ASSOCIATION OF ZOOS & AQUARIUMS

Kori Bustard (*Ardeotis kori*) Care Manual

Created by the
AZA Gruiformes Taxonomic Advisory Group
in Association with the
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Introduction

Preamble

AZA accreditation standards, relevant to the topics discussed in this manual, are highlighted in boxes such as this throughout the document (Appendix A).

AZA accreditation standards are continuously being raised or added. Staff from AZA-accredited institutions are required to know and comply with all AZA accreditation standards, including those most recently listed on the AZA website (www.aza.org) which might not be included in this manual.

Taxonomic Classification

Table 1: Taxonomic classification for kori bustards

Classification	Taxonomy
Kingdom	Animalia
Phylum	Chordata
Class	Aves
Order	Gruiformes
Suborder	---
Family	Otididae

Genus, Species, and Status

Table 2: Genus, species, and status information for kori bustards

Genus	Species	Common Name	USA Status	IUCN Status	AZA Status
Ardeotis	*kori*	Kori bustard	Not Listed	Least Concern	SSP
Ardeotis *Ardeotis*	*kori struthiunculus (eastern Africa)* *kori kori (southern Africa)*		Not Listed	Least Concern	SSP

General Information

The information contained within this Animal Care Manual (ACM) provides a compilation of animal care and management knowledge that has been gained from recognized species experts, including AZA Taxon Advisory Groups (TAGs), Species Survival Plan® Programs (SSPs), biologists, veterinarians, nutritionists, reproduction physiologists, behaviorists and researchers. This ACM is based on the most current science, practices, and technologies used in animal care and management and are valuable resources that enhance animal welfare by providing information about the basic requirements needed and best practices known for caring for *ex situ* kori bustard populations. This ACM is considered a living document that is updated as new information becomes available and at a minimum of every five years.

Information presented is intended solely for the education and training of zoo and aquarium personnel at AZA-accredited institutions. Recommendations included in the ACM are not exclusive management approaches, diets, medical treatments, or procedures, and may require adaptation to meet the specific needs of individual animals and particular circumstances in each institution. Statements presented throughout the body of the manuals do not represent specific AZA accreditation standards of care unless specifically identified as such in clearly marked sidebar boxes. AZA-accredited institutions which care for kori bustards must comply with all relevant local, state, and federal wildlife laws and regulations; AZA accreditation standards that are more stringent than these laws and regulations must be met (AZA Accreditation Standard 1.1.1).

AZA Accreditation Standard

(1.1.1) The institution must comply with all relevant local, state, and federal wildlife laws and regulations. It is understood that, in some cases, AZA accreditation standards are more stringent than existing laws and regulations. In these cases the AZA standard must be met.

The ultimate goal of this ACM is to facilitate excellent kori bustard management and care, which will ensure superior kori bustard welfare at AZA-accredited institutions. Ultimately, success in our kori bustard management and care will allow AZA-accredited institutions to contribute to kori bustard conservation, and ensure that kori bustards are in our future for generations to come.

Information in this ACM has been taken and adapted, with permission, from the "Kori Bustard (*Ardeotis kori*) Species Survival Plan Husbandry Manual" (Hallager and Boylan 2004). Additional information on kori bustard biology and management can be found within this husbandry manual.

Natural History: Kori bustards are large, terrestrial, omnivorous birds that inhabit open plains and semi-desert areas within their natural habitats (Bailey et al. 1997a). Kori bustards are indigenous to the grasslands and lightly wooded savannas of southern and eastern Africa (Hallager and Boylan 2004). *A. k. kori* can be found in Botswana, Zimbabwe, Namibia, southern Angola, South Africa and Mozambique (Johnsgard 1991). In eastern Africa, *A. k. struthiunculus* can be found in Ethiopia, Uganda, Sudan, Kenya, and Tanzania (del Hoyo et al. 1996). Natural predators of kori bustards in these environments include black-backed jackal (*Canis mesomelas*), spotted hyena (*Crocuta crocuta*), martial eagle (*Polemaetus bellicosus*), tawny eagle (*Aquila rapax*), Verreaux's eagle (*Aquila verreauxii*), leopard (*Panthera pardus*), lion (*Panthera leo*), and caracal (*Caracal caracal*) (Hallager and Boylan 2004).

