Brolga *(Grus rubicunda)* Husbandry Guidelines – 2008.

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Adult male Brolga. (*Photo – Tegan Christophersen, TWP.*)

Status:

Federal:	**Vulnerable**
IUCN:	**Lower Risk**
ASMP:	**Australian Non-passerine TAG. Management Level 3**
Conservation status:	**Refer Table 1.1.**

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Figures/photos:

1. Introduction.

The Brolga, one of two cranes native to Australia, also occupies a small area in New Guinea (Meine, C. & Archibald, G. 1996). A tall; stately grey bird with long neck, beak and legs; can be observed either singular, in pairs, or in flocks. Brolgas are omnivorous, preferring habitat with ephemeral or permanent water-bodies. They move from area to area depending on weather/breeding season and food availability. Although breeding is not difficult in the wild, in captivity there are only a few brolga pairs that breed successfully (pers.obs.)

Weights:
Adult Males: 4.5 – 7 .25 kg, Adult Females: 3.2 – 5.2 kg (ARKS. 2004)

Measurements:
Males: 1050 – 1250 mm, Females: 950 – 1150 mm. (Schodde & Tidemann eds. 1997).

Eggs: Figure 1.2.
Tapered – oval**,** roughly 92 x 61mm; basically cream with reddish-brown and lavender markings (Schodde & Tidemann eds. 1997), weighing 170 – 195gms (Ozcranes 2006).

Sexing Methods:
Laparoscopy; DNA Analysis (see Appendix), Faecal, Steroid, Feather Pulp, or Vent Sexing. A natural way would be in observing the behaviour of the birds (Scott, Swengel. 1996).
At Territory Wildlife Park (TWP), the female is timid, showing neck-retracted submissive postures. The male is the dominant, with a more erect and aggressive posture, spending a lot of time observing and approaching intruders. (pers.obs)
Although it is usually the male that is the aggressive of the sexes, at Perth Zoo it was noted that their female Brolga was the aggressive one (Robertson, H. 2005).
In a pair situation, plumage wise, Brolgas are sexually monomorphic, but the visual and vocal characteristics of the Unison Call are sexually distinct. In the interpretation of the

Unison-call: (Figure 1.1.), the male stands with elevated wings and drooped primaries; while the female, initiating the call, stands with her wings closed. (Archibald, G. & Lewis, J. 1996).

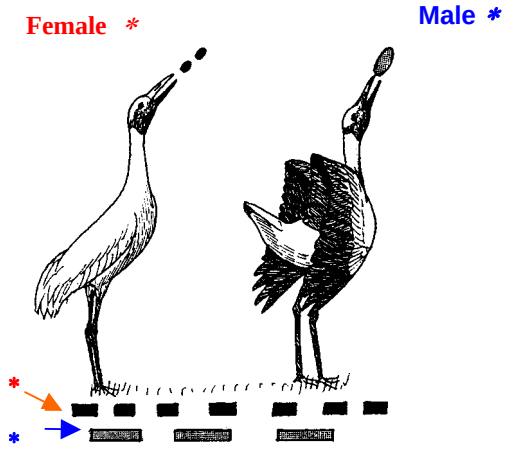

Figure 1.1. ***Unison-call.*** *(Scott, Swengel. 1996).*

* ***Shaded bars*** *(male),* * ***Black bars*** *(female) indicate duration of vocalization.*

Balloons *indicate typical number of female per male calls.*

Figure 1.2.
Brolga eggs showing colour variations.
(*Photo: author*)

Figure 1.3. ***Brolga chick and second egg***
(Photo: ICF)

Figure 1.4. ***Brolga pair on nest.***
(*Photo: Peter Merritt*)

Conservation Status – (Meine, C. & Archibald, G. 1996a).

Species: CITIES – Appendix II, IUCN Category – Lower Risk

Population: Northern Australia – Lower Risk (least concern), Southern Australia – Vulnerable, under criteria C1b, c D, and New Guinea – Data Deficient

Value as a Tool in Education, Conservation and Research:
Displaying Brolga pairs in a naturalistic exhibit says a thousand words to the public. Captive management of these birds allows us the managers; to conserve, find the best in reproductive methods, gather information, and gain experience that would not be possible in the field. To document and share this valuable knowledge between institutions and individuals alike.

2. Taxonomy.

Meine, C. & Archibald, G. (1996a) states that the Brolga, one of a worldwide group of cranes numbering 15 species; is more closely related by DNA to the White-naped Crane (*Grus vipio*) than that of the morphologically similar Australian Sarus Crane (*Grus antigone gilliae*). The Sarus Crane is the next closest by DNA, followed by both the Siberian Crane (*Grus leucogeranus*) and the Sandhill Crane (*Grus canadensis*). Refer Figures 2.1 – 2.

The White-naped Crane breeds in the northeastern areas of Mongolia, China, and adjacent parts of southeastern Russia. The Australian Sarus Crane, slightly larger than the Brolga, breeds in northeastern Australia and is one of three subspecies of Sarus Crane, the other two subspecies being the Indian Sarus Crane and the Eastern Sarus Crane. (Meine, C. & Archibald, G. 1996b).

The Brolga was first described in 1810 and misclassified as *Ardea,* the herons and egret genus. In 1865 the famed ornithological artist John Gould gave the bird the name "*Australian Crane"*. The Royal Australian Ornithologists Union gave the official name of "Brolga" in 1926, a name derived from the Gamilaraay *burralga,* meaning – *a bird species.* The Gamilaraay is the traditional language of the Kamilaroi people, of South East Australia. The Brolga was reclassified to genus *Grus* (Cranes), in the order Gruiforms, that also includes the crakes and rails. (Wikipedia. 2006).

2.1 Nomenclature

Class:	Aves
Order:	Gruiforms
Family:	Gruidae
Subfamily:	Gruinae
Genus Species:	*Grus rubicunda*

2.2 Subspecies

None – the northern and southern Brolga are now regarded as discrete populations, and are no longer subspecies (Meine, C. & Archibald, G. 1996b).

2.3 Other common names

Australian Crane or Native Companion. (Wikipedia. 2006).

An overview of Crane Morphology.

Figure 2.1. ***15 Crane spp.***

8. Sarus Crane
9. Brolga
10. White-naped Crane

1. Black Crowned Crane

2. Gray Crowned Crane

3. Demoiselle Cranes

4. Wattled Crane

5. Blue Crane

6. Siberian Crane

7. Red-crowned Crane

11. Hooded Crane

12. Sandhill Crane

13. Whooping Crane

14. Black-necked Crane

15. Eurasian Cranes

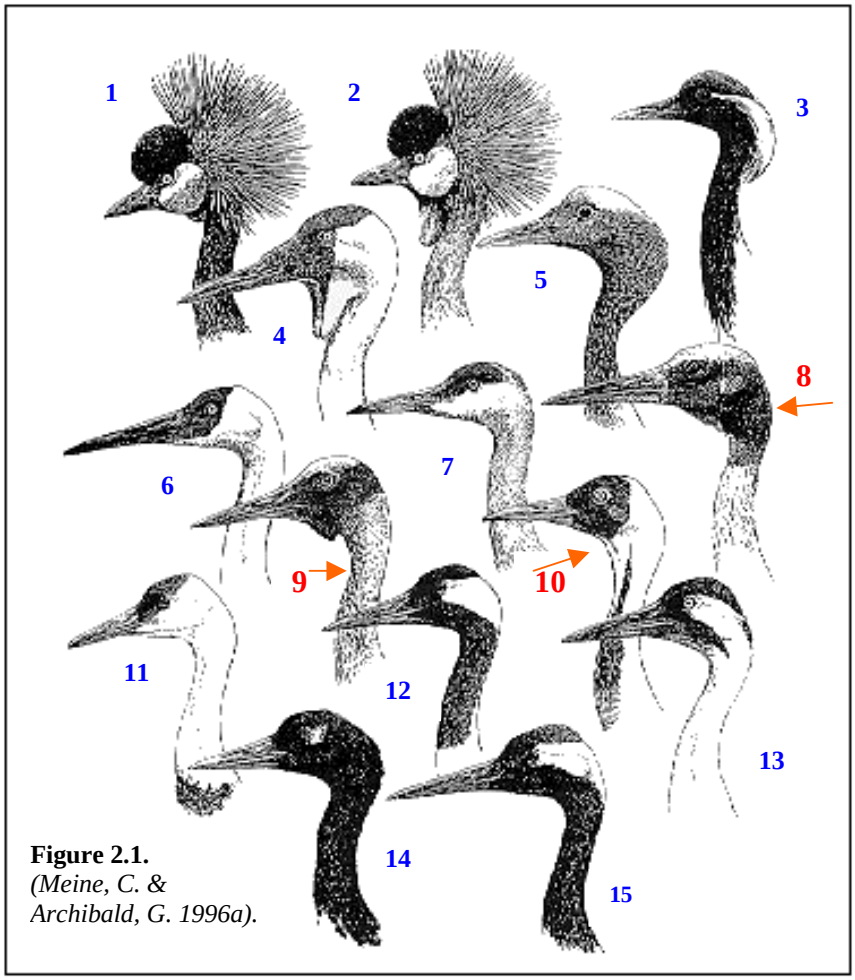

Figure 2.1.
(Meine, C. & Archibald, G. 1996a).

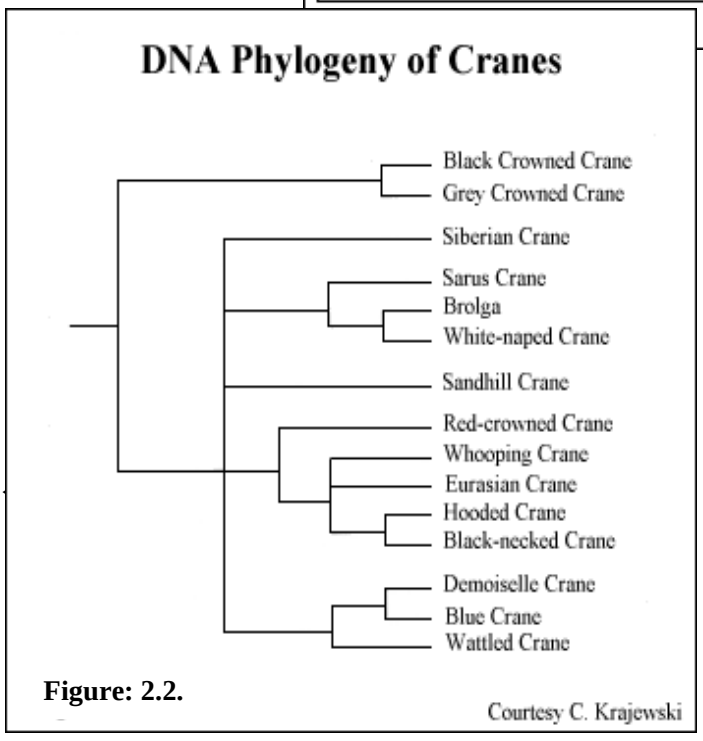

Figure: 2.2.

Figure 2.2. ***Crane DNA Phylogeny***

←The Brolga is more closely related to the White-naped Crane than the Sarus Crane
(Meine, C. & Archibald, G. 1996a).

3. History.

The Brolga and the Australian Sarus Crane are the only cranes native to Australia. Brolgas still occupy most of its historical range, although in recent decades, there has been a decline in southeastern Australia mainly due to habitat loss and degradation. Other threats include collision with utility lines; subdivision and subsequent fencing of large private land holdings; and feral animals (mainly the Red Fox – *Vulpes fulva*). (Meine, C. & Archibald, G. 1996a).

3.1 Diagnostic Features. (Guesclin 2003).

Adults: Both sexes have similar features (Figure 1.4), with the females slightly smaller in size. Brolgas are light grey in colour, long necked, standing 1.8 metres tall, dark grey/black legs and feet, with a wingspan of 1.7 – 2.4 metres. Bill is long, straight and dark in colour, being relatively large in comparison to head. Head is conspicuous orange/red, with grey ear converts, a bare crown of greenish grey skin, and has a dark pendulous dewlap. Iris is yellow to reddish/orange. (Refer photo first page).

Juvenile: (11 to 22 months) Head feathering gradually disappears and attains the reddish colouring.

Immature: (up to 10 months) Iris dark brown, head fully covered with grey feathers lacking the red band. (Refer Figure 3.1 below).

Figure 3.1.
Brolga Chick – 50 Days old.
(Winton 2003).

3.2 Distributions and Habitat.

Brolgas are found in open swamplands of coastal and sub-coastal tropical Australia, and into the eastern interior (Figure 3.2.). Small local populations occupy through Murray-Darling basin to western Victoria, with none in Tasmania. Population trend and numbers of sub-tropical Northern Australia far outweigh the South Australian population (Table 3.1). Vagrant to New Zealand, Coral Sea and southwestern Asia, Brolgas also inhabits southern New Guinea. (Schodde & Tidemann eds. 1997).
The only crane of New Guinea, the Brolga lives mainly in the Trans-Fly lowlands of Papua New Guinea and Irian Jaya, Indonesia. There is evidently no regular migration or interbreeding between New Guinea and Australian Brolgas. (Ozcranes 2006).

Brolga numbers in Northern Australia are between 20,000 and 100,000 and are considered stable. Southern Australia numbers are approximately 1,000 with numbers possibly declining. New Guinea numbers are unknown. The northern population appears to be expanding in recent decades due to increasing use of croplands – in the Northern Territory, on the Kimberley Plateau, and elsewhere further south of Western Australia. (Meine, C. & Archibald, G. 1996a).

Brolga are non-migratory, but move around in response to the seasonal rains. They are regarded as one of the most opportunistic of the cranes, evolved to use the weather to their advantage with an ability to exploit a wide variety of habitat types. Flocks with numbers up to several hundred form out of breeding season traveling long distances in search of food, reaching as far as the Simpson Desert. Northern populations concentrate during the dry season in coastal freshwater wetlands where they subsist on the bulkuru sedge (*Eleocharis dulcis*), and in the wet they spread to breeding territories in freshwater and brackish marshes, wet meadows and other seasonal wetlands. Southern populations also move between wet season breeding territories and traditional dry season flocking grounds, although these areas are less marked. Southern populations utilise similar wetland types, but generally use salt marshes far less than the northern population. (Meine, C. & Archibald, G. 1996a).

