattern in Ostrich a Key for Better Management, 2015)

9.7 Age at First Breeding and Last Breeding

Females will start to become sexually mature at 26 months and males at 30 months but this can also range from 2-4 years old will continue to breed until they die.

9.8 Ability to Breed Every Year

Ostriches can breed every year, as they are in groups with multiple females to one male allowing for the access to always have young, although it might not always be the same female with the young.

9.9 Ability to Breed More than Once Per Year

Individual females don't normally reproduce more than once a season. It must fall between the breeding season months and is spread out over those months.

9.10 Nesting, Hollow or Other Requirements

A nest consists of a scrape in the ground, 2-3 m across. The male makes nests and he makes a number of them within his territory to display to the females.

9.11 Breeding Diet

It is beneficial to maintain production age birds on a maintenance diet during the non-laying period that differs from that used during the laying period. This maintenance diet should allow the bird to maintain but not gain weight and perhaps even loose (not more than 5-10% body weight) during the non-laying period. Beginning about 2 months before the laying period, the higher protein, more balanced laying diet can again be given to boost the birds prior to laying and breeding.

9.12 Incubation Period

Incubation of the eggs by the major female starts about 16 days after she laid the first egg and lasts 39 - 53 days. She incubates for most of the day and then the male takes over from late afternoon and continues through the night. He also sometimes relieves the female from incubating on very hot days. The major female recognises her own eggs and keeps them near the centre of the clutch, pushing minor female eggs to the periphery where they are not incubated and usually fail to hatch.

9.13 Clutch Size

Clutch size can range from 4 to 78 eggs per nest, but in South Africa, normal clutch size range is 4-26, averaging 13. Large clutches are the result of additional eggs laid by minor females.

9.14 Age at Fledging

The parent care for young for about nine months before they become independent and not needing the parents help anymore, although specifics change for individuals.

9.15 Age of Removal from Parents

At 9 months old, the young is generally fully fledged and no longer requires the assistance of the adults and is fully capable to care for its self.

9.16 Growth and Development

During their first year, Ostrich chicks grow around 25 centimetres per month. The chicks hatch out over a period of 3-5 days. Chicks do not have an egg tooth and instead break out of their eggs by contracting their muscles - this takes a long time: about nine hours. Young are nourished through their first four days by yolk reserves inside them, which take up about a quarter of their body mass. After three days in the nest, the young leave the nest with the adults and feed with the adults. Sometimes they form up into crèches with up to 60 young of different ages from different nests.

10 Artificial Rearing

10.1 Incubator Type

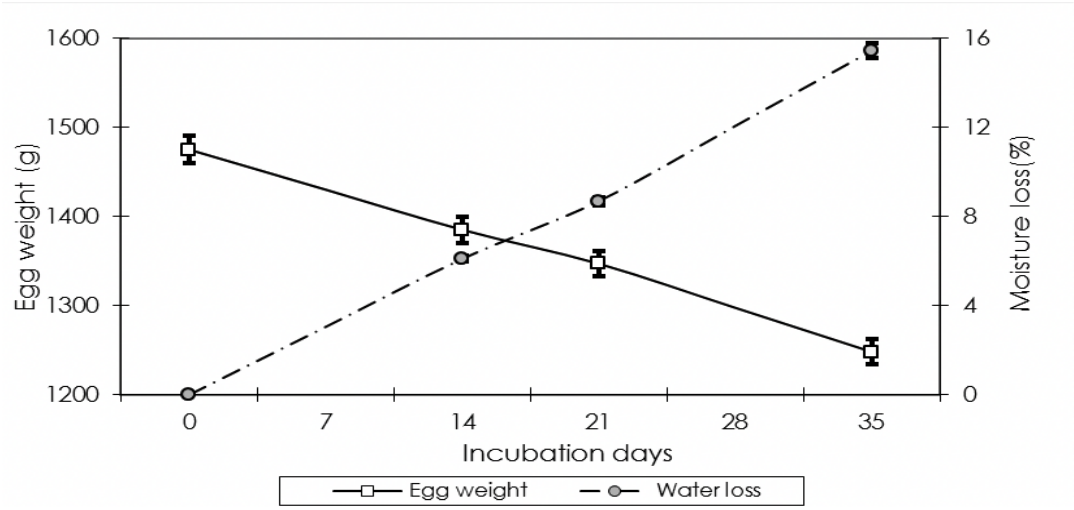
Any incubator is adequate as long as optimal temperature, humidity, ventilation, turning, etc., can be maintained. In most cases the choice of an incubator is determined by the price. Although the cost per egg set in wooden incubators is significantly lower than the cost of eggs incubated in electronic incubators, wooden incubators require special management skills in order to deliver incubation results similar to electronic incubators. A thorough study of the temperature and relative humidity in the particular farming area should be made before deciding what type of incubator to purchase. Controlling the incubator environment is often so expensive that it would be more cost-effective to acquire an electronic incubator that can function optimally under widely varying environmental conditions. (Sell, R, 1994) *Fig.31* Commercial Buckeye incubator, Floeck's Country Ranch 2008