Kori bustards are omnivorous, and have been observed consuming flowers, leaves, seeds, fruits, pods, acacia gum insect prey (e.g., Hymenoptera, Orthoptera, Coleoptera, Lepidoptera), and non-insect prey (e.g., Chilopoda, Diplopoda, Annelida, and Reptilia) (Mwangi 1988; Osborne 1998). When drinking from water sources, kori bustards use an unusual sucking action (Hallager 1994), which may be an adaptation to arid climates where water can be limited (Hallager and Boylan 2004).

The daily activity of wild kori bustards involves periods of activity in the morning and evening (0900 and 1700), with birds awaking 30 minutes before sunrise to begin feeding, and periods of rest during the heat of the day (1130-1530) (Mwangi and Karanja 1993; Osborne 1998). Preening and dustbathing were observed to occur most frequently during the middle of the day (Mwangi 1988). During the breeding season, males also spend time performing courtship displays during the early morning and late afternoon/evening periods (Hallager and Boylan 2004). Kori bustards spend much of their time on the ground, generally moving about in a slow walk; running and flying are performed to escape from danger (Mwangi 1988).

In the wild, kori bustards have a lek-like breeding system, where males gather either singly or in loose lek-like formations during the breeding season and perform "balloon" displays to attract females (Hallager and Boylan 2004). During a male's display, the esophagus can be inflated up to four times its normal size, and with the neck expanded, the tail and wing feathers pointed downward, and the crest erected, the male emits a low-pitched six-note booming vocalization as he snaps his bill open and shut (Hallager and Boylan 2004). Prior to copulation, males often spend 5-10 minutes pecking the head of the recumbent females; copulation itself lasts no more than a few seconds (Hallager and Boylan 2004). Males play no role in egg or chick care, and continue to display to other females after copulation; males do not associate with females outside of breeding interactions (Hallager and Boylan 2004).

The chicks of kori bustards are precocial, have open eyes at hatching, and are able to stand within hours (Bailey et al. 1997b). Average brood size of wild birds is 1.52 chicks (Osborne and Osborne 1998). Females are thought to feed newly hatched young with insects as the primary food item. Chicks remain with the dam until the start of the next breeding season, when they disperse (Hallager and Boylan 2004). Adult and sub-adult males have been found to disperse widely (up to 120km) following the breeding season, while juvenile females were found to emigrate only 2-5km from their natal areas (Osborne and Osborne 1998, 1999, 2000).

Physical Description: The following information on the physical appearance of kori bustards has been adapted in part from Johnsgard (1991). Table 3 provides ranges for kori bustard size and weight parameters.

Table 3: Size and weight parameters for *A. k. struthiunculus* (adapted from Johnsgard 1991)

	Male	**Female**
Weight	22-33.1lb (10-15kg)	12.1-15.4 (5.5-7kg)
Breeding season weight	33.1-41.9lb (15-19kg)	---
Tail	14.6-15.2" (370-387mm)	11-13.5" (280-342mm)
Wingspan	29.6-30.2" (752-767mm)	23.6-25.8" (600-655mm)
Culmen	3.7-4.7" (95-120mm)	3.2-3.7" (81-95mm)
Tarsus	9.1-9.7" (230-247mm)	7.1-8.1" (181-205mm)

Adult male: Kori bustards show size-based sexual dimorphism, with adult males being larger than females; the weight of adult males ranges from 15.4-30.9lb (7-14kg), while adult females usually weigh less than 15.4lb (7kg) (Bailey and Hallager 2003). Sub-adult males are similar in size to adult males but have a thinner neck (Osborne and Osborne 2001). During the breeding season, male kori bustards (*A.k.struthiuncul*s) have a darkened throat patch, which becomes less black following post-breeding molt. Plumage coloration is generally similar between the sexes.

Adult female: Adult females are smaller than males, approximately 3-6kg (Bailey and Hallager 2003), with the black on the crown and with the eye stripe somewhat reduced (Urban et al. 1986). Juvenile females have a slighter appearance with a slimmer bill, thinner legs, and a brownish back (Osborne and Osborne 2001). Table 4 provides a general description of male and female coloration.