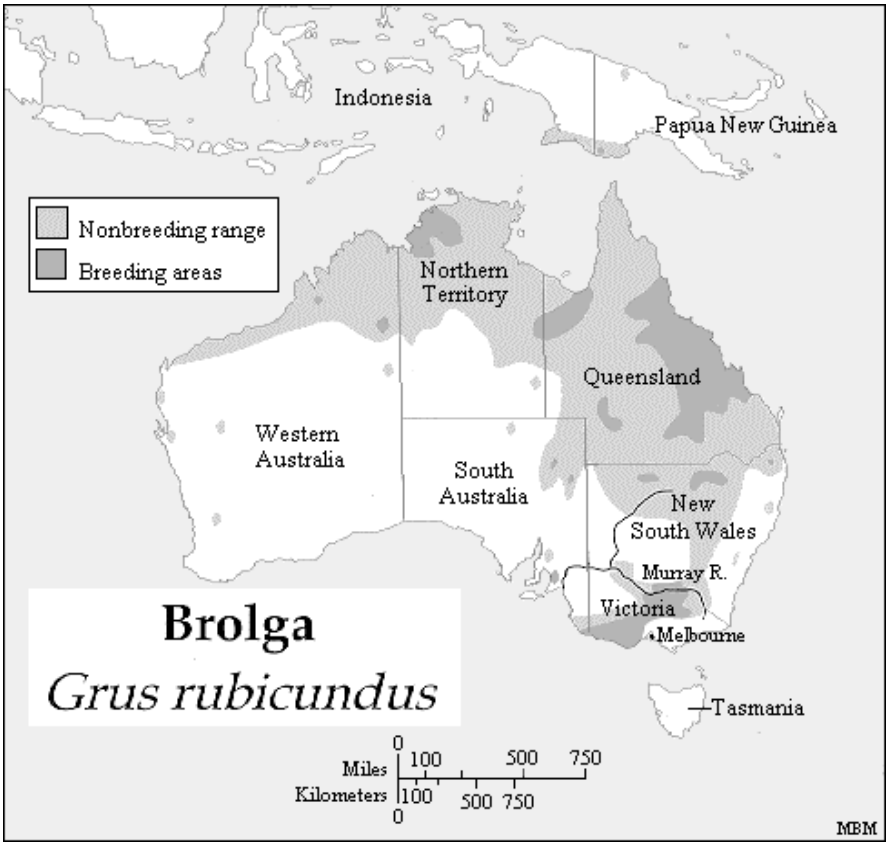

Figure 3.2. ***Breeding and non-breeding ranges of the Brolga.*** *(Meine, C. & Archibald, G. 1996b).*

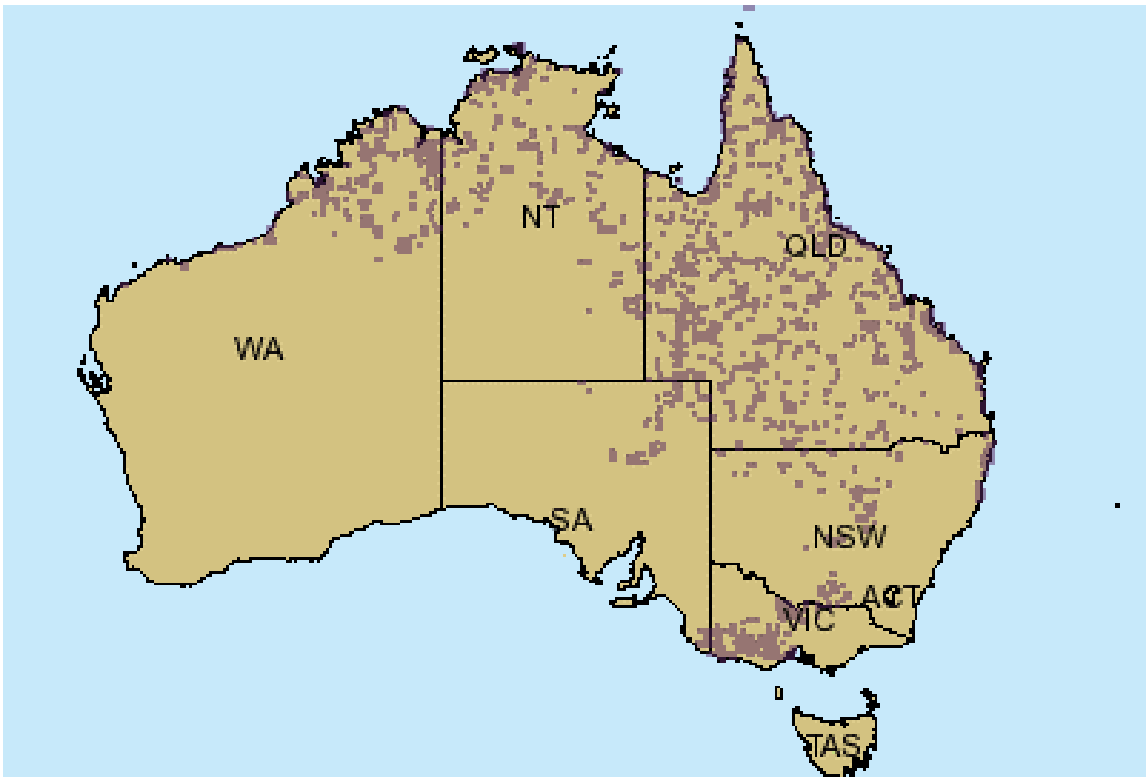

Figure 3.3. ***Distribution of the Brolga in Australia*** *(Birds Australia 2005).*

3.3 Longevity.

3.3.1 *Wild.*
Not much known or documented.

3.3.2 *Captivity.*
The oldest Brolga on record still living is 42 years old (SPARKS 2007).
A Siberian Crane has been documented to live to 78 years plus, with other species of cranes living into their sixties (Mirande *et al* 1996).

3.3.3 *Techniques to Determine the Age of Adults.*
Unknown.

4. Housing Requirements.

4.1 Exhibit Design.
While predator-proofed from foxes, dingoes, dogs and goannas, designed to minimise injuries (lacking projections).
Enclosures are best designed to encompass as much naturalistic furnishings as possible, while minimising the risk of injuries and predators. Excluding the public viewing area, visual barriers serve the dual purpose of making a smoother fence and minimising stress. Allowing an ample-sized exhibit area for movement and space away from the public allowing birds to feel safe and secure, allows for nesting at the back; and encourages foraging and other natural behaviours. Buildings not needed as the weather is not cold enough although a shelter that either encompasses just 4 uprights and a roof, or some trees is recommended for shade and protection from the natural elements. The recommended fence height is 2.3 to 2.6 metres and if the birds are able to fly, nylon flight roof netting should be used. Fencing material to be either 5cm mesh 11 gauge galvanised steel or aluminium chain link, supported with posts at 5 – 8 m intervals. Specify “knuckled” when ordering to avoid the hazard of twisted barbs at the top and bottom of the chain link. (Scott, S. & Besser, R 1996).

4.2 Holding Area Design.
A predator proof construction is recommended with fence heights and fencing material allowing sheltering for food and weather. The design depends on the use intended, whether it is used to separate the male off exhibit while working in exhibit, holding the bird for a lengthy period of time, or for medical reasons.

At TWP a 3 x 4-metre holding/safety enclosure (HSE) is used to separate the male (of a bonded pair) when entering the exhibit. This HSE is built within exhibit towards the back and has two gates, one designed to open/shut from outside of the exhibit as a safety requirement for keeper. The other gate is to allow entry/exit from the exhibit to HSE. The pair of Brolgas is fed in this HSE and the entry/exit gate is left open throughout the day (a good conditioning tool). (Pers. comm.).

4.3 Spatial Requirements.

In Victoria the minimum requirements for holding Brolgas is 60 x 30 metres (Helman pers. comm.). Under the Exhibited Animals Protection Act in NSW, there are no guidelines for Brolgas (Jackson pers. comm.). Scott *et al (*1996) recommends that mated pairs need an area of at least 100 m², with preference to 300 m² for successful breeding.

4.4. Weather Protection.

A shelter provides a dry place for food and helps protect Brolgas during inclement or very cold conditions. "Shelters" can range from sheltering trees, opened-roofed four-posted shelters (pers.com); to three-sided or a fully closed building. (Scott, S. & Besser, R. 1996).

4.5 Heating Requirements.

Ambient temperatures of -10°C (14°F) at which the Brolga will need to be moved indoors and at -20°C (- 4°F) recommend added heat (Scott, S. & Carpenter, J.1996).

4.6 Substrate.

Soft substrates such as soil, grass, tussocks, mulch (Scott, S. & Carpenter, J.1996).

4.7 Enclosure Furnishings.

Shallow water moat/pond or stream with aquatic plants to promote natural feeding and encourage breeding behaviour. Sheltering trees and a soil based substrate covered in grass and tussocks. (Pers. comm.).

5. General Husbandry.

5.1 Hygiene and Cleaning Requirements. (Scott, S. & Carpenter, J.1996).

- Holding facilities or pens should be built large enough to prevent build up of microorganisms and parasites in soil and under shelters. To keep outdoor pens clean you need to allow the soil pathogens to die. More than one pen should be made available to allow for rotation each year. If rotated pens are $50m^2$ of space then they normally do not need to be cleaned. If there is an unusually high amount of pathogen load, then disinfecting can be done by tilling the topsoil and applying lime, formalin, or a commercial disinfectant.
- Shallow pools should have either a slow, continuous flow or be cleaned every 3 to *5* days (if a chick is in the pen, then more frequent cleaning required). If the water stagnates there is a possibility of the lethal bacteria called *Clostridium botulinum* to flourish. Cranes need fresh drinking water at all times.
- Feeders should be elevated to prevent contamination by vermin and be placed at least 1 m away from the water supply to prevent contamination.
- Soft substrates are required to prevent damage to the birds' feet.

5.2 Record Keeping.

All records and dates relating to health; veterinary treatments; behavioural and reproductive observations; changes in diet; weights/measurements and growth; catching, handling and transport techniques; internal and external movements; necropsy record and history; need to be documented in either ARKS or medARKS as well as in in-house diaries.

5.3 Methods of Identification. (Scott, S. & Carpenter, J.1996).

5.3.1. ***Leg Bands***.
Metal (aluminium) and/or coloured plastic bands placed above the hock. Inside band diameter of 16-18 mm. If the sex is known before permanent banding, the males can be banded on one leg and the females on the other. This gives ease of long distance sex identification.
Metal bands are engraved with individual (ID) numbers. Coloured bands allow for individual long distant identification of a bird in a flock situation. Various colours and positions of one to three bands allow for a multitude of combinations. If using this method, an interlocking aluminum band positioned between two coloured bands prevents one colour band slipping over the other.

5.3.2. ***Transponder*****:**
IUCN recommends the Trovan A.E.G. system, with the dorsal base of the neck as preferred implantation site.

5.3.3. ***Tattoos:***
Placed on the underside of patagium (as a permanent marker).

5.4 Routine Data Collection.
Long-term studies of selected projects such as genetic management programs, health/medical management/prevention programs, and growth/development studies.

6. Feeding.

6.1 Wild Diet.
Brolgas are omnivorous, eating tubers of the Bulkuru Sedge, their main diet in the dry season (in the northern parts of Australia). Other wetland plants, upland plants (including cereal grains), insects, freshwater and saltwater molluscs, crustaceans and frogs are also utilised as food items (Meine, C. & Archibald, G. 1996a). Brolgas have a salt gland located near the eye to allow the birds to excrete a concentrated salt solution indicating that salt water is often consumed (Ozcranes 2006)**.**

6.2 Captive Diet.
Scott, S. & Carpenter, J. (1996) documents that Brolgas consume roughly 4% of their body weight per day and most formulated crane diets are composed of less than 10% animal matter and the rest vegetable matter. (Refer Appendix).
The following institutions have either bred Brolgas recently or in the last couple of years. Their Brolga Diets are in the Appendices:

- Auckland Zoo **—** Hand-rearing and Adult Diets
- Cairns Tropical Zoo – adult and juvenile diet
- David Fleays Wildlife Park – adult diet
- Healesville Sanctuary – adult diet
- Serendip Sanctuary **—** Hand-rearing and Adult Diets.

6.3 Supplements.
Refer to Diet sheets in Appendices

6.4 Presentation of Food.
At TWP, food is either presented in a shallow tray placed in an elevated weather/vermin proof Brolga feeder-stand or in an elevated tray positioned in the holding safety/enclosure (refer chapter 4.2). Aquatic food-plants are placed around the swamp/stream area in the interior of exhibit. Food items such as mice can be thrown to Brolgas within exhibit/enclosure and can be used as rewards or treats.

7. Handling and Transport.

7.1 Timing of Catching and Handling.
Capture and handling is accomplished usually as early as possible, in the coolest part of the day and allows ample time for observations following release. (Pers. obs.).
To keep a bird away from you for a short time, a long rod with a curve towards the end, can be used (refer Figure 7.1 below).

Figure 7.1. ***Rod used to keep the Brolga at a distance.*** (Photo: author).

7.2 Catching Bags. Not needed.

7.3 Capture and Restraint Techniques.
As a safety issue it is wise to wear light glasses as the Brolga may attack the eyes.
Capture at TWP: The best method to catch a territorial Brolga in a large space is by one person only. When you first approach and open the gate, the aggressive Brolga is there and usually stands and preens whilst assessing you, this is when you do not hesitate; you step in

and catch the bird. The left hand is used to capture the head and the right hand is used to go over the right side of bird's body and catch the shoulder /wing, at the same time drawing the bird in close to you with his back to you, and legs facing away from you. For catching quiet Brolgas the bird is herded by 2 persons into an in-exhibit HSY (refer 4.2) and caught by one person again (pers. obs.).

Scott, S. & Carpenter, J. (1996) recommends that for capture of a Brolga, 2 – 4 people are needed to approach the bird slowly with arms outstretched, herding the individual into a corner. As the Brolga is about to escape past you, rush in and grab the bustle (rearward, protruding, elongate tertiaries), one or both wings, and the neck. Brolgas that tend to jump you must angle your arms up and outward when cornering the bird and be prepared to grab a wing as the bird tries to jump over you.

Restraint: (Refer Figure 7.2 – 7.5.). Wings and legs are restrained when the bird is caught then pull the body of bird towards your own, and divert the head of Brolga away from you avoiding facial injury. If grasping the legs above the hocks, always place one finger between the hocks to preventing legs abrading each other. If Brolgas legs must be folded, tarsi are to be gently forced around, but if the bird locks its hocks rigidly, legs must not to be forced to fold. Instead, keep steady pressure on the tarsi until the bird allows you to fold its legs. Do not support the Brolga's weight on their folded legs. When holding with folded legs, support the Brolga's weight with the arm holding its body. Legs are not to be kept folded for more than 30 minutes. Brolgas' head can be hooded to keep them quiet if necessary (Scott, S. & Carpenter, J. 1996).

Figure 7.2.
Hold the crane's wings and body with one arm and its legs with the other arm.
(Scott, S. & Carpenter, J. 1996).