10.2 Incubation Temperatures and Humidity

Length of incubation, temperature and humidity suggestions vary greatly, Requirements for relative humidity during incubation also vary with species: 10–40% (usually around 20%) for ostrich eggs. Unless you intend to contract incubation and hatching with another producer, you will need a forced-draft incubator able to maintain a constant temperature of between 35.5 and 37.5□C. Temperature for incubating ratite eggs is around 35.8□C. Before eggs are set in the incubators, they should be acclimatised for at least 12 hours at a room temperature of 25°C. Although there is no change in the hatchability, the sudden change in temperature may cause condensation on the shell of the cold eggs. This causes an increase in the humidity inside the incubator, which in turn enhances the environment for the growth and multiplication of microbes. Temperature is the most critical incubation parameter. The incubating temperature should be 36°C with fluctuations not exceeding 0.5°C. Research has shown that deviations of 1 to 1.5°C above the allowed temperature could result in 50% more early embryonic mortalities. (Sell, R. 1994)

10.3 Desired % Egg Mass Loss

Ratite eggs need to lose between 10-18% of their weight (in moisture loss) to hatch properly. Most growers weigh eggs weekly to monitor water loss. If the eggs are not losing the proper amount of moisture, you may need to change the relative humidity. (Bunter, K. and Cloete, S, 2004)



10.4 Hatching Temperature and Humidity

Three to 5 days before eggs are expected to hatch, transfer them to a separate incubator used only for hatching. Do not turn the eggs after transfer. A slight lowering of temperature and an increase in relative humidity may be beneficial. (Sell, R. 1994, Hermes, J.C., 1996)

10.5 Normal Pip to Hatch Interval

Hatching time varies from 36–45 days for ostrich eggs with a rough average of an external pip 2 days before hatching.

10.6 Brooder Types/Design

Early chick management of ratites is similar to that of chickens, turkeys, or game birds. Like most birds, ratite chicks are cold-blooded; they cannot sustain their body temperature from metabolism alone. Supplement heat for up to 4 months (depending on conditions) It is imperative that the birds be given an area with a range of temperatures so they can select the temperature they require. If they get cold, they can move to a warmer area and vice versa. Chicks are maintained for 6 to 8 weeks in a rearing shed. They have access to vermin proof runs (3x50 meters is ideal) outside the shed during the day and are confined to the shed at night and during cold or bad weather. Temperature control is essential as these chicks are extremely susceptible to cold. Chicks from 6 to 8 weeks to 12 to 14 weeks are kept in similar situation. However their dependence of artificial heat continually decreases and their requirement for exercise increase. The shed is usually only used for night confinement and for protection in poor weather conditions. Shed ventilation is acutely important, particularly as bird's age, because of the ammonia and disease risks associated with dung and urine. (Sell, R. 1994)

10.7 Brooder Temperatures

Approximately 26°C for the first two weeks is ideal. The temperature should be monitored regularly to ensure that the immediate environment of the chicks is at the optimal temperature to ensure normal behaviour. (Shanawany, M. and Dingle, J. 1999)