Table 4: Coloration of kori bustards (adapted from Johnsgard 1991; Hallager and Boylan 2004)

Body Part	Coloration
General coloration (back)	Dark sandy brown, with blackish vermiculations, and with a slight grayish shade
Mantle and upper back feathers	As above, but generally more blackish
Lower back, rump, and upper tail coverts	Similar to back, but upper tail coverts are rather more coarsely freckled
Lesser wing coverts	Similar to back
Median coverts	Mostly white, coarsely mottled with black or grey freckles, with a broad black subterminal bar and a white tip
Greater coverts	Similar to median coverts, but more thickly mottled with black or grey vermiculations
Alula	Similar to median or greater coverts, but subterminal bar not so strongly indicated
Primary coverts	Ashy brown, with the inner ones mottled and broadly tipped with white
Remiges	Brown, with two outer ones scarcely freckled with white on the outer web, but inner ones becoming more white on the inner web, barred with bluish grey, and tipped with white
Inner primaries	Some are checkered with sandy buff on the outer webs
Secondaries	Bluish-gray, mottled with white, with a white tip, and a subterminal bar of blackish-brown; the innermost secondaries are like the back
Rectrices	Ashy brown at base, crossed by two broad bands of white, separated from each other by black bands, one broad and one narrow, the latter band is followed by an indistinct white band which merges into the sandy brown ending of the tail. This portion has a narrow band of black, a broader subterminal band of black, and a white tip
Crown	Strongly crested, black, with a grayish band of feathers down the center, and a black post-ocular stripe (stripe reduced or lacking in *A. k. kori*).
Nape and sides of posterior crown	Grayish white and barred with black, exactly like the neck
Sides of face, throat, streak over eye, patch in front of eye, anterior cheeks, and chin	White
Foreneck	A crescentic band of black is partly concealed by the long barred feathers of the lower throat
Sides of the upper breast	Marked with black

Body Part	Coloration
Axillaries and under wing coverts	White
Lower primary coverts	Ashy freckled with white
Iris	Lemon yellow to orange brown
Bill	Light horn color, darker brown above and yellowish below
Tarsi and toes	Light yellowish

Conservation Issues: Kori bustards are listed in Appendix II of the Convention on International Trade in Endangered Species (CITES). Any importation of kori bustards to the United States require a CITES import permit. The southern race, *Ardeotis kori kori,* is listed as Vulnerable in the South African Red Data Book (Brooke 1984), as well as the Eskom Red Data Book of Birds of South Africa, Lesotho, and Swaziland (Barnes 2000). The AZA kori bustard population is managed as a Species Survival Plan® (SSP).

The main threats to wild kori bustards are in the form of human-induced factors, and include habitat destruction through increasing agricultural development (Dale 1990; Ottichilo et al. 2001), bush encroachment caused by over-grazing from livestock, hunting for the bushmeat trade, and trapping for private collections in the Gulf States. Poison used to control locusts is generally toxic to birds, and may also be affecting kori bustard populations (Barnes 2000). Although the kori bustard is listed as "protected game," it continues to be hunted over much of its range. In Namibia, it is commonly referred to as the "Christmas turkey" (Osborne and Osborne 2001), and in South Africa it is called the "Kalahari Kentucky" (Barnes 2000). In general, the greatest numbers of kori bustards in southern Africa can be found in protected areas, where they are 45 times more likely to be seen in protected areas than in unprotected areas (Herremans 1998).

Collisions with overhead power lines are also a serious problem for kori bustards, with one 6 mile (10km) stretch of overhead power lines in the Karoo (South Africa) leading to the death of 22 kori bustards during a 5-month period (Van Rooyen 2000). Very little is currently known about natural health and disease issues affecting wild kori bustards, or how their health status relates to declining populations. Recent studies have begun to collect such valuable baseline information on free ranging kori bustards.

Natural factors affecting populations of kori bustards in the wild include an inherent low reproductive rate and reduced breeding activity in dry years, despite a constant predation pressure. In addition, favored areas such as tree-lined watercourses are becoming unsuitable for kori bustards because they are being invaded by alien plant species (Barnes 2000).

Present range of *Ardeotis kori struthiunculus*: The present range of this subspecies is smaller than in previous times. In Ethiopia, the species is now found only south of 9º latitude. From there, the range extends west to the extreme southeastern part of Sudan and south to western Kenya and northeastern Uganda. There are no records of birds in Somalia since 1970. In Tanzania, it is restricted to the northern plains (P. Goriup, personal communication; N. Baker, personal communication). They are scarce around the coastal lowlands of Tanzania and Kenya (Zimmerman 1996).