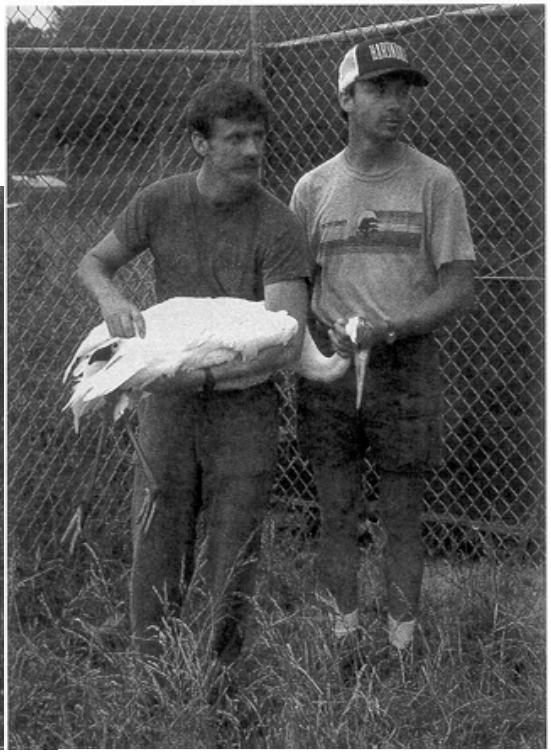

Figure 7.3.
For aggressive birds, the head may be restrained by a second person.
(Scott, S. & Carpenter, J. 1996).

At Serendip Sanctuary Brolgas heads are hooded to keep them quiet and less stressful. (Refer figure 7.4 & 5).

Figure 7.4. ***Brolga Wrap & Hood*** *(Photo: author), Velcro in wraps & hood used as main security, with additional rope around shoulders & tail.*

Figure 7.5. ***Transporting secured Brolgas.*** *(Photo: author).*
Rangers Michael Smith & Suzanne Coates at Serendip Sanctuary, Victoria.

7.4 Weighing and Examination. (Scott, S. & Carpenter, J. 1996).

Weighing:

- Chicks to be placed in cardboard boxes that are high enough to prevent escaping, with carpet flooring for sound footing. A keeper should be there to place a hand on top of the box to keep it closed and to prevent tipping.
- Brolgas > 2kgs can be weighed either on a platform scale, or while being held by a keeper on a scale.
- Another method is to use a 10 – 15 kg capacity suspension spring scale with 0.1kg accuracy weighing birds held either in a weighing sling, or a cloth sack tail first, with the neck and head projecting from the bag. There have been injuries noted with weighing birds with the cloth sack method, as the legs have to be folded.

Examination:

- One method is to hold the Brolga down on the ground with legs folded in a sitting position, without placing your weight on the bird kneel down with your legs surrounding the bird's wings (Figure. 7.6).
- Hands are used if the bird struggles. Handy for examining the head, dorsum or treatments such as force-feeding. Hooding can also be used.

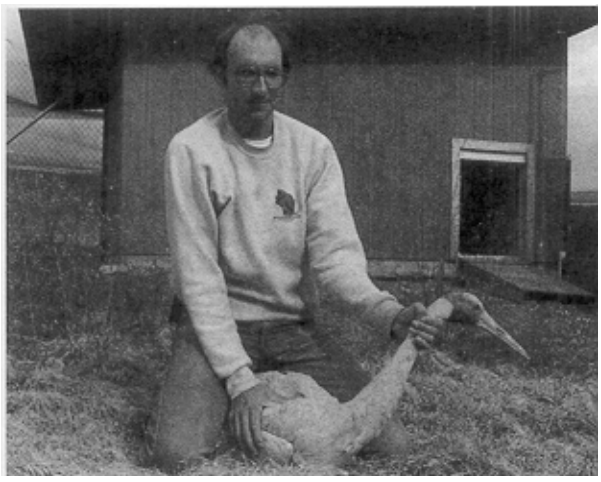

Figure 7. 6.

Restraint of a Brolga by sitting over it, with the hand placing pressure on the bird.

(Scott, S. & Carpenter, J. 1996).

7.5 Release.

Upon releasing a Brolga, allow its legs to touch the ground first, moving forward a step or two with the bird before letting go of the wings and body. Hold the bustle or one wing whilst releasing the legs to keep the Brolga steady on its feet. This is a leg injury prevention method except for birds that tend to thrash around violently on release, in which case it would be better to just let the bird go cleanly. (Scott, S. & Carpenter, J. 1996).

7.6 Transport Requirements. (Scott, S. & Carpenter, J. 1996).

Adults:

- Move birds as little as possible to minimize stress.
- Moves less than 200 meters, you can carry the Brolga while walking to destination.
- Longer moves, you would be best to hand-carry the bird into a vehicle and hold it during transport. Use a hood or covering with a towel for nervous or aggressive birds.
- For longer distances a crate is recommended. The crate can be in an open truck, but needs to be tied down. Whilst driving, avoid bumps, abrupt turns, and sudden changes.
- Shipping Brolgas by air, – crate design and shipping arrangements should comply with

International Animal Transfer Association (IATA), guidelines that are available from the airlines.

Chicks:

- Young Brolgas (especially < 4months old) should not be transported except for special purposes, and even then be accompanied by a keeper.
- Young Brolgas are prone to leg and wing injuries during transport and need extra floor padding in their crate.

At Serendip Sanctuary, a wrap is used to move a Brolga for a lengthy distance within sanctuary grounds. (Refer Figure 7.4 & 5)

7.6.1 ***Box design and materials.***

Should comply with IATA guidelines available from ICF or IATA.
In general, the crate has inside dimensions of 95cm high x 90cm long x 40cm width (refer Chapter 7.6.5).

7.6.2 ***Furnishings.***

5cm layer of wood shavings on floor to absorb faeces.

7.6.3 ***Water and Food.***

Adults:

- Food not needed during trips of less than two days.
- After one day of travel in cold to moderate temperatures the Brolga needs to drink. The higher the temperature the more water the bird drinks. Placement of a familiar water dish in the crate for 1/2 hour will give ample time for the bird to drink. Installation of a permanent water dish can cause injuries.

Chicks:

- Young Brolgas (especially < 4months old) are less tolerant to extreme temperatures.
- Require one good feed a day.
- Require drinks of water every few hours.

7.6.4 ***Birds Per Box.***

One Brolga per crate, double crates with a solid divider for two birds.

7.6.5 ***Preventing Injuries.***

- Minimise wing injuries by temporarily brailing the feathers, taping pads on the carpus of pinioned wings, or fastening gripable floor material fairly securely along its perimeter and eliminating rough edges inside crate.
- The groove of the sliding crate door should be made narrow as possible to prevent the Brolgas getting their toenails hooked during transport.
- When transporting juveniles, minimise the crate size to prevent it from turning around.
- In general, the crate should be 12.5 cm wider than the bird with folded wings.
- Height and length of crate should be proportionally adjusted to enable Brolga to stand comfortably with its neck curved, but small enough to prevent it opening their wings or jumping around.

7.6.6 ***Timing of transportation.***

- Avoid airline shipments when temperature is > 21° C (70° F) and < - 1° C (30° F).

- During a long hot road trip Brolgas need to be checked hourly or more if stress is likely.
- Use the conditions of the natural environment to guide you for Brolga's tolerance to the heat and cold conditions while transporting.
- Allow for unseen events that may change transport schedules and jeopardize the bird.
- Transport best done during non-breeding time of year.

7.6.7 *Release from the Box.*

Never leave a Brolga in a crate for >10 minutes, when temperature are > 30° C (86°F). Upon release in chosen quarantine pen (shaded area), leave door open to allow Brolga to exit at will. The pen is to be unoccupied by any other species. An observation routine is to be kept up to ensure all is well for the rest of day.

8. Health Requirements (Olsen *et al.* 1996 - except where stated otherwise).

8.1 Daily health checks.

Keepers' personal observations on behavioural and physical changes of the Brolgas are noted whenever within sight. Keepers to know the history, both normal behaviour and physical appearance of the Brolga beforehand. Listlessness, going off food, dull appearance and lack of their usual personal habits are some of the signs of ill health. Observations of aggressive or submissive behaviour help to manage the birds, indicating the need for separation (pers. obs.).

8.2 Detailed Physical Examination.

Physical examination whilst restrained to be brief but thorough.

Head & Eyes:

Eyes checked – swollen lids, discharge, squinting, or a change in colour of the globe. Possible cause – infection, injury, foreign bodies, or swollen tissues. Dilated pupils may indicate shock, blindness, or concussion. Bleeding in the anterior chamber of eye could possibly be head trauma. A small light source to check pupillary response. Pupils respond individually in birds. An Ophthalmoscope to be used for deeper examination of eyes if abnormalities are suspected. Atropine will not cause pupil dilation (as in mammals), because of their striated rather than smooth muscle in the iris and ciliary body.

Beak & Mouth:

Beaks grow several centimetres a year, so need checking for evenness of wear, bite and overgrowth. If over grown, the beak may need constant trimming every 2 – 4 months. If trauma is suspected, the beak should be palpated for fracture or other damages. Nares should be checked for any plugs or discharges. Beaks often open in vocalisation upon inspection of mouth to allow viewing of inside, if not, then gently pry with the index finger on one side and the thumb on the other side. Mucous membranes are usually bright pink, but some cranes have black or grey-pigmented tissues on the mucous membranes. Based on the moistness of the mucous membranes, the level of hydration can be estimated.

Auditory Canal & Neck:

Check auditory canals (ear), which are covered in small, fine feathers: for exudates, blood, and infection. Trauma of the canal from aggression can be observed as partially closed, swollen, and filled with blood. Neck, oesophagus and trachea should be palpated for the

presence of liquids, solids, or air. The lower section of the cervical oesophagus called the crop (unlike other bird groups) is undeveloped as a storage area, with liquids and food passing quickly to the proventriculus, resulting in the oesophagus being empty upon examination. Gross distension indicates blockage or impaction.

Thorax:
The thorax is examined by palpation and listening to the heart. Some cranes infrequently develop subcutaneous emphysema. Trauma, with rupture of an air sac and leakage of air under the skin, is suspected as the general cause, and frequently no wound can be detected.

Body Condition Index (BCI):
BCI can be determined by palpating the pectoral muscles and keel to get an estimate the degree of development or atrophy of the bird. Generally birds with an amputated wing will show a loss of pectoral muscle on the amputation side of body. BCI is best determined with the comparison evaluation of the individual, not between birds. Taking an evaluation every time the bird is handled could accomplish this. (Refer Figure 8.1 below).

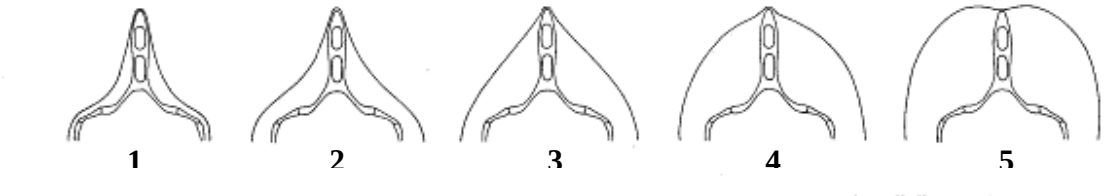

Figure. 8.1. ***BCI, an indicator of nutrition.***
Cross-section through mid sternum of Sandhill Crane (spaces are tracheal cavities).
On a scale of 1 – 5 the BCI:

- 4 or 5 – indicate a well-muscled or plump bird and the pectoral muscles will be rounded convexly from the keel.
- 3 – have a flat profile to the pectoral muscles.
- 2 – have a concave shape to the pectoral musculature.
- 1 – indicates severe muscle atrophy and emaciation.

Abdomen:
Gently palpate for internal masses, ovulated eggs, and fluids. The vent area can be checked for growths, lesions, protrusions, and for urates or faeces accumulating on the feathers. The preen gland above the tail base should be checked for enlargement, possibly caused by impaction, neoplasma, or infection.

Skin & Plumage:
Elasticity of skin indicates general level of hydration. Check for parasites, skin swellings, and missing/damaged feathers. Feathers with dull, frayed, split or with stress bars across may indicate nutritional deficiencies, stress, or hormonal imbalances. Skin irritation and broken feathers or an area of missing feathers are an indication of possible self-mutilation. Similarly, this condition is often associated with reproductive activity in males after being handled for artificial insemination.

Wings:
Check all bones and joints while assessing muscle tone and extension. Swellings, abrasions or bruising are common on the carpus. In subcutaneous haemorrhages, green pigment discolouration will develop as the red blood cells (RBC) are destroyed.

Legs:
Check as for wings, also broken/missing nails or for swollen areas on toes or plantar foot. Toe swellings occur with dislocations, fractures and Bumblefoot.

Auscultation:
The use of a stethoscope is included in every examination. Determine heart rate, rhythm, and location to detect sounds including heart murmur, and assessing the respiratory system. Crane respiration, unlike smaller birds, produces distinct sounds normally louder on inspiration than expiration.

Temperature:
Unlike smaller birds, cranes appear to have constant body temperatures of 40.5° - 41.1° C. Although cranes are understood to have higher temperatures when not well; cloacal temperature monitoring is not normally part of the physical examinations.

8.3. Anaesthesia.
For more in-depth examinations such as radiographs; repair or surgery on wings, serious fractures of beaks, lacerations; endoscopic examinations for sexing or diagnosing respiratory and abdominal disorders; and ventriculotomy (foreign body removal), sedation is required. The best technique for sedation or surgical anaesthesia is gas, using isoflurane. Induction and recovery are rapid and smooth, a critical factor for both bird and handler. Halothane has been used, but has been associated with a greater incidence of respiratory and cardiac problems. Cranes are generally induced by mask and then intubated (2.5 – 6.0 uncuffed endotracheal tubes), although pre-anaesthetics such as midazolam or tiletamine-zolezapam can be used. Injectable anaesthetics such as tiletamine-zolezapam or ketamine combined with midazolam, diazepam, xylazine can be used, but cardiac and respiratory complication rates are greater and the crane must be carefully monitored and preferably contained in a small padded room during recovery. When using xylazine, yohimbine has been used on several occasions to speed recovery. Local anaesthesia is workable using small amounts of iodocaine (0.25 - 0.5 ml in adults) or another local anaesthetic.

8.4 Routine Treatments.
Annual health checks including physical examinations, a blood count and blood chemistry profile, a screening for likely or common infections, and a faecal parasite analysis, will help to pick up health problems early. Normal haematologic and serum chemistry values for captive cranes, WBC haematologic values for healthy cranes, Pediatric hematologic and serum values of crane chicks are presented in the Appendices.

Worming at the TWP depends on if the Brolgas have a problem with worm infestation. If the birds are normally free of worms, faecal tests are executed every 6 months. If there is a problem then faecal test are executed every 3 months, with a treatment followed by a faecal test. If negative, then another faecal test the following 2 weeks, then again if clear, a faecal check is done 3 months later. If at any one of those faecal test checks turns up positive, we treat and start over again (for treatments refer Appendices).
Note: TWP veterinarian does not consider vaccinations are necessary.