10.8 Diet and Feeding Routine

Some growers allow their birds access to forage, while others provide only the prepared feed. Alfalfa works well in growing and breeding pens. The general consensus is that ratites may require more fibre in the diet than chickens. Exact levels, however, are unknown. Open beaks and spread wings are an indication that the chicks are too hot, which could lead to diarrhoea. Chicks that are too cold will climb on top of one another, which could in turn result in skin damage. These chicks will also not grow optimally due to using their energy to keep warm. Chicks must get a balanced diet right from the start. Food and water troughs should be cleaned regularly and enough food and drinking water should be available at all times. Chicks must be given free access to feed (fed *ad libitum*) from the start. In the early stages fresh feed should be provided in the mornings and afternoons. This way food intake can be closely monitored. A sudden drop in food intake is an indication of disease and should be attended to immediately. The type of ration fed to chicks is determined by their body mass. Typically the different weight groups and rations are:

- 0-10kg body mass: Pre-starter crumbs/meal
- 10-40kg body mass: Starter crumbs/meal
- 40-60kg body mass: Grower pellets
- 60-90kg body mass: Finisher pellets
- >90kg body mass: Maintenance pellets

The chicks should be given stones if they do not have access to natural stones, as stones (gastroliths) are needed for proper digestion.

10.9 Specific Requirements

Eggs must be turned at least 3 to 5 times per day and up to 12 to 24 times per day. Many growers routinely wash eggs with water and sanitizers. However, it is best not to wash eggs. Instead, set only nest clean eggs. If washing eggs is necessary, use only warm water (110–120 F) and approved hatching egg sanitizers.

10.10 Pinioning Requirements

As the ostrich is a ratite, there is no reason to pinion the wings at any stage of life for these birds as their wings are not developed for the use of flight, so they will not be able to escape using their wings.

10.11 Data Recording

Records should ideally be done every day. Record all egg progression, hatch dates, temperature and humidity changes, weights, movements between incubator, hatcher and brooder, food taken, and growth progress.

10.12 Identification Methods

Identification can be hard in hatchlings. It should normally be done after a couple of weeks with a plastic rings with identification numbers until they grow up and can receive a neck tag or micro chipping.

10.13 Hygiene

Litter floors (sawdust shavings, straw, etc.) can be a problem, especially for ostrich chicks. Young ostriches will eat almost anything, especially litter, which can block the intestines, usually resulting in death. The problem may be reduced if chicks are placed on litter immediately after hatching instead of several days later. Work at Oregon State University suggests that emu chicks perform well on wood shavings as litter or on chopped grass straw. Absorbent litter reduces labour by decreasing the time required to clean pens. Solid surfaces, such as concrete overlaid with rubber mats, are becoming increasingly popular. Packed dirt or sand that is free of foreign material such as stones, wire, string, nails, etc. seems to be adequate. However hard floors are difficult to clean, and as the birds age, pen floors become heavily soiled and virtually unclean able.

It is preferable not to wash the eggs. Minimise soil contamination on egg. Most cleaning method can remove the protective mucin film surrounding the egg. The previously suggested removal of slight soiling by dry cleaning with a fine grade sandpaper is not recommended. Sanding does not remove bacteria but does damage the mucin film and so exposes the egg to bacterial infections. (Sales and smith 1995). Dirt should be removed only with a brush or cloth, but remember this will not remove bacteria present on the eggs surface. The eggs surface can be disinfected with a fine mist spray of disinfectant that just wets the surface and is allowed to dry. Like other methods of cleaning, washing the egg can damage the protective mucin film that may be present. If eggs are to be washed, the water must be clean and contain recognized disinfectant. The water temperature should be approximately 5-10ºC warmer than the egg (if the temp of the washing water falls, egg contents contract and contaminants can be sucked into the egg through microscopic pores in the shell). Information

indicates that problems of washing eggs are minimized if:

- The washing solution is kept clean and free of all contamination (continuous replacement of the washing solution is ideal)
- The washing solution is kept to 5-10ºC warmer than the egg
- Eggs are kept totally immersed in solution and washed as quickly as possible
- They are immediately dipper in a second clear solution, and
- Left to air dry

(Tuckwell, C. 1997)

10.14Behavioural Considerations

Imprinting is the biggest behavioural consideration. The chicks may look to their carer as their parent and rely on their care for guidance in how to work and operate as a functional adult ostrich. Imprinting can be helpful when coming to physical things like health checks or stress relief as the bird is more inclined to know you and possibly feel more comfort with their rather than others.