Historical distribution of *Ardeotis kori struthiunculus*: The subspecies historically ranged throughout most of Ethiopia (Ash 1989) and southeastern Sudan (below 9º latitude). The subspecies also ranged southeast to northwestern Somalia, and west and south to northern Uganda, Kenya, and the highlands north of the Singida providence in Tanzania.

Present range of *Ardeotis kori kori*: The present range of this subspecies is also smaller than in previous times. It is now distributed in the semi-arid areas in the western half of southern Africa, including Namibia, extreme southern Angola (rarely), western Zambia, Botswana, western Zimbabwe, South Africa, and the Limpopo Valley of Mozambique.

In South Africa, it is found mainly in the Transvaal lowveld and the northern Cape Province, as well as the Kruger and Kalahari Gemsbok National Parks (Kemp 1980), although it is very scarce along the eastern border of Kruger National Park near Mozambique (Barnes 2000). *A. k. kori* is a vagrant in Lesotho (P. Goriup, personal communication). Allan (1988) reported that the subspecies has declined in the Transvaal, Orange Free State, and parts of Cape Province; Parker (1994) noted that this subspecies went extinct in Swaziland prior to 1960.

Historical distribution of *Ardeotis kori kori*: This southern subspecies historically ranged throughout most of southern Africa, including Zimbabwe, Botswana, southern Angola, Namibia, South Africa, southern Mozambique (Johnsgard 1991) and Swaziland (Harrison et al.1997).

Population: Throughout its range, the species (including both subspecies) is uncommon to locally common, but generally declining (Urban et al. 1986). The habitat of both subspecies is under threat from the spread of agriculture, high human densities, illegal hunting, over grazing by livestock, and bush encroachment. According to del Hoyo et al. (1996), the kori bustard is showing signs of chronic decline and local extinction over its entire range. Total population size has not been reported for either subspecies.

The entire East African region is currently undergoing widespread ecological changes as a result of increased agricultural practices and other forms of land use (Mwangi 1988). Since 1950, the area of land used for agriculture has increased by 26% (Happold 1995). Lado (1996) states that habitat destruction and/or alteration the most serious threat to the future of wildlife in Kenya. As an example, the area used for wheat production in the Masai Mara has grown from 4875ha in 1975 to over 50,000ha in 1995. In the nearby Loita plains (where kori bustards are known to frequent), wheat production continues to expand as the human population grows, and as farmers realize the agricultural potential of the land. As areas used for agriculture expand in Kenya, it can be expected that the numbers of wildlife, including kori bustards, will decline (Ottichilo et al. 2001).

The spread of agriculture, urbanization, pollution, pesticides (including those that are banned in other countries), and other consequences of an exploding human population, are all contributing to a deteriorating situation for many species of wildlife, including kori bustards. The following table (Table 5) provides information on the conservation status of kori bustards in range countries.

Table 5: Status of *Ardeotis kori struthiunculus* and *Ardeotis kori kori* in range countries

Country	**Population Size/Status**
Ardeotis kori struthiunculus	
Sudan	Breeding populations exist in the extreme southeastern area of the country, but total population size is unknown. Kori bustards may be only a dry season visitor to this country (Nikolaus 1987).
Kenya	Kori bustards are most numerous in the dry grassland areas of northern and western Kenya, and in the Rift Valley highlands south to Mara Game Reserve, Loita Plains, Nairobi National Park, and Amboseli National Park. They are scarce and localized from the Tana River south to Tsavo West and Tsavo East National Park (Zimmerman 1996). Total population size is unknown. Mwangi (1988) estimated 0.3 birds per km^2 in Nairobi National Park in 1986/87.
Uganda	Breeding populations exist in Acholi, Lango, and Kidepo National Park. Total population size is unknown.
Ethiopia	Kori bustards were formally common in Ethiopia south of 9º latitude, but numbers have declined (P. Goriup, personal communication). Total population size is unknown.
Somalia	There are no records of birds in Somalia since 1970.
Tanzania	The Serengeti National Park, Ngorongoro Conservation Area, Tarangire National Park, Maswa Game Reserve, Arusha National Park, and Mkomazi Game Reserve offer long-term protection to kori bustards, and viable populations of birds can be found in these protected areas. Kori bustards are still relatively common in the Rift Valley highlands. There is a small and isolated population in central Tanzania, which occupies a small area at low densities (N. Baker, personal communication). This subspecies is regarded as scarce around the coast (Zimmerman 1996). The birds are hunted around the Lake Eyasi Basin, Lake Natron, and in the foothills of Mt. Kilimnajaro (N. Baker, personal communication). Total population size is unknown.
Ardeotis kori kori	
Botswana	Despite low human densities, kori bustards in Botswana are under severe pressure from habitat loss. Nonetheless, strongholds for the species include the Kalahari Gemsbok National Park (with an estimated population size of 100-140 birds – Barnes 2000), Central Kalahari Game Reserve, Nxai Pan National Park, and the Chobe National Park, where road counts found 1 bird/106km. However, in unprotected areas, the density level dropped to 1 bird/4356km (Harrison et al.