8.5 Known health problems. For medications and administrations refer Appendices.
- For all sick or injured birds, a heated environment 30 – 32° C (85 – 90° F) is best.
- Prior to assessment, it is often imperative to initiate some form of therapy. Of all

therapies, fluid therapy is the most significant except in the cases of severe anemia or hypoproteinemia.
- Stress can contribute to the outbreak and spread of bacterial diseases.
- Chicks are more susceptible than adults to *Aspergillus* and other pathogens (Scott, S. & Carpenter, J. 1996)

Problem: **Vitamin A Deficiency**
Cause: A lack of Vitamin A, occurs more in birds kept in artificial conditions and on artificial diet, disallowing the birds to pick up natural foods from the soil
Signs: Symptoms can appear as proliferative, plague-like lesions of the epithelium of the alimentary mucosa, ear canal, skin, eyelids, or conjunctiva.
Treatment: Vitamin A injection
Prevention: Green feed, vitamin supplement, or a well balanced diet. (Cutter pers. comm.).

Problem: **Fungal Pneumonia** (Cutter pers. comm.).
Cause: *Aspergillus fumigatus* (Cutter pers. comm.).
Signs: Respiratory problems. Using a stethoscope, sounds are unilateral and dull. Fails to respond to standard antibacterial therapy.
Treatment: Itraconazole, though treatment not generally successful (Cutter pers. comm.). Maintain in a non-stressful, warm environment (21 – 29° C or 70 – 85° F). Tracheal flushes and nebulising also recommended. In chicks, nebulising is best with Clotrimazole medication
Prevention: Sound hygiene (pers. obs.)

Problem: **Ectoparasites**
Cause: Outside contamination (pers. obs.)
Signs: Skin irritation, excessive preening, behavioural signs of stress and discomfort (Olsen *et al.* 1996). Visible parasites (Cutter pers. comm.).
Treatment: Fipronil, Derris Dust or Carbaryl (use with caution, ensure dust not breathed in by bird), Ivermectin (Cutter pers. comm.).
Prevention: Constant monitoring (pers. obs.)

Problem: **Helminth Parasites**, including Trematodes, Cestodes and Nematodes
Cause: Ingestion from eating contaminated foods (pers. obs.), and wild birds (Cutter pers. comm.).
Signs: Faecal tests (direct smear, floatation, and sedimentation). Large infestation — progressive anorexia, weight loss.
Treatment: Fenbenanzole, Ivermectin, Moxidectin or Praziqumtel (Cutter pers. comm.).
Prevention: Correct hygiene. (Pers. obs.)

Problem: **Avian Tuberculosis.**
Cause: *Mycobacterium avium* (Cutter pers. comm.).
Signs: Bone problems.
Clinical Signs: Anorexia, weight loss, abdominal organ enlargement, presence of masses on radiograph, and an elevated WBC count.
Diagnosis: Laproscopy, faecal culture, and liver biopsy.
Treatment: Difficult to treat and usually unsuccessful (Cutter pers. comm.).
Prevention: Quarantine, identification and removal of carriers, and good hygiene (Cutter pers. comm.).

Problem: **Coccidia.**
Cause: Protozoan.
Signs: Oocytes found in faecal test. Large infestation — dysentery, anorexia, depression and dehydration.
Treatment: Baycox and Trimethroprim/sulfa (Cutter pers. comm.).
Prevention: Hygiene and ongoing monitoring. (pers. obs.)

Problem: **Avian Pox infection.**
Cause: Avian Pox virus — through biting insects, mainly mosquitoes
Signs: Proliferative lesions (lumps) around bare-skin areas and feet
Treatment: Self-limiting
Prevention: Mosquito prevention (Cutter pers. comm.).

Problem: **Orthopedics *Bumblefoot***.
Cause: Foot wounds infected by *Staphylococcus aures* (Olsen *et al.* 1996) and other bacteria (Cutter pers. comm.).
Signs: Swelling at base of foot (Cutter pers. comm.).
Treatment: Surgical debridement, antibiotic therapy — Enrofloxacin, Clavulanic acid, Trimethroprim/sulfa, Lincmycin and antiflamitory eg, Meloxican (Cutter pers. comm.).
Prevention: Good hygiene and early treatment to wounds.

Problem: **Shock**
Cause: Trauma, injury and or disease
Signs: Dilated pupils, shock and/or abnormal, slow behaviour
Treatment: Lactated Ringer's solution or normal saline (Olsen *et al.* 1996)**,** cortiosteroids, oxygen (Cutter pers. comm.).

Problem: ***Salmonella* spp** (Cutter pers. comm.).
Cause: Carriers of *Salmonella* (Cutter pers. comm.).
Signs: Found in faeces (Cutter pers. comm.).
Treatment: Either of the following antibiotics – Trimethroprim-sulfa, Tetracycline or Ampicillin.
Prevention: Find and eradicate carriers.

Problem: ***Escherichia coli* in chicks.**
Signs: Over abundance of bacteria in gastrointestinal tract, diarrhoea or death.
Treatment: Antibiotics — Enrofloxacin, Clavulanic acid and Trimethroprim/sulfa amoxcillin (Cutter pers. comm.).
Prevention: Good Hygiene (Cutter pers. comm.).

Problem: **Thrush** (Cutter pers. comm.).
Cause: *Candida albicans* (Cutter pers. comm.).
Signs: Thick white raised plaque-like lesion covering the mucosa within the oral cavity and may extend into the esophagus, proventriculus and such. Lesions also noted for beak erosion.
Treatment: Nilstat (Nystatin), Amphotericin B (Cutter pers. comm.).
Prevention: Sound hygiene (pers. obs.)

Problem: **Osteomylitis**
Cause: Can be secondary to open fractures contaminated during or before surgical procedures or in Bumblefoot.
Signs: Limb problems, also shows up in radiographs.
Treatment: Antifungals or antibiotics, chosen by sensitivity and culture testing.

Problem: **Avian Botulism** (Cutter pers.comm.)
Cause: Bacteria - *Clostridium botulinium,* either by ingesting the toxin directly or eating invertebrates infected with the toxin. Bacteria are prevalent in the soil and require – warm temperatures, a protein source and an anaerobic environment so as to become alive and produce toxins.
Signs: Loss of wing and leg movement, or control of third eyelid, neck and other muscles.
Treatment: Mildly affected birds provided with shade, fresh water and cover from predators may help. Botulism antitoxin is accessible but requires specific handling and must be given early in the intoxication.

8.6 Quarantine requirements.
Ideally, quarantine facilities should be situated at least 1 km away from other crane pens. Any contaminated soil-areas should be left a year before re-use (Swengel, S. & Besser, R. 1996). For cranes entering or leaving, implement 30 – 60 day quarantine with disease screening (Olsen *et al.* 1996). Using an antibiotic (antibacterial or antiviral) footbath can reduce cross contamination of a number of pens. The footbath is a shallow container at least 40cm in diameter containing 6 – 10cm of fluid, located at gateway of each pen enclosure. (Swengel, S. & Carpenter, J. 1996)

9. Behaviour.

9.1 Habits.
Diurnal, spending a lot of time foraging.
Early sexing increases early reproduction through behavioural management. In unpaired flocks, once Brolgas are paired, they should be immediately removed to breeding pen, so as to stop aggression and possibly fatality to others. (Swengel, S. & Besser, R. 1996).

9.2 Reproductive Behaviour.
Well-synchronized, frequent Unison-calling, signal that a pair is properly bonded, although there has been exceptions to that rule (Veyret, L. 2005). Duetting appears to be important in the synchronization of the breeding cycle. (Swengel, S. 1996).

9.3 Behavioural Problems.
Brolgas in zoos, appear to breed successfully only when they are the only inhabitants of the exhibit/enclosure that they are in (exceptions are wild freeloading waterfowl) along with that of minimal stress. At TWP, the paired males' behaviour turns to attacking approaching humans, whilst the female is incubating their eggs. Exhibit displaying and breeding from the same Brolgas can be a problem, as the visitors can and usually often, draws the male away from nesting duties because of his territorial behaviour. The male does not usually eat during these confrontations. (Pers. Obs.). Mirande *et al* (1996) recommends that valuable breeding pairs be kept off exhibit, as public display pairs produce significantly fewer eggs.

9.4 Behavioural Enrichment.

At TWP

- Supplements of different species of live invertebrates to chase and catch.
- Include a slow flowing creek/swamp to forage and drink out of.
- Planting of Bulkuru Sedge or Tapioca, to forage through, and/or dig up and consume.

9.5 Introductions and Removals.

Brolgas have to go through a 6-week quarantine period, clear of parasites and disease before being introduced to another bird. Separation of Brolgas depends heavily on the reason for separation. Sometimes persistence in small doses pays off, but if there is too much aggression then there may be a need to keep birds separate permanently. Keeping the birds next to each other in separate pens for observation of behaviour and being a method of familiarization in between introductions and removals is certainly an option (pers. obs)

For introduction of a juvenile individual to a flock situation – the procedure at Serendip Sanctuary is to have the main group placed in the next enclosure to where the introduction is to take place. The intended individual is to be placed in the actual introduction enclosure and to be left next to the group for familiarity. The late evening and following day is the most critical period for close monitoring for any aggression between the individual and the main flock. One month later, if their behaviour indicates that the Brolgas want to coexist with each other, ie. Pacing fence and vocalising, the main group is let into the enclosure with the individual (introduction yard) and monitored. When pairs are formed out of this flock, the pair is immediately removed to another enclosure a distance away (on their own), to prevent any aggression between the pair and other individuals. (Smith pers. comm. 2007).

9.6 Interspecific Compatibility.

Brolgas will eat chicks of other avian species, but seem to leave the adult species alone. At TWP, various species of wild cockatoos, ducks, ibises and geese, coexist at different times of the year. Brolgas have been observed chasing away Black Necked Storks *(Ephippiorhyncus asiaticus australis)*. TWP have displayed Brolgas with mammals such as Water Buffalo, Banteng and Macropods. The only problems occurring between the mammals and Brolgas, is when the Brolgas food containers are placed under the mammals shelter or too close to the mammals' access raceway into and out of the exhibit. The Brolga's food dish must be placed away from active area of the mammals, other than this they seem to coexist fine. (Pers. obs.)

9.7 Intraspecific Compatibility.

Brolgas three months to three years of age should mingle with conspecifics, to develop normal social behaviour. If groups of juveniles are kept of the same gender, this can lead to aggression and unwanted homosexual pairs can happen. It is recommended to keep intended mates separate until they are at least 18 months of age. (Swengel, *et al* 1996).

10. Breeding.

Breeding occurs in Australia between September – October in the south and January to March in the north (Archibald, G. & Lewis, J. 1996).
The length of the "wet season" is what really dictates the extent of breeding period. At TWP, Brolgas lay eggs starting anywhere from September through to April, depending on the length of the wet season. Both sexes share the incubation with the female usually incubating at night. Upon changing over nesting duties the pair usually go through a ritualized Unison-calling. Care of precocial young is shared for up to a year, or until the onset of the next laying of eggs. If a clutch fails to hatch then they will immediately nest again, as would wild birds. (Pers. obs).
In the wild, the Brolga return seasonally to the same breeding ground. The nest can be a platform of dry grass or sedge of up to 1.5 m in diameter, in or beside swampy grasslands; or just are a few pieces of vegetation laid as a simple nest on dry ground (NRE 2003).

10.1 Mating System.

Brolgas appear to be monogamous. Once a male and female bond strongly, they generally bond for life, although some mate swapping has been reported. When a partner dies, the existing Brolga can partner up again (Gee, G. & Russman, S. 1996). The pairing of sub-adult (i.e., 3 years of age) may be not strong and usually short-lived. Pairs should not be regarded as bonded until observed as stable for several months and /or produced eggs. (Swengel *et al.*1996). Potential mates should be placed in adjacent pens, ideally with a common door, to allow herding of a bird from one pen to another. Pairing can be observed of interaction between fencing (food and water along dividing fenceline) and upon introduction, where intervention may be needed if not successful. (Pers. obs.). Birds being of around the same age are an advantage. An older bird with a young inexperienced bird can be a little intimidating. In pairs, the female usually initiates the calling and dancing. Pairing signs are observed when their behaviours and displays are synchronized. (Swengel *et al.*1996).

10.2 Initiations of egg laying.

Egg laying usually beginning at 3 – 6 years of age, or 2 – 3 years after pair bonding. Weather (excess rain) triggers the breeding season. (Archibald, G. & Lewis, J. 1996).

10.3 Techniques used for Control Breeding.

Techniques that include –

- Artificial Insemination (refer chapter 10.4)
- Separation of sexes.
- Removal of eggs and replacing with dummy or infertile egg.
- Double clutching **—** taking a clutch away to incubate, or cross-foster allowing adults to lay again to raise their next brood.
- Multiple clutching – taking eggs or clutches away as soon as they are laid, allowing for a number of clutches to be laid within a season.

10.4 Artificial Insemination *(AI).*

International Crane Foundation (ICF) has used Al successfully but has not recommended the procedure, unless the birds are injured or psychologically incapable of copulating naturally. AI is considered time consuming and very stressful to the bird, with the attendant possibly causing injury. (Luthin *et al.* 1986).

At Serendip, Victoria; and Cairns Tropical Zoo, Queensland; Al has also been used easily and successfully (Refer Figures 10.2 – 5) I have seen personally the procedure at Serendip, and once the birds are conditioned; there seems no evidence of undue stress or possible injury. (Pers. comm.).

The following AI procedure is performed at Serendip Sanctuary This has not only proved successful at Serendip a number of times, but also at Cairns Tropical Zoo, Queensland (pers. comm).

AI can be done by anyone that knows how to handle a Brolga safely and securely and is familiar to the birds involved. Two people are needed for the procedure.

Hooding the Brolga upon catching helps to calm the bird. In the photo below (Figure 10.1.) the male was just left standing for a while (unperturbed), while other work was done in the enclosure. Velcro was used to position the flap comfortably around neck.

Figure 10.1 ***Hooded male Brolga standing quietly and calmly.***
(Photo: author)

***Male**:*

After catching and facing the bird to you, the main handler bends over the body allowing the head and neck of Brolga through your legs, with the bird's shoulders resting on your legs (refer Figure 10.2).

Figure 10.2
Brolga hooded during procedure.

(Photo: author)

Placing a hand on each of the Brolga's legs, up in the groin area, gently but firmly massage up and down the inside top of legs with your thumbs (not letting off the pressure). While this is being applied, the male will start to voluntarily lean on you giving a soft sort of trilling sound. Upon this you apply more pressure with your thumb going up and down within the muscle area (refer Figure 10.3).

Figure 10.3.

Applying pressure with your thumb going up and down within the muscle area.
(Photo: author)

Figure 10. 4. ***Taken during a mock procedure.*** *(Photo: author).*

The second handler during this time has in one hand a sterilised medicine flask positioned under the cloaca, and the other hand gently rubbing the top of bird's back at the base of tail (refer Figure 10.4). What follows should be a squirt of a couple of milligrams of semen into the flask. This is drawn up into a syringe and would then be immediately administered to the female Brolga.