10.15 Use of Foster Species

Foster species are not used, as there has never been a record of successful attempt at cross fostering. This generally is not needed though as the parents are quite protective and paternal. Although the use of other ostriches as foster parents have been used with successful results. The foster parents are generally older and more docile birds. They are allowed to incubate their own eggs and the new chicks are added to the clutch after they have all hatched. (Tuckwell, C. 1997)

10.16 Fledging

At roughly 9 months of age.

10.17 Rehabilitation and Release to the Wild Procedures

Due to the non-threatened population of this species, there are no rehabilitation or release procedures to the wild available. This population is maintaining its numbers incredibly well and there for captive breeding for the purpose of release is useless.

11 Collection Management

11.1 Current Collection Census and Plan holdings

Report: Regional Census and Plan

Date Printed: Friday, 15 April 2016

Class: Aves

Order: Struthioniformes **Family: Struthionidae**

Ostrich *(Struthio camelus)*

ALTINA	7	12	0	7	12	0	Maintain; breed on request		
AUCKLAND	1	2	0	1	2	0	Maintain		
CAVERSHWP	1	1	0	1	1	0			
CROCODYLU	1	1	0	1	1	0	Maintain	for display/education/interpretation	Long-term (5 years plus)
CLIFTONAU	1	5	0	1	6	0	Acquire female; breed to requirements		
KEYSTONE	0	3	0	0	0	6	Acquire as available		after
CUDLEE PK	2	1	3	2	1	3	Maintain		
HALLS GAP	1	1	0	1	2	0	Acquire		
HAMILTON	0	4	0	0	4	0	Maintain		
LOVEDALE	1	2	1	1	2	1	Breed		Medium-term (3-5 years)
MOGO	0	7	0	0	7	0	Maintain	single-sex group	Long-term
MONARTO	8	9	0	10	10	0	Breed	for display	
YARRALUML	0	0	0	0	2	0	Acquire		
OAKVALE	1	1	0	0	0	0	Maintain	for display	Long-term
ORANA	1	0	0	0	3	0	Acquire		Short-term (1-2 years)
NOUMEA PK	2	0	0	2	0	0			
DUBBO	2	1	0	6	6	0	Acquire	for display	
WELLINGTN	0	3	0	0	2	0	Acquire		during
WERRIBEE	4	0	0	5	0	0	Maintain		
Total	**33**	**53**	**4**	**38**	**61**	**10**			

CITES: NA **IUCN:** NA **VPC:** NA

TAG: Birds; **ASMP:** No Regional Program

TAG Notes:

Most institutes that have ostriches within their facility seem to not want to expand their collection, but instead stay with the current collection that they have. This excludes Lovedale, Monarto and Altina which both have plans to breed to requirement to fulfil the acquisitions of the other instates e.g. Halls Gap, Orana and Dubbo. As the ostrich is not a threatened species, it is not a bird that requires breeding to ensure a long-term survival, hence the small numbers in captivity throughout the country.

11.2 IUCN Category.

Struthio camelus camelus (Common Ostrich) – Least Concern (LC)
Code: N/A
Struthio molybdophanes (Somali Ostrich) – Vulnerable (VU)
Code: A2cd+3cd+4cd

A2cd: Reduction in population size based on any of the following: An observed, estimated, inferred or suspected population size reduction of ≥ 30% over the last 10 years or three generations, whichever is the longer, where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on a decline in area of occupancy, extent of occurrence and/or quality of habitat or actual or potential levels of exploitation.
3cd: A population size reduction of ≥ 30%, projected or suspected to be met within the next 10 years or three generations, whichever is the longer (up to a maximum of 100 years), based on a decline in area of occupancy, extent of occurrence and/or quality of habitat actual or potential levels of exploitation.
4cd: An observed, estimated, inferred, projected or suspected population size reduction of ≥ 30% over any 10 year or three generation period, whichever is longer (up to a maximum of 100 years in the future), where the time period must include both the past and the future, and where the reduction or its causes may not have ceased OR may not be understood OR may not be reversible, based on a decline in area of occupancy, extent of occurrence and/or quality of habitat actual or potential levels of exploitation.