Country	Population Size/Status
	1997). Suitable habitat for kori bustards has been lost due to grazing by livestock (Herremans 1998), which has increased dramatically over the past 100 years. Livestock numbers continue to grow despite reports of overgrazing and forecasts of devastating long-term land degradation since the early 1970's. Total population size of kori bustards is unknown.
Namibia	The stronghold for kori bustards in Namibia and possibly the world is in Etosha National Park, where Osborne and Osborne (1998) found 1 bird/16km. Outside the park boundaries however, birds are hunted.
Zimbabwe	Suitable habitat for kori bustards is deteriorating through overgrazing by livestock, and the situation is similar to Botswana. Matabeleland is the stronghold for the species in Zimbabwe (Rockingham-Gill 1983). The species has decreased in several areas, most noticeably in the Mashonaland plateau (Harrison et al. 1997), where birds are hunted. The decline in this area was first noticed in the 1920's (Irwin 1981). Total population size has been variously reported in 1980, when an estimation of 10,700 birds was given by Rockingham-Gill (1983), although Dale (1990) reported 5000 birds, and Mundy (1989) estimated 2000 birds, and states that Rockingham-Gill's 1983 estimate is vastly over estimated. Total population size is unknown.
South Africa	Numbers declined in the 20th century, but the extent of the decline is unknown (Brooke 1984). Kruger National Park supports 100-250 individuals (Barnes 2000). Outside protected areas, kori bustards are found in relatively large numbers only in the Platberg-Karoo Conservancy in South Africa (Barnes 2000). Allan (1988) reported that the species has declined in the Transvaal, Orange Free State (where it is uncommon to rare), and in parts of Cape Province. Total population size is estimated to be between 2000-5000 birds.
Mozambique	The kori bustard population is locally threatened (hunting is the greatest threat), and probably numbers less than 100 birds (Parker 1999).
Other	Parker (1994) noted that this subspecies went extinct in Swaziland prior to 1960. In Angola, the species is a rare visitor. In Zambia, kori bustards are found only west of the Zambezi River, although their status there is unclear. The Sioma Ngwezi National Park may offer some protection. This subspecies is considered very sparse in Natal with one sighting reported in 1976 (Cyrus and Robson 1980).

Chapter 1. Ambient Environment

1.1 Temperature and Humidity

Kori bustard collections within AZA-accredited institutions must be protected from weather detrimental to their health (AZA Accreditation Standard 1.5.7).

AZA Accreditation Standard

(S1.5.7) The animal collection must be protected from weather detrimental to their health.

Cold weather: Kori bustards are susceptible to frostbite (Bailey and Hallager 2003). In climatic zones where temperatures fall below 32°F (0°C), it is strongly recommended that institutions have winter holding facilities available for housing birds during inclement weather. To avoid frostbite, it is also strongly recommended that these institutions provide their kori bustards with supplemental heat when temperatures fall below 32°F (0°C). Although kori bustards do not like confinement, all birds should be locked into heated winter holding quarters when the wind-chill temperature is forecasted to be below 20°F (-6°C), especially when it is raining or sleeting, and always when it is snowing (Hallager and Boylan 2004). Kori bustards should not be left outside during periods of freezing rain or snow. Winter holding facilities should be heated to 50-60°F (10-15.5°C). When heat bulbs are used, they should be encased in protective wiring to prevent the birds from breaking the bulbs with their bodies or beaks where contact is possible. Both wild-caught birds and birds born in zoos will readily utilize heated straw piles in their enclosure when temperatures fall below 40ºF (4.4ºC). The availability of heated pads (e.g., pig warmers) covered with straw will also allow birds to remain outside for longer. This is especially advantageous when working with wild-caught birds, which can be more reluctant to utilize indoor shelters. The straw should be replaced when it becomes wet, as kori bustards will not use wet straw piles. As the feathers of