Female:
The main handler manages and massages the female legs; the same as the male, to where the female will lift up her tail to expose the cloaca (refer Figure 10.5).
The cloaca should have a moist glistening appearance when in season (and a dry appearance when not).
The second person is ready with the syringe and applies the semen to the cloaca. This is a non-invasive procedure and the seamen should be administered starting at the right-hand-side of the bottom lip and syringed slowly out along to the left of cloaca-lip (photo below), making extremely sure that you do not protrude syringe any further in past the cloaca-lip. After applying, give a gentle tickle under the belly to which she will instantly close the cloaca and withdraw the semen.

Cloaca lip.

Figure 10.5.
Picture taken of a female Brolga out of breeding season. *(Photo: author).*

AI is to be applied one week after the first clutch, and then done 3 times a week e.g. Monday, Wednesday and Friday, until the first egg of the second clutch is laid (which is usually 2 weeks later). AI is then administered every day until the second egg is laid.
It is recommended that your Brolgas be conditioned to the handling techniques prior to the onset of the breeding season.
At Cairns Tropical Zoo, staff there inseminates every second day following the first clutch being laid as apposed to 3 times a week (Croft pers. comm. 2007)

10.5 Occurrence of Hybrids.

Brolgas have similarity in looks to the only other native crane, called the Australian Sarus Crane. The Sarus Crane can be identified as having extra bare red around the upper neck, plus their legs are pink in colour instead of the grey-black legs of the Brolga. These two species have been known to roost and forage together, and have been documented to occasionally crossbreed and hybridise both in captivity and in the wild. Resulting offspring presently named *Sarolga*, are fertile and can produce young of their own. (ICF 1999).

10.6 Timing of Breeding.

Brolgas are seasonal layers, depending mainly on the rainy season. It was noted by the ICF, in USA (Luthin *et al.* 1986; Archibald. G & Lewis, J. 1996), that their Brolgas adjusted to Northern Hemisphere conditions and bred July to August. A sprinkler device that is turned on three times daily for half-an-hour is used to simulate rainy season conditions, thus stimulating the Brolgas to breed.

10.7 Age of First Breeding and Last Breeding.

Sexual maturity occurs at 2 – 3 years of age. Last breeding is not well documented, but in other species of cranes, the age of still being able to breed is at 75 years of age for a Siberian Crane at ICF. (Archibald. G. & Lewis, J. 1996),

10.8 Ability to Breed Every Year.

Availability of quality food and plentiful water enables the Brolgas to breed every year. At Serendip Sanctuary, if their pair does not seem interested in breeding, they build an island within the enclosure pond (refer Figure 10.6) to enable them more security, (Smith pers.comm. 2005.)

Figure 10.6.
Breeding pen at Serendip Sanctuary.
(Photo: author).

10.9 Ability to Breed More than Once Per Year.
Brolgas are capable of renesting and multiple clutches. Our female at TWP does not leave her eggs, so unless we physically remove them or they hatch, she stays incubating. Candling of eggs to see embryo formation is at 8 days, if infertile, they are taken away and the female renests 2 weeks later, with usually a 2 – 3 day interval between first and second egg laid. There have only been 2 eggs per clutch laid at TWP, with intervals between clutches ranging between 14 – 39 days, 14 – 21 days being the average (ARKS 2007).

10.10 Nesting Requirements.
An undisturbed area utilising dry twigs, leaves and long dead grass stems left laying around. Moist vegetation will mould more rapidly. (Scott *et al* 1996).

10.11 Breeding Diet (refer Appendices & Chapter 6.2)
20.5 – 22.0% (by weight) Protein, 2.45 – 3.0% Calcium, and 0.8 – 0.89% Phosphorus. Oyster shell *ad libitum* 1 – 2 months prior to egg laying. (Scott, S. & Carpenter, J. 1996).

10.12 Incubation Period.
28 – 36 days, mean – 30 days.
Aggression between siblings of different ages in the nest has been noted, so it has been recommended to replace the first egg upon being laid with a dummy egg until second egg is laid. Return the first egg back to nest on the same day as second egg is laid (taking away dummy egg). This ensures the same day hatching of the siblings and prevents rivalry, as there is virtually no size difference. (Smith, pers.comm. 2005).

10.13 Clutch Size.
Usually 2 eggs, 3 possible (Pizzey 1999; SPARKS 2007).
Recorded by Winton (2003) egg weights of two eggs were l7Og each (1 egg rotten and 1 egg fertile). Healesville Sanctuary recorded weight of two eggs (both infertile) being - 147g & 155g, (ARKS 2006).

10.14 Age of Fledging.
It takes around 100 days for a Brolga chick to learn to fly (ABC Online Home 2001). Fledging at 90 – 100 days and staying with their parents until the onset of the next breeding season or for another breeding season if the parents did not re-nest (Guesclin 2003).

10.15 Age of Removal from Parents.
At TWP, we have had our breeding pair distress and chase off their chick when it was just learning to fly, as they were preparing to lay and incubate another clutch of eggs within that same breeding season. Therefore the recommendation is – if the fledgling had hatched early in the breeding season and their was a chance that the parents would go down again, remove at roughly 100 days, otherwise, you have the option to leave with the parents and remove before next breeding season. Careful monitoring of parents and young interaction is still advised as there have been cases where parents were aggressive towards there young after fledgling age for unknown reasons (pers obs).

10.16 Growth and Development.

Crane chicks loose their egg tooth within the first couple of days (Meine, C. & Archibald, G. 1996a). Brolga chicks are precocial with feeding encouraged by parents. Chicks are first covered in grey natal down, are active by first or second day, and will swim following parents through the water (refer Figure 11.4). During the first few weeks of growth, the legs and neck grow proportionally faster than the wings (Archibald, G. & Lewis, J. 1996).

Moult: Crane's contour feathers appear during the first two months. The primaries first, then the secondaries, followed by the tail feathers. In the next 2 – 3 weeks, the body contour feathers emerge completing the juvenile plumage. The natal feathers cling to the emerging feathers for a few weeks before breaking off. (Refer Figures 10.7 – 9). This is again replaced by basic plumage before they are a year old. Subsequent moults are yearly throughout the bird's life. (Gee, G. & Russman, S. 1996).

Meine, C. & Archibald, G. (1996a) state that Cranes have ten functional primary feathers, where most species have a vestigial eleventh. Brolgas (gradually) moult annually, post-breeding season, and do not actually experience an extended flightless period.

Juveniles to adults: An abrupt change in a juvenile's voice from a high pitch "peep-like" call to a loud deeper call of an adult, coincides with the period during which the youngster leaves its parents of its own free will or is driven off. After leaving their parents the juvenile joins other non-breeders to form a flock and move to roosting or foraging sites, where they remain while adults breed elsewhere. At roughly 18months of age, a young crane exhibits adult-like social behaviour which includes the following signs – red-crown or a full-grown wattle, Unison-call, and dancing. Pairing can culminate from this period onwards. (Archibald, G. & Lewis, J. 1996).

Photos of Brolga chicks taken at and by Serendip Sanctuary.

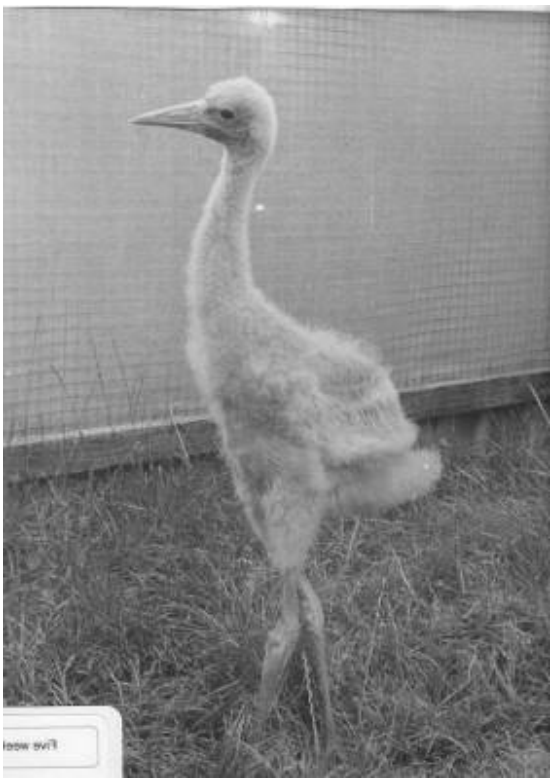

Figure 10.7. ***Five weeks old.***

Figure 10.8. ***Eight weeks old.***

Figure 10.9. ***Twelve weeks old.***

Hand reared chicks
Weights (Figure 10.8), as recorded by Winton (2003).
Chick # 1 – hatched with the weight of 121 grams loosing 8 grams (7%) the following day. On day 4, the chick's weight had increased and continued to do so. Day 14 the chick weighed 339 gram.

Chick # 3 – hatched weighing 122 grams and lost 88 grams (27%) the following day. This chick was uncoordinated and would often peck at the spoon and fall over backwards. It was assumed it was from an aggressive action of being pecked on the head from its mother on day one. Day 14 the chick weighed in at 161 grams. Both (sexed as females) have survived, and are doing well.

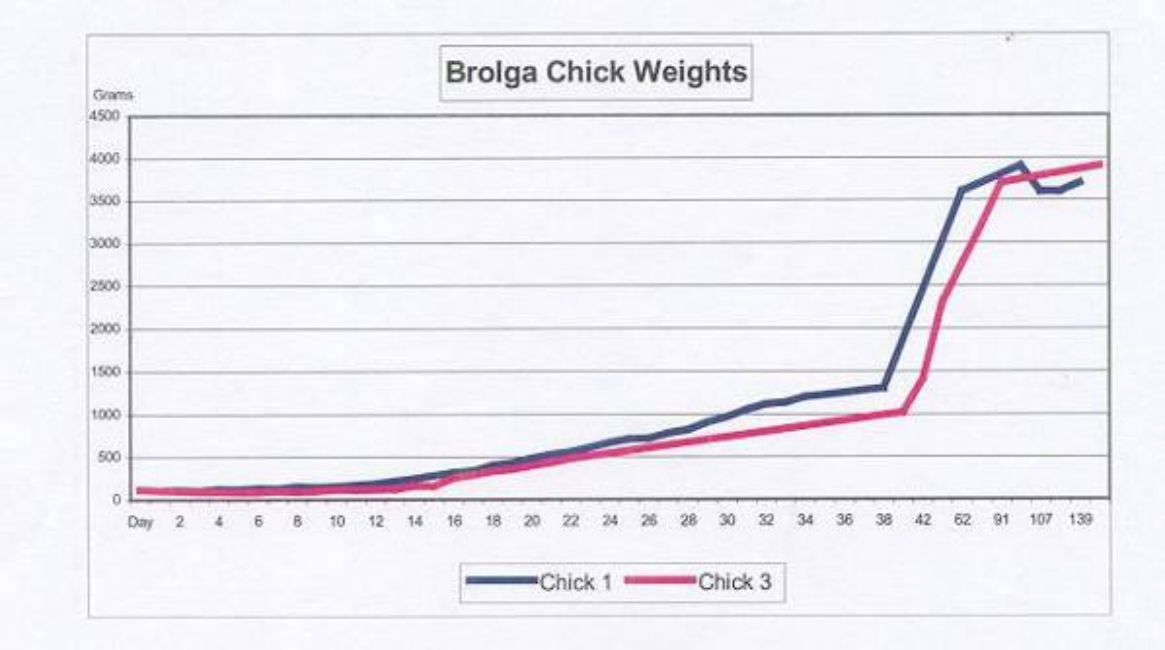

Figure 10.10. ***Hand reared Brolga chicks' growth weight*** *(Winton 2003).*

10.17 Potential Growth Problems. (Wellington *et al* 1996).
A weight loss of 10 – 15 % is normal in the first 3 – 5 days, losing more than 15% should be monitored closely and encouraged to eat. If weight loss continues or lethargy sets in, support is required by subcutaneous injection of fluids or by gavage feeding.
Excessive weight gains are quite common in hand rearing cranes during the most rapid growth period of approximately 10 – 14 days. Continuous weight gains exceeding 10 – 15% per day can be troublesome (refer Appendix on Food Rationing for Hand reared Chicks). Even chicks under 10 days, or whose weight gains are less than 10%, occasionally suffer leg deformities; therefore, daily monitoring is paramount. Unlike hand reared chicks, parent raised chicks rarely suffer from leg and wing deformities. Exercise is one of the preventing factors, so it is advisable that Brolga chicks are encouraged.

Chick diets should take note to use vegetable protein only. Diets containing too high content of sulphur amino acids develop more wing and leg abnormalities than diet fed with low levels of sulphur amino acids. A diet of live insects fed to chicks, is nutritionally inadequate, and provides excessive levels of methionine and cystine which has been noted to be correlated with bone growth problems. Crumble feed needs to be incorporated as soon as possible to prevent this problem.

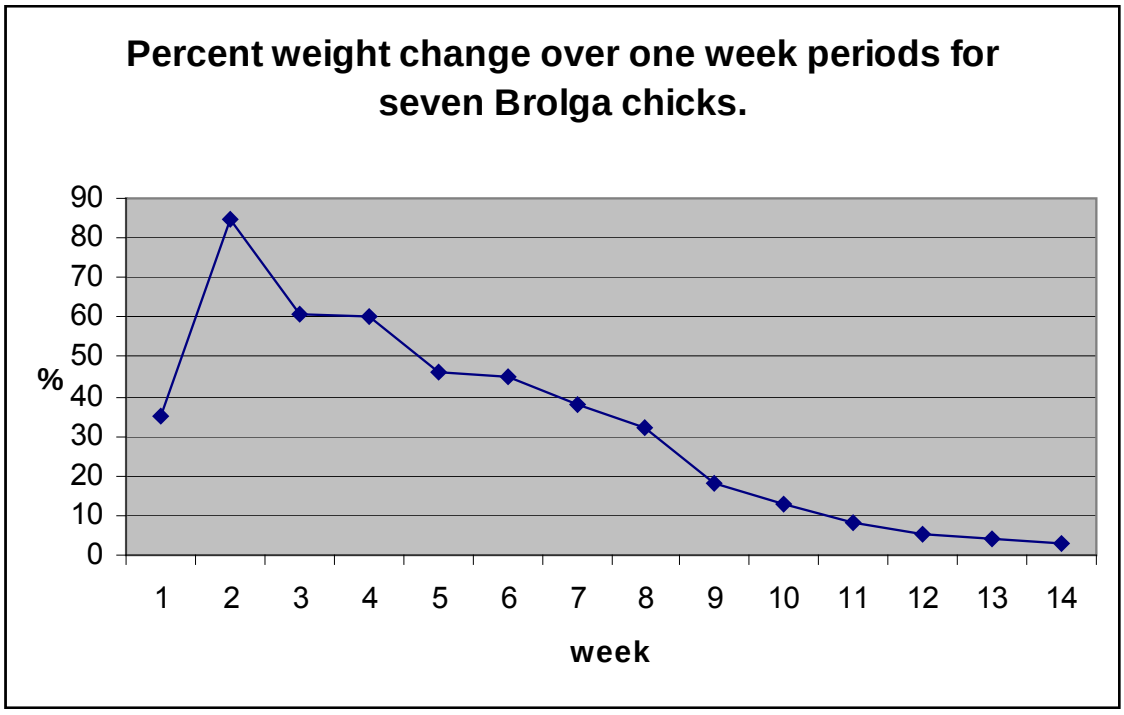

Figure 10.11. ***Example of Brolga chicks' weight changes taken from week one to fourteen****. (Wellington et al 1996).*

11. Artificial Incubation and Rearing of Brolgas.

11.1 Incubator Type (Gabel, R. & Mahan, T. 1996).
Consistent and reliable incubator operation requires a system that includes a duel temperature control consisting of primary and secondary thermostats. Use egg trays of an open mesh, rigid construction so as to allow air flow around the eggs. Developing embryos necessitate a constant flow of oxygenated air for respiration and removal of carbon dioxide. An alarm that notifies all personnel of extremes and power outrages is an important component of the artificial incubator.