(Butchart, S., Ekstrom, J., Khwaja, N., Taylor, J. and Symes, A. 2016)

> "This newly-split species is suspected to be undergoing a rapid decline over three generations (50 years) given the apparent severity of a variety of threats including hunting for feathers and food, egg collection and habitat loss and degradation. It has therefore been listed as Vulnerable, but better information on population trends and the scope and severity of threats is highly desirable." (Bird Life International)

11.3 C.I.T.E.S. Appendix

Struthio camelus – Appendices I (valid from 2/1/17)
(Only the populations of Algeria, Burkina Faso, Cameroon, the Central African Republic, Chad, Mali, Mauritania, Morocco, the Niger, Nigeria, Senegal and the Sudan; all other populations are not included in the Appendices)

"Appendix I lists species that are the most endangered among CITES-listed animals and plants (see Article II, paragraph 1 of the Convention). They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial (see Article III), for instance for scientific research. In these exceptional cases, trade may take place provided it is authorized by the granting of both an import permit and an export permit (or re-export certificate). Article VII of the Convention provides for a number of exemptions to this general prohibition."

11.4 National Category

Not applicable to Australia.

11.5 State or Territory Categories

South Australia – classed as pest species.

11.6 Wild Population Management

Not applicable to this species.

11.7 ASMP Category of management

Not applicable to this species.

11.8 Key Personnel

Not applicable to this species.

11.9 Captive Management details

None available.

11.10 Population Viability Assessment

No PVA available. The captive population of the *Struthio camelus* is not in a sustainable state. The population of the vulnerable Somali ostrich could not survive on the captive population, as there is no plan put forward to sustain this subspecies. Creating and implementing a CMP for the Somali ostrich would while the species is still within the vulnerable bracket would significantly impact on the numbers of population before they progress higher up the list into Endangered.

12 Acknowledgements

I would like to thank my family, friends and those who have worked closely with me to enhance my skills and encourage and support me through the construction of this manual. I would also like to thank anyone else who assisted me in anyway with the creation, information or support roles of this manual. The help and encouragement has been greatly appreciated. I would like to also extend an extra special thank you to:

Alana Doel – Lead Keeper, Get Wild Animal Experiences
For your knowledge on all round care, needs and requirements to care for animals and teaching me how to capture, feeding and safely deal with any ostrich.

Daniel Brighton – Owner, Get Wild Animal Experiences
For allowing me to work with your ostrich teaching me about ostrich behaviour.

Lochlan Bartley – Keeper, Get Wild Animal Experiences
For teaching me all your knowledge and experience regarding the care and needs of ostriches.

Adrian Mifsud – Mogo Zoo
For supplying me with your institutes diet.

Jocelyn Hockley – Teacher, Richmond College TAFE
For directing me to contact Mogo about their captive ostriches and providing knowledge on bird care and how to work effectively.

Jackie Salkeild – Teacher, Richmond College TAFE
For your positive directions and suggestions to improve my knowledge.

Graeme Phipps – Head teacher, Captive Animals Richmond College TAFE
For being an awesome teacher and helping whenever the manual got tricky and leading me onto the correct path to make it as useful as possible, reviewing and being supportive.

Justine Ruta – Volunteer Co-ordinator and Trainer, Wildlife Sydney Zoo
For helping me through the whole course and giving great ideas and suggestions to make my manual better, editing and check over.

Chantel Whitten – Veterinarian, Mogo Zoo
For your useful information regarding common health problems, how to fix them and giving me an example from your institute.

Joanna Gubbins – Classmate.
For editing my manual and suggesting great considerations, ideas and photographs.

Dick Daniels – Photograpgher.
For allowing me to use your photographs in my manual.

Tracy Poynter – Librarian, Richmond College TAFE
For helping me locate useful books and websites and tracing them from other libraries.

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Cover photo supplied by Joanna Gubbins.

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14 Glossary

Antibiograms - A collection of data usually in the form of a table summarizing the per cent of individual bacterial pathogens susceptible to different antimicrobial agents

Autogenously - Self-produced/generated

Biological - Relating to biology or living organisms.

Biopsy - An examination of tissue removed from a living body to discover the presence, cause, or extent of a disease.

Carnivorous - (of an animal) feeding on other animals.

Contamination - The action or state of making or being made impure by polluting or poisoning

Enteritis - Inflammation of the intestine, especially the small intestine, usually accompanied by diarrhoea.