11.2 Incubation Temperature and Humidity (Gabel, R. & Mahan, T. 1996).
Proper dry bulb temperature is 37.6° C (99.5 – 99.75°F) and Wet-bulb temperature is 30.0° C (85 – 87° F). Incubator conditions should be closely monitored and recorded at least 2 – 3 times daily. This enables you to observe any trends, such as decreases or increases in humidity and temperatures allowing early detection and correction. (Figure 11.1).

Humidity is controlled by the addition of water through evaporation from a reservoir, by misting, and regulating airflow through the incubator or through the incubator room from outside.

Temperature variations vary within, especially among egg trays at different levels.

Temperature levels can be measured to within 0.1° C (0.2° F) accuracy, by moving thermometers to different areas of incubator. A stable temperature is also needed in the incubator room itself to ensure stable temperatures in incubator. Sharp temperature increases can be almost immediately lethal. Temperature increases of 1 – 1.50 C (2 – 3° F) may not be instantaneously fatal, but the embryo is inclined to die after 4 – 5 days.

Figure 11.1. ***Relative Humidity Calculations.*** *(Gabel, R. & Mahan, T. 1996).*

		Dry-Bulb Temperature												
	°C	28	29	30	31	32	33	34	36	37	38	39	40	41
Wet-Bulb Temperature °C	°F	82	84	86	88	90	92	94	96	98	100	102	104	106
28	82	100	92	84	77	71	65	60	55	50	46	42	39	36
29	84		100	92	85	78	72	66	61	55	51	47	43	40
30	86			100	92	85	78	72	66	61	56	52	48	44
31	88				100	92	85	79	73	67	62	57	53	49
32	90					100	92	85	79	73	68	62	58	53
33	92						100	93	86	79	73	68	63	58
34	94							100	93	86	80	74	69	64
36	96								100	93	86	80	74	69
37	98									100	93	86	80	75
38	100										100	93	87	81
39	102											100	93	87
40	104												100	93
41	106													100

11.3 Desired % Weight Loss. (Gabel, R. & Mahan, T. 1996).
Humidity conditions inside the incubator controls the egg weight loss. Optimally, eggs lose 15% (range, 13 – 17%) of their fresh weight range over incubation period, whereas eggs that lose considerably more or less than this amount often hatch, either with assistance or independently. Eggs to be weighted twice weekly to assess weight loss.

Loss of weight can be the result of conditions that include low temperature, high humidity, blocked pores in the shell, or thicker than normal shell. Weight loss can be corrected by decreasing humidity. Extremely thin-shelled eggs can be dipped in sterile water at intervals of a few hours, or daily as needed, to maintain normal weight loss. The dip should be cooler than the egg at ca 10°C (50° F) so the egg contents constrict and draw water into the egg. (For more in-depth details read Incubation and Hatching – Gabel, R. & Mahan, T. 1996).

Increase of weight can be the result of conditions that include high temperature, low humidity, or an abnormally thin or porous shell. Weight increase can be corrected by increasing humidity.

11.4 Hatching Temperature and Humidity.
Auckland Zoo increased their humidity to around 75%, 2 days before hatching. The chick was heard chirping and moving within. (Winton 2003).

Gabel, R. & Mahan, T. (1996) notes that during hatching, egg shell membranes may become dry and adhere to the chick, therefore, highest humidity possible to be maintained. Generally after an egg pips, it is moved to a hatcher that should produce a wet-bulb temperature of 32° C (90 ° F) or higher. A hatcher is a modified incubator maintained at a higher humidity to facilitate hatching and to be maintained at 37.2° C (98.5 – 99.0° F).

11.5 Normal Pip to Hatch Interval.

Noted by Winton (2003), observations of chick externally pipped one morning, and roughly 24 hrs later hatched out.

11.6 Brooder Types/Design (Swengel, S. & Besser, R. 1996).

Example Figure11.2.

- To avoid the cold floor, floor brooders should contain insulated substrates, and portable brooder boxes should be elevated.
- Electrical outlets placed out of reach of chicks.
- At least O.5 – 1m^2
- Fine mesh screen or plexiglass to enable chicks to see each other but prevent fights and injury.
- Insides compartment at least 35cm high for small chicks and 50cm for taller ones.
- Avoid rough or abrasive surfaces, minimizing chick injuries.
- For incompatible chicks, provide opaque dividers.
- Install a mirror to promote proper sexual imprinting of isolated chicks.
- Provide a 15cm high rim chick guard in front of box, to prevent chick falling out when box is open.
- Top and/or sides of box to be well ventilated, to prevent over-heating, promote air circulation, and to quicken the drying of wet surfaces.
- A thermometer mounted on one side of each box.
- Rubber-backed non-toxic carpets cut to size, to cover the floor.

Figure 11.2. ***Brooder box and a hatchling chick within.***
(Swengel, S. & Besser, R. 1996).

11.7 Brooder Temperatures (Gabel, R. & Mahan, T. 1996).

- First week maintain ambient temperatures 35 – 37° C (95 – 98° F).
- Monitor not only the temperature but the chicks condition as well.
- For healthy chicks temperatures may be decreased by 3° C (5°F) each week, but should not drop below 21.5°C (70°F) until the chicks are at least 3 weeks old.

11.8 Diet and Feeding Routine (Wellington *et al* 1996). Diet examples refer Appendices.

- Food to be recently milled (within 3 months), intact, dry and free of contaminants including vermin and mould.
- Recommended diet is to be no more than 24% protein and 0.73% sulphur amino acids for slowing growth and thereby reducing risk of abnormal leg development
- In the wild Brolga feed their young by offering food in their bill tips. Therefore food and water should be offered by similar methods. Preference has been seen to be that chicks respond to long thin red shapes, so implements such as red plastic spoons, red-tipped dowels or puppets with red-taped bills can be used. Taxidermic heads or syringes also can be used.
- Chicks to be introduced to feeding within the first day of hatching.
- Offer food to chicks when they are alert and active, as they may be exhausted after hatching.
- Crumbles fed instead of pellets (because of pellet size) from hatching to 2 – 3 weeks' age. As the chick begins eating on its own, pellets can be slowly introduced until the chicks are eating pellets on their own at the age of 3 – 4 weeks. Parent-raised chicks can be given both crumble and pellets from day 1.
- Fresh water is to be always available and replaced daily or when contaminated.
- Chicks have to be taught to drink. Dehydration is a notable health concern when handraising; and careful monitoring in their first week for <u>both</u> handraised and parent raised chicks is essential.
- Non-spill bowls provided that ensures depth enough to allow chick to drink yet still allows the chick to scramble out should it fall over.
- Upon fledging (when primaries have all grown), protein requirement can be changed to 15 – 19%.

11.9 Specific requirements.

- Each chick is to have all relevant information kept on record including – parental information, ID numbers, hatching history and medical information. (Wellington *et al* 1996).
- Use a separate hatcher for each chick, or if there are two or more they can be possibly placed in the same hatcher by separating them within the machine. Dividers made from vinyl-coated wire are to be non-abrasive to chicks, allow air to circulate and are to be high enough to prevent chicks mixing together or inflicting injury. (Gabel, R. and Mahan, T. 1996).
- Indoor-outdoor removable carpeting lining the bottom of each compartment provides a good substrate and prevents the chick from catching its toes in the wire floor. (Gabel, R. and Mahan, T. 1996).
- Chick should be removed from hatcher to brooder box once it has dried or its properly heated pen (4 – 24hours post hatching). Chicks examined and weighed, umbilicus viewed and swabbed/sprayed with Betadine (a provine iodine solution). (Wellington *et al* 1996).

- Handling of chicks (Figure 11.3). Crane chicks are very fragile, and improper handling can lead to broken or damaged bones, lacerations and ruptured yolk sac, all of which can be fatal. (Wellington *et al* 1996).

Figure 11.3. *(Wellington et al 1996).*
Scoop method of newly hatched chicks

11.10 Pinioning Requirements. (ARAZPA 2006).
ARAZPA guidelines state that pinioning of Brolgas not to be encouraged and that the ARAZPA institutions are evolving to the deletion of this practise. **Feather clipping or construction of covered facilities, is a desired alternative to pinioning for flight restraint of the Brolga.**

Feather clipping involves the cutting of primary feathers of one wing as a temporary restraint, and can be initiated after each moult. Moulting occurs yearly in adults and more often in juveniles. Each feather-clipping event is to be documented to enable staff to know when the Brolgas has been clipped and when a re-clip is due. Close monitoring of feather growth is advised prior to when re-clipping is due. When feather clipping, the first two or three primary feathers may be left for aesthetic reasons - if preferred. Care must be taken to leave blood feathers intact on the wing until fully formed.

Pinioning is a surgical procedure that involves amputation of the second and third metacarpal bones of a wingtip rendering the Brolga permanently incapable of flight.

11.11 Identification Methods.

Coloured plastic removable leg bands are usually recommended.

At Serendip Sanctuary a coloured plastic leg band is used for temporary identification of Brolga chick and changed to a metal band at 6 – 7 mths old (Helman pers.comm.).

11.12 Hygiene.

- Regular vet examinations especially during the first critical week.
- Have a replacement of brooder floor carpet handy, so the soiled carpet can be replaced during daily cleaning. Wet carpet, after cleaning, can be dried in the sun to allow help destroy the bacteria and fungi.
- Fresh food and water to be provided daily or whenever contaminated.

11.13 Behavioural Considerations.

(Wellington *et al* 1996 – except where stated otherwise).

- When chicks are cold they shiver and call
- Over heated chicks pant and/or hold their wings away from body.
- Chicks should have access to cooler areas throughout day, but need to be coaxed back or returned to warmer area when chilled and for over-night accommodation.
- Brolgas like wading, so a shallow, non-slip flat dish of water should be made available.
- Have the chick go for a swim (if it likes it), which is also excellent for exercise. Refer Figure 11.4.
- In the wild, parents teach the chick to eat by offering food on the tip of their bill. When hand-rearing chicks, similar methods must be applied Refer Figure 11.5a & b. Crane chicks' best respond to thin, long, red shapes. Red plastic spoons, red tape attached to the bill of a puppet, red-tipped dowels, taxidermic head, or feeding syringes may all be used in training the chick to drink and eat. It is best to prevent a Brolga chick to imprint to a human, as this would cause social and breeding problems in the future. For Imprinting prevention techniques, refer to "Cranes: Their Biology, Husbandry, and Conservation", Ellis *et al.* eds, 1996.
- Chicks at two months or more of age like to spend time practicing flying, and an unobstructed area of at least 15m long is recommended for this exercise (Scott *et al* 1996).

Figure 11.4 *(photo: Peter Merritt).*

One-week-old Brolga chick
(following parents)

Figures: 11.5a (top) and **11.5b** (RHS).
Puppet feeding Brolga chick at Auckland Zoo - to avoid imprinting.
(Winton, C. 2003).

11.14 Use of Foster Species (Wellington *et al* 1996.
There are different adoption methods that have proven successful apart from the natural way. If fostering chicks, only the ones that have had previous exposure to either live cranes or taxidermic brooder models and heads should be used. It does not matter how attentive the parent, if the chick is unresponsive or afraid of live cranes the fostering would be likely to fail.

Fostering of eggs and chicks allows you to manage breeding programs of endangered species more successful, such as one of the following —

- Cross-fostering (the rearing of a chick by parents of another species). Results in near-normal behaviour. However, the chick may become sexually imprinted on the foster species, causing difficulty in breeding with its own species. This may be corrected by removing the chick just before fledging, socializing it in a juvenile cohort of conspecifics, and then force pairing at 2 years of age.
- Fostering a conspecific, whether it is egg/s or chick/s.

- Replacing a chick with another can be done if the replacement chick is roughly the same weight, age, activity level and appearance. This technique would be done if the chick taken away was sick or dying, thus utilizing the parent rearing capabilities of a valuable pair while allowing more intensive care to the sick chick.
- Replacing infertile eggs with fertile eggs from another species enable the proven species to lay another clutch before the season is out (double clutching).

11.15 Rehabilitation procedures.

At Auckland Zoo, New Zealand (Winton 2003).

- 3 days old, leave the brooder to an environmentally controlled indoor pen.
- 14 days old, their diet changed from crumbles to pellets.
- 21 days old, left outside during the day, brought in at night.
- 45 – 72 days old, left outside day and night.

At Serendip Sanctuary, Victoria (Helman pers. comm.).

- After 24 hrs in brooder, the chick is placed in a totally enclosed room with a heater close by within.
- 1 day old to 4 – 5 mths old, chick to be placed in larger areas as they progressively grow, with the heater being raised higher in height.
- 4 – 5 mths old, place permanently outside in a fully open enclosure, but still allows access to warmth from a heater until no longer needed.

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Distribution of Brolgas in Australia Map (Figure 3.3) Accessed online:
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Brolga pair on nest (Figure 1.4). Accessed online:
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One-week-old Brolga chick swimming (Figure 11.4): ABC Online Home (2001).
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Personal Comments

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15. Glossary

Anaerobic – no oxygen.

Atrophy – wasting away of an organ or part of body.

Auscultation – listening to various internal sounds made by the body, usually with the aid of a stethoscope.

Carpus – wrist area.

Concave – curving inwards.

Convexly – curving outwards.

Diurnal – active during day.

Emaciation – to become abnormally thin.

Ephemeral – transitory; short-lived.

Fledging – able to fly.

Monogamous – having only one partner.

Musculature – the arrangement of muscles in an organ or a part of body.

Nares – nostrils.

Omnivorous – eating any type of food category.

Patagium – membrane of skin attaching the wing to the shoulder.

Pectoral Muscle – either of two large muscles of the chest, that assists with the movement of the shoulder and wing.

Plantar – sole of foot.

Precocial – upon hatching chicks are covered in down and are capable of leaving the nest within a couple of days.