Endothermic - (of an animal) dependent on or capable of the internal generation of heat.

Ergonomic - Relating to or designed for efficiency and comfort in the working environment.

Exudation (exude) - (with reference to moisture or a smell) discharge or be discharged slowly and steadily

Harem - A group of female animals sharing a single mate

Hepatitis - A disease characterized by inflammation of the liver.

Herbivorous (herbivore) - An animal that feeds on plants

Imprinting - (of a young animal) come to recognize (another animal, person, or thing) as a parent or other object of habitual trust.

Melanoma - A tumour of melanin-forming cells, especially a malignant tumour associated with skin cancer.

Metabolism - The chemical processes that occur within a living organism in order to maintain life.

Mucin film - A glycoprotein constituent of mucus

Omnivores - (of an animal or person) feeding on a variety of food of both plant and animal origin

Ossification - Turn into bone or bony tissue.

Polygamous – (of an animal) typically having more than one mate.

PPE – Personal Protective Equipment

Quarantine - A state, period, or place of isolation in which people or animals that have arrived from elsewhere or been exposed to infectious or contagious disease are placed.

Ratite - (of a bird) having a flat breastbone without a keel, and so unable to fly.

Sexual maturity - he state, fact, or period of being mature.

Solicitation - he act of asking for or trying to obtain something from someone.

Struthio camelus – Scientific name for Ostrich

Zoonotic – A disease which can be transmitted to humans from animals

15 Appendices

15.1 Appendix 1 Products Mentioned in Text. (Supplements, drugs, meds, etc.)

- Supercool pellets 'Feed n Fire' – Bran, pollard, corn, soybean meal, lupins, murcern meal, dolomite and salt

- GG Grain mix (Grenfell Commodities) – oats, barley, cracked corn, black sunflower, creacked faba bean, molafos

- Electroguard – sodium chloride 750 mg/ potassaium chloride 500 mg / vitmin a 75 000 IU / vitamin D3 15000 IU / Vitamin E 300 IU / Vitamin K3 20 mg / Vitamin B1 20 mg / Vitamin B2 60 mg / Vitamin B6 40 mg / Vitamin B12 0.3 mg / Vitamin C 500 mg / Niacin 300 mg / Panthothenic acid 70 mg / folic acis 10 mg / Biotin 1 mg / Magnesium 110 mg

- Lucerne chaff
- Shell grit
- Dehydrated molasses powder
- Chlorahexadine
- F10
- Animal Safe detergent
- Virex 2
- WD-40
- Emerald disinfectant
- Valium
- Panacur25
- Fenbendazole
- Ivermectin
- Tetracyclone
- Furaltadone
- Norfloxacin
- Danofloxacin
- Penecillin

15.2 Appendix 2 MSDS (Material Safety Data Sheets). (Chemicals)

Chlorahexadine
https://www.perrigo.com.au/upload/product/document/CHL02501F-MSDS.pdf

F10
http://www.vetnpetdirect.com.au/core/media/media.nl/id.197681/c.1032112/.f?h=3f696eb050e2891de2ae

Animal House detergent
http://www.glason.com.au/assets/products/cleaning/Air-Tech_PETZ_AnimalHouse.pdf

Virex 2
https://facilities.ofa.ncsu.edu/files/2016/07/SDS_VIREX256_One-Step-Disinfectant.pdf

WD-40
https://www.wd40company.com/files/pdf/sds/mup/wd-40-multi-use-product-aerosol-sds-us-ghs-7-20-14.pdf

Emerald disinfectant
http://www.tandcc.com.au/disinfectant_commerial_grad-e_various.pdf

15.3 Appendix 4 (Personal Protection Equipment)

Goggles
Gloves
Disposable gloves
Ear protection
Safety tools – wooden board, rake,
Capture tools – hook, pillowcase, neck sock

15.4 Appendix 5 (Exhibit signs)

Behind the Scenes:
Quarantine (if isolated)
Hazardous/Dangerous animal warning
Animal ID (Cage Card)
Medications required
PPE required
Enclosure safety (uneven ground, loose substrate)
Fact sheet on individuals
Authorised entry level
Mixed exhibit notification
Record sheet

Displayed to Public:
Enrichment in progress
Ostrich facts
Talk times (if any)
Distribution map