Transponder – sterile electronic coded microchip injected via syringe under the skin, where the code # can be read by a hand-held electronic scanner.

Vagrant – bird of passage, drifter, itinerant, have no fixed address, wanderer.

16. Appendices

Feed Formulas [1] (Scott, S. & Carpenter, J. 1996).
Chicks (starter), Non-breeding and Breeding Adults.

	Starter	**Maintenance**	**Breeder**
Ground yellow corn	24.4%	38.8%	41.2%
Soybean Meal (44% Protein)	-	13.5%	15.0%
Soybean Meal (49% Protein)	31.5%	-	-
Wheat Middlings	12.0%	12.6%	10.0%
Fish Meal (60% Protein)	-	4.0%	5.0%
Ground Oats	11.5%	15.7%	7.5%
Meat and Bone Meal	-	5.2%	4.0%
Alfalfa Meal (70% Protein)	5.0%	5.2%	5.0%
Corn Distillers Solubles	3.0%	-	1.5%
Brewers Dried Yeast	2.5%	-	2.0%
Corn Oil	3.3%	-	-
Dried Whey	1.2%	3.2%	3.5%
Limestone	1.5%	0.5%	3.5%
Dicalcium Phosphate	3.0%	0.5%	1.0%
Iodised Salt	0.25%	0.5%	0.5%
Vitamin/mineral premix *	0.5%	0.5%	0.5%
Composition of Formulated Diet			
Percent Protein	23.8%	19.4%	20.5%
Metabolizable Energy, kcal/kg	2689	2530	2533
Percent Calcium	1.4%	1.0%	2.45%
Percent Phosphorus	0.90%	0.86%	0.89%
Percent Methionine and Cystine	0.7%	-	-
Percent Lysine	1.3%	-	-

***Vitamin/mineral Premix for Feed Formulas** [1] (Scott, S. & Carpenter, J. 1996).

	Starter	**Breeder and Maintenance**
Chlorine Chloride 60%	40%	40%
DL-Methionine	13%	13%
Vitamin E 227	7%	
Niacin 99.5%	7%	7%
Calcium Pantothenate 160	1.1%	1.1%
Vitamin B12 300	0.5%	0.5%
Riboflavin 100	0.5%	0.5%
Vitamin A 650	0.25%	0.25%
Vitamin D3 400	0.1%	0.1%
Selenium 0.8%	27%	27%
Zinc oxide 72%	3%	3%
Manganese Oxide 60	4.5%	4.5%
E.D.D.I 79%	0.001%	0.001%
Biotin 1%	0.4%	
Folic Acid 10%	0.1%	

[1] *ICF custom premix. Commercial premixes for turkeys or chickens are also used with manufacture's inclusion rates followed.*

Auckland Zoo Hand-rearing and Adult Diets.

Chick diet, first two weeks

2 T Turkey starter crumble
½ t Wombaroo Insectivore mix
½ shelled boiled egg, white and yolk
I t grated cheese
Sliced finely silverbeet

Live food
Mealworms, galleria, small locust crushed and small earthworms
First two days, small or white mealworms

Feed above three times a day
Live food ab lib

Chick diet, after 14 days

½ Insect container Turkey 'grower' pellets *(Estimate weight of pellets = 220-225 grams)*
100 grams Wombaroo Insectivore mix
I boiled egg chopped finely
2 – 3 t grated cheese
Silverbeet, sliced finely

Feed three times a day
Live food five times a day

Adult Brolga diet

Feed I insect container full per bird, twice daily.

Base mix:
60 grams wheat
60 grams maize
60 grams oats
40 grams sunflower seeds
40 grams peanuts (in shell)
60 grams peanuts (husked)
60 grams Peck-n-lay poultry pellets
60 grams cat biscuits (science diet)
3 – 4 slices wholemeal bread cut into small squares
I apple, diced
2 raw sprats, chopped into chunks
Raw meat, chopped into chunks
2 boiled eggs, whole or cut into quarters

Extras for variety
Boiled root vegetables (potato, kumera)
Husked nuts
Live invertebrates (mealworms, locusts)
Fruit
Freshly killed mice
Silverbeet
Cheese, diced into small squares

Cairns Tropical Zoo Brolga Diet

For one Adult specimen

- 1 large carrot or one small gold kumera sweet potato, grated;
- 1 apple, grated or chopped;
- 1 cob fresh corn, husked and kernels removed from cob;
- 1 cup greens, cut into ½ cm cubes;
- 1 handful Lucerne chaff;
- 1 boiled egg, chopped;
- 15g Wombaroo Insectivore Rearing Mix;
- ¼ tsp Balanced Cal;
- ½ cup turkey starter mix;
- 2 cup mixed grain;
- ¼ cup meat mix;
- 50g whitebait

Greens may include Broccoli, Silverbeet, Celery, Snow Peas, Snow Pea Sprouts, Bean Sprouts, frozen Peas, Bok Choy, Parsley or Brussell Sprouts
Mix all ingredients thoroughly and divide into two portions

Meat mix contains

- 1 kg Kangaroo mince;
- 2 boiled eggs, chopped;
- 1 cup brown rice, boiled;
- 50g Madeira cake, grated;
- 1 medium carrot, grated finely;
- 1 cup dog kibble, soaked and mashed;
- 2 tsp Balanced Cal;
- 60g Wombaroo Insectivore Rearing Mix;
- 1 cup Bran;
- 3 cups egg and biscuit;
- 1 cup grated tasty cheese

Mix all ingredients thoroughly to moist, crumbly consistency

Supplements and additions to Brolga diet

- Sunday - Mealworms;
- Monday - ¼ tsp Soluvet + 1 Day old chick;
- Tuesday - Nil;
- Wednesday - Mealworms;
- Thursday - ¼ tsp Soluvet + 1 Day old chick;
- Friday - Nil;
- Saturday - Probotic + 1 mouse

This diet is supported with natural foraging by the birds. All are housed in large open enclosures containing either an extensive watercourse and/or areas to rummage.

Juvenile diet is supplemented with additional live foods such as earthworms, cockroaches, crickets and any other bugs, grubs or termites collected

opportunistically. Carrot is grated finely, and greens chopped finely for juvenile Brolgas.

Portions are fed more frequently - usually four times daily.

David Fleay Wildlife Park Diet

Food Item Amount per Adult:

Meat Mix – 200g
Egg Custard – 6 2cm squared pieces
White Bait – 7 if available
Greens Mix – 100g
Meal Worms – 30g
Seed – 40g

Total: 400g Approx.

All food is to be mixed together, white bait is to be thawed of a morning and added to the mix for morning feeding. The mix is then dusted with vitamin e and balanced calcium.

Feeding Regime
Feeding is done once daily, although in breeding season, if young are reared, feeding is to be done twice a day

Healesville Sanctuary Brolga Diet

Natural diet: Tubers, seeds, frogs, small fish, and molluscs.

Ad lib: Water.
50% Layer pellets and 50% Pigeon seed mix.

Daily diet (per animal):

Breeding Season
50g Sprouted seed
1 Pilchards (85g) cut in 1cm strips.
50g Trout pellets.
1 Hard boiled egg
25g Mealworms
100g Ecopet (in 2cm cubes).
6 Peanuts in shell.
1 Mouse – **weekly**.

Non-Breeding Season
100g Ecopet
1 Hard boiled egg
6 Peanuts in shell.
1 Mouse – **weekly**.

Supplements: none.

Serendip Sanctuary Diets (Helman pers. comm.)

For 2 adult Brolgas per day:
9-litre bucket ½ full of Wheat and Layer Pellets.
Cricket sized ball size of mash mix. *****

Brolga chicks kept with parents:
Mealworms thrown in with food.

For hand reared Brolga chicks between 1 —3 or 4 mths old.
Wheat and Mash mix. *****

For hand reared Brolga chicks 2 days to 1 mth old.
Small amount of Mealworms twice a day to increase activity, also to get them pecking and eating. Turkey crumbles ad libitum.

**** Mash mix:***
1 kg Turkey Crumble
1 kg Mince
500 grams Parrot mix
500 grams Meatmeal (blood and bone)
All above mixed with water to a soup consistency then add 500 grams Lucerne Chaff, and mix.

Food Rationing for Hand-reared Chicks.

(Wellington, M. *et al.* 1996).

For over weight Brolga chicks, a food management program is to be used along with exercise.

Some birds gain weight excessively even with regular exercise. In such cases, the following food withholding techniques can be used to limit weight gain.

1. Remove food only at night. Usually chicks do not consume much food at night so removal limits only the amount of food available to them in the early morning hours when cranes normally feed.
2. Provide food four times a day for 15 – 60 minute intervals, then leave it in the pen overnight. This is the preferred method for most chicks, because the chick still has access to enough food to grow properly, to stem its hunger, and to prevent it from developing vices such as eating bedding or faeces.
3. If the chick is eating pelleted food, provide either crumbles only or a mixture of crumbles and pellets so the chick has to expend more time and energy to eat the same amount of food.
4. Remove food at night and provide it three or four times a day for an hour at a time. On this regime, chicks may become frantic or consume bedding in which case using one of the other options must be implemented.

Regardless of which technique is used, food-rationing ends as soon as the chick's weight gain slows for several days or abnormal behaviour develops. Weight gain should be monitored daily, however, until the period of rapid growth is over (ca 4° days of age).

In a group-rearing situation, if even one chick is showing excessive weight gain, the entire pen should be rationed or the bird of concern can be temporarily removed to limit its feeding opportunities. However, carefully monitor the social interactions of the chicks because deprivation of food can result in increased aggression.

Microchip equipment including scanner

Trovan
Central Animal Records
22 Fireways Boulevard
Keysborough
Victoria, 3173.
Ph: 03 97063100.

Sexing using feathers — DNA

DNA Solutions.
23 Wadhurst Drive,
Boronia,
Victoria 3155.
Toll free: 1800 000 362
Fax: 03 98001792
Send 2 freshly pulled secondary feathers to the above address. Results should be obtained within 3 – 5 working days.

Genetic Science Services.
PO Box 115
Fitzroy VIC 3065
Phone – (03) 8412 7077
E-mail – birds@genetype.com.au

Medications commonly used for cranes Olson, G. *et al.* 1996

Drug	Indications	Route of Administration[a]	Dosage	Treatment Schedule
Antibiotics				
Amikacin	Broad-spectrum, less nephrotoxic than gentamicin; often used in conjunction with piperacillin sodium; ensure adequate hydration	IM	10 mg/kg	2/day
Ampicillin	Broad-spectrum antibacterial drug for gram-negative and gram-positive bacteria, useful for several pathogenic enteric organisms	IM	100 mg/kg	2/day
Carbenicillin	Good only for 3 days after mixing; synergistic with aminoglycosides	IM,IV	100 mg/kg	2-3/day
Cefotaxime sodium	Broad-spectrum; sometimes used in conjunction with aminoglycosides	IM	50-100 mg/kg	3/day
Cephalexin	Broad-spectrum; effective against most gram-positive organisms and some gram-negative organisms, including various enteric organisms	oral	35-50 mg/kg	4/day
Cephalothin	Same as cephalexin	IM	100 mg/kg	4/day
Chloramphenicol	Broad-spectrum activity against both gram-positive and gram-negative bacteria, rickettsia, and chlamydia	SQ	100 mg/kg	3/day
Enrofloxacin	Broad-spectrum antibiotic	IM, oral	8-15 mg/kg	2/day
Gentamicin	Broad-spectrum; used therapeutically to treat bacterial infections in cranes and prophylactically against bacterial infections in newly hatched chicks; ensure adequate hydration	IM	5 mg/kg	2-3/day (1 in newly hatched chicks)
Piperacillin sodium	Used with amikacin	IM	100 mg/kg	2/day
Trimethoprim sulfa	Respiratory and enteric infections, also used as anticoccidial; regurgitation common orally	oral IM	16-24 mg/kg[b] 8 mg/kg[c]	2-3/day 2/day
Tylosin	Effective against gram-positive and some gram-negative bacteria mycoplasma, and chlamydia; useful for respiratory infections	SQ	15 mg/kg	3/day
Corticosteroids				
Dexamethasone	Shock, trauma, endotoxemia capture myopathy, etc.	IM, IV, SQ	2-8 mg/kg (reduce doses for long-term therapy)	1-2/day
Prednisolone	Shock, trauma, chronic lameness	IM, IV	2 mg/kg	1-2/day
Prednisolone sodium succinate	Shock	IM, IV	10-20 mg/kg	as needed

Medications commonly used for cranes cont. Olson, G. *et al.* 1996

Drug	Indications	Route of Administration[2]	Dosage	Treatment Schedule
Vitamins				
Vitamin A (Aquasol A) 100,000 units/mL	Hypovitaminosis A, sinusitis, ophthalmic diseases, avian pox	IM	1.0 mL/kg	twice weekly
Vitamins A, D_3, E (Injacom-100) 100,000 units A, 100,000 units D_3/mL	Hypovitaminosis A, ophthalmic diseases, fractures, egg binding, soft shelled eggs, and respiratory infections (especially sinusitis)	IM	1.0 mL/kg	once weekly
Vitamin B complex	CNS signs, trauma, muscular weakness, anemia, debilitation, and anorexia	IM	1-3 mg/kg	1/day
Vitamin E and selenium (50 mg Vitamin E, 1 mg Se/mL)	Muscular weakness, capture myopathy, leg dysfunctions, prior to or at times of capture or stressful event	IM	0.05-0.10 mg/kg	once every 14 days
Injectable Tranquilizers and Anesthetics				
Ketamine HCl	Disassociative anesthetic	IM	10-22 mg/kg	once, lasts 10-30 min
Xylazine	Tranquilizer, given with ketamine	IM	1.0-2.2 mg/kg	once
Diazepam	Tranquilizer, use alone or with ketamine	IM	0.5-1.0 mg/kg	once, lasts 2-6 hr
Midazolam	Tranquilizer	IM	15 mg/kg	once
Yohimbine	To reverse xylazine	IV	0.1 mg/kg	repeat in 10 min as needed
Tolazoline	To reverse xylazine	IV	15 mg/kg	once
Flumazenil	To reverse midazolam	IM	0.1 mg/kg	once
Other Medications				
Doxapram	Respiratory stimulant	IM, IV	5-10 mg/kg	1/day
Iron dextran	Following hemorrhage or for iron deficiency anemia	IM	10 mg/kg	once every 7-10 days if hematocrit is still low
Phenylbutazone	Non-steroid anti-inflammatory, and anti-pyretic	Oral	3.5-7 mg/kg	2-3 times per day
Methocarbamol	Muscle relaxant	Oral IV	50 mg/kg 32.5 mg/kg	once

[1] *From Custer et al. 1979; Bush et al. 1979, 1981a, 1981b; Lock et al. 1982; Carpenter 1986, 1993; Klein et al. 1994; Olsen and Carpenter 1996.*

[2] *IM = intramuscular; SQ = subcutaneous; IV = intravenous.*

[3] *Dose based on trimethoprim suspension (8 mg trimethoprim and 40 mg sulfamethoazole/mL).*

[4] *Dose based on trimethoprim 24% for injection (4 mg trimethoprim and 200 mg sulfadiazine/mL).*

Medications used for nebulization of cranes Olson, G. *et al.* 1996

Medicine	Indications	Dosage
Enrofloxacin	Antibacterial	22 mg in 10 mL saline
Gentamicin	Antibacterial	50 mg in 10-30 mL saline or distilled water
Amikacin	Antibacterial	50 mg in 10 mL saline
Tylosin	Antibacterial	100 mg in 10 mL saline
Erythromycin	Antibacterial	200 mg in 10 mL saline
Polymyxin B	Antibacterial	333,000 U in 5 mL saline
Sulfadimethoxine	Antibacterial	200 mg in 15 mL saline
Piperacillin sodium	Antibacterial	200 mg in 10 mL saline
Amphotericin B	Antifungal	5-10 mg in 15 mL water[1,2]
Clotrimazole	Antifungal	30 mg, do not dilute[2]
Acetylcysteine[3]	Mucolytic	0.25-1.0 mL 10-20% solution in 10-15 mL saline or distilled water

[1] *Can use distilled or sterile water for injection.*

[2] *Use disposable pediatric nebulizer and O_2.*

[3] *Can be mixed with other medicines.*

Pediatric hematological & serum chemistry values (mean; range) for captive Sandhill Crane chicks Olson, G. *et al.* 1996

AGE IN DAYS	0-2	6-8	13-15	20-25	27-29	34-36
Hematocrit (%)	33; 27-37	28; 23-30	28; 25-30	29; 25-33	28; 24-35	28; 25-32
Red Blood Cell Count (10^6/mm^3)	1.47; 1.22-1.71	1.31; 1.12-1.52	1.30; 1.09-1.48	1.32; 1.14-1.59	1.37; 1.18-1.65	1.32; 1.17-1.56
Mean corpuscular volume (MCV) (Fl)	217; 206-231	216; 187-235	206; 190-235	212; 195-235	208; 185-223	215; 192-235
White Blood Cell Count (10^3/mm^3)	20.5; 13.6-33.5	12.0; 7.0-48.3	16.0; 9.7-28.5	13.2; 7.8-19.4	12.9; 7.9-16.4	18.3; 8.3-29.1
Heterophil (%)	52; 38-77	52; 36-66	53; 36-75	53; 40-68	45; 24-61	43; 24-61
Lymphocyte (%)	40; 15-50	42; 30-59	45; 24-64	43; 28-49	50; 33-69	54; 35-76
Monocyte (%)	4; 1-8	5; 2-13	2; 0-6	4; 0-12	4; 1-11	3; 0-9
Eosinophil (%)	2; 0-4	2; 0-4	0; 0-1	1; 0-1	1; 0-2	0; 0-2
Basophil (%)	0; 0-1	1; 0-3	0; 0-1	1; 0-2	0; 0-1	0; 0
Total Protein (g/100mL)	3.4; 3.1-4.2	3.4; 2.9-4.5	3.5; 2.3-5.4	3.3; 3.0-3.6	3.4; 3.2-3.8	3.5; 3.0-4.0
Albumin (g/100mL)	<0.5	<0.5-0.5	<0.5	<0.5	<0.5-0.8	<0.5-0.5
Alkaline Phosphatase (IU/L)	179; 23-224	274; 186-372	331; 203-524	369; 230-538	391; 283-553	282; 327-510
Lactic Dehydrogenase (IU/L)	—	—	—	241; 204-288	271; 192-384	308; 293-322
Aspartate Amino-transferase (IU/L)	99; 88-110	262; 221-322	191; 143-263	144; 123-161	146; 118-160	151; 111-195
Glucose (mg/100mL)	—	—	228; 205-240	212; 178-251	241; 229-261	221; 204-237
Uric Acid (mg/100mL)	4.7; 3.7-6.9	5.5; 4.4-7.2	6.8; 6.4-8.3	7.6; 6.0-9.9	6.2; 4.8-9.3	5.4; 4.6-6.4
Gamma Glutamyl Transferase (IU/L)	—	—	—	2; 2-3	3; 2-3	3; 2-6
Creatinine (IU/L)	—	—	—	128; 62-252	144; 40-247	228; 140-290
Calcium (mg/100mL)	8.1; 6.0-10.6	6.9; 5.5-7.9	7.9; 6.8-8.8	8.0; 6.7-10.2	7.7; 5.7-9.9	8.9; 7.1-9.6
Phosphorus (mg/100mL)	—	—	5.8; 5.1-7.2	5.9; 4.5-8.1	6.1; 4.9-7.0	6.3; 5.7-7.0

Pediatric hematological & serum chemistry values (mean; range) for captive Sandhill Crane chicks cont Olson, G. *et al.* 1996

Age in Days	41-43	48-50	55-57	62-64	69-76
Hematocrit (%)	29; 28-32	29; 28-31	28; 26-34	30; 28-34	34; 30-39
Red Blood Cell Count (10^6/mm^3)	1.30; 1.17-1.65	1.38; 1.19-1.62	1.34; 1.17-1.55	1.44; 1.29-1.73	1.57; 1.40-1.75
Mean corpuscular volume (MCV) (Fl)	211; 189-235	209; 191-223	210; 200-222	206; 196-223	214; 206-225
White Blood Cell Count (10^3/mm^3)	24.1; 14.5-32.8	23.6; 10.8-39.8	16.4; 10.8-23.9	14.7; 6.7-24.1	15.8; 5.6-20.4
Percent Heterophil	35; 20-61	42; 20-68	41; 21-64	40; 31-60	39; 18-49
Lymphocyte (%)	61; 38-77	56; 21-75	57; 31-73	60; 51-68	60; 49-83
Monocyte (%)	3; 2-5	4; 1-7	2; 1-6	3; 1-7	2; 1-3
Eosinophil (%)	0; 0-2	0; 0-1	0; 0	0; 0	0; 0
Basophil (%)	0; 0	0; 0	0; 0	0; 0	0; 0
Total Protein (g/100 mL)	3.0; 3.4-4.3	3.6; 3.3-3.8	3.7; 3.4-4.0	3.7; 3.1-4.1	3.8; 3.3-4.2
Albumin (g/100mL)	<0.5-0.6	<0.5-0.6	<0.5-0.5	<0.5-0.8	<0.5-0.8
Alkaline Phosphatase (IU/L)	449; 232-691	388; 286-529	399; 281-529	386; 271-616	288; 225-354
Lactic Dehydrogenase (IU/L)	239; 222-262	249; 194-292	285; 240-431	294; 192-499	324; 176-472
Aspartate Amino-transferase (IU/L)	159; 151-161	159; 110-184	152; 133-177	152; 119-182	173; 152-199
Glucose (mg/100mL)	228; 219-259	219; 214-233	214; 196-228	223; 197-254	212; 202-222
Uric Acid (mg/100mL)	6.1; 5.9-6.4	5.4; 4.7-8.1	5.2; 5.0-5.3	5.6; 4.8-8.4	6.4; 4.7-8.0
Gamma Glutamyl Transferase (IU/L)	3; 3	3; 2-5	2; 2-4	2; 2-4	2; 2-3
Creatinine (IU/L)	159; 128-191	168; 152-184	127; 92-169	172; 81-306	169; 71-337
Calcium (mg/100mL)	8.9; 6.1-9.3	8.0; 6.9-9.2	9.3; 8.2-10.2	8.9; 6.4-11.0	9.2; 7.1-10.9
Phosphorus (mg/100mL)	6.9; 5.9-7.9	6.5; 5.4-7.1	6.8; 6.0-7.7	6.8; 6.0-7.8	6.9; 6.0-7.8

[1] *Based on unpublished work from ICF*

Antiparasitic medications used in cranes. [1] (Olson, G. *et al.* 1996)

Drug	Indication	Route of Administration	Dosage	Treatment Per Day Schedule
Anticoccidias				
Amprolium	Anticoccidial	Food	0.0125 mg/kg (prophylactic) 0.025 mg/kg (Therapeutic)	Continuous for 2 weeks, minimum
Amprolium	Anticoccidial when other forms of this drug are not appropriate	Drinking water	0.006%	Continuous
Monensin sodium	Anticoccidial	Mixed in feed	90 ppm	Continuous or seasonally
Triple Sulfa Soluble Powder [2]	Use when clinical evidence of coccidiosis	Drinking water	1.5 tsp/gal	2 days on; 3 days off; 2 days on; 2 days off; 1 day on
Trimethroprim Sulfa	Use when clinical evidence of coccidiosis	Oral IM	See Common Medicines	1-2/day
Ormethroprim Sulfadimethoxine	Use when clinical evidence of coccidiosis	Food	0.015% ormethroprim 0.026% sulfa	Continuous for 3 weeks
Sulfa dimethoxine	Use when clinical evidence of coccidiosis	Oral	50mg/kg	1/day for 2 weeks
Antinematodals				
Fenbendazole	Capillariasis, or other nematodes	Oral	100mg/kg	5days, repeat in 10-14 days
Ivermectin	Broad-spectrum	IM	0.2mg/kg	2 doses in 10-14 days apart or as needed
Levamisole	Safe- efficacious broad-spectrum anthelminthic	Oral	40mg/kg (25 mg/kg for chicks)	Bi-weekly or as needed
Piperazine	Treating individuals or groups of cranes for ascarids	Drinking water	15-20 g/gal	3days; repeat in 2 weeks
Pyrantel pamoate	Intestinal nematodes	Oral	4.5mg/kg	2 doses in 10-14 days apart
Thiabendazole	Wide range of antiparasitic action with a high degree of efficacy and safety	Oral	100mg/kg	Weekly or bi-weekly as needed
Anticestodals and antitrematodals				
Albendazole	Effective in treating some trematodes	Oral	20mg/kg	2 doses 1 week apart
Praziquantel	Effective in treating cestodes; potentially toxic	Oral	6mg/kg	Bi-weekly or as needed
Ectoparasiticals				
Carbaryl	Control of most ectoparasites	Topical	5% powder	Weekly or bi-weekly as needed
Pyrethrins	Control of most ectoparasites	Topical	0.10% powder	Weekly or bi-weekly as needed

[1] *Based o Olsen and Carpenter 1996.* [2] *Active drug ingredients: Sulfamerazine sodium 27.20%, Sulfamethazine sodium 27.20%, and sodium sulfathiazole sesquihydrate 29.85%*

(Olson, G. *et al.* 1996)

White blood cell hematological values (average, standard deviation, and range) for healthy cranes of six species.[1]

	Whooping Crane N=17	Sandhill Crane N=5	Red Crowned Crane N=11	Sarus Crane N=12	Siberian Crane N=14	Wattled Crane N=6
White Blood Cell (N/µL)[2]	16999	13430	14933	14446	10770	12672
SD	6671	4626	4303	2687	2132	4761
Range	9752-29726	8392-20900	6327-23539	9072-19820	6506-15034	3150-22194
Heterophil (%)	56	53	41	59	53	48
SD	10	2	10	7	10	15
Range	38-74	50-56	22-62	45-73	33-73	21-81
Lymphocyte (%)	41	40	48	32	39	39
SD	11	3	9	8	10	20
Range	21-60	38-43	29-65	16-48	18-58	0-75
Monocyte (%)	2	6	6	4	3	5
SD	2	4	2	4	1	3
Range	0-6	3-13	2-10	0-12	2-6	0-11
Eosinophil (%)	1	2	5	5	5	8
SD	2	1	1	1	2	4
Range	0-5	0-3	3-7	3-7	1-9	1-17
Heterophil (N/µL)	9597	7078	6120	8486	5678	6108
SD	4616	2385	1859	1755	1030	1701
Range	4702-21997	4448-10868	2402-9838	4976-11996	3618-7738	2706-9510
Lymphocyte (N/µL)	6836	5353	7213	4571	4183	4890
SD	3064	2136	3051	1633	1814	4067
Range	3129-13506	3609-8987	1111-13315	1305-7837	555-7811	0-13024
Monocyte (N/µL)	390	802	882	606	370	604
SD	322	515	348	535	117	413
Range	0-976	334-1544	186-1578	0-1676	136-604	0-1430
Eosinohil (N/µL)	138	210	700	783	546	1070
SD	230	204	314	290	198	258
Range	0-688	0-418	72-1328	203-1363	150-942	554-1586

[1] *Basophils were absent in samples.*

[2] *As stated in the text, the White Blood Cell count is not derived from, and does not exactly equal, the totals for all WBC groups at the bottom of the table.*

Normal Haematological and Serum Chemistry Values for Captive Cranes. (Olsen, G. *et al* 1996).

	Sandhill Crane		Siberian Crane	
	Mean	*Range*	*Mean*	*Range*
Hematocrit (%)	43.0	37 – 49	45.0	40 – 5 0
Hemoglobin (g/100L)	13.5	10.5 – 18.7	--	--
Red Blood Cell (10^6/mm^3)	2.5	1.9 – 3.3	--	--
White Blood Cell (10^3/mm^3)	13.0	6.2 – 22.6	10.8	6.5 – 15.0
Total Protein (g/100L)	3.9	2.9 – 7.9	3.6	3.1 – 4.1
Albumin (g/100L)	1.5	1.0 – 2.5	1.4	1.2 – 1.5
Globulin (g/100L)	2.3	1.8 – 3.4	2.3	1.9 – 2.7
Albumin/ Globulin	0.6	0.4 – 1.3	0.6	0.5 – 0.7
Alkaline phosphatase (IU/L)	164.0	34 – 423	45.2	28 – 68
Lactic Dehydrogenase (IU/L)	278.0	108 – 488	202.3	100 – 323
Asparate Aminotransferase (IU/L)	181.0	16 – 260	181.6	117 – 254
Alanine Aminotransferase (IU/L)	50.0	19 – 162	16.1	6 – 25
Glucose (mg/100mL)	247.0	87 – 323	266.4	109 – 314
Uric Acid (mg/100mL)	9.7	4.1 – 24.6	9.0	5.5 – 12.6
Creatinine (mg/100mL)	0.7	0.4 – 1.2	0.3	0.3 – 0.4
Cholesterol (mg/100mL)	128.0	87 – 187	212.3	148 – 286
Creatine kinase (U/L)	--	--	106.1	48 – 205
Triglyceride (mg/dL)	--	--	142.4	128 – 555
Iron (mg/dL)	--	--	106.3	61 – 155
Calcium (mg/100mL)	9.7	8.8 – 10.9	10.5	9.5 – 11.2
Phosphorus (mg/100L)	3.6	1.7 – 5.4	3.8	1.9 – 5.8
Sodium (mEq/L)	148.0	142 – 160	148.5	146 – 151
Chloride (mEq/L)	108.0	101 – 115	109.1	106 – 113
Potassium (mEq/L)	3.4	2.2 – 4.8	2.9	1.6 – 4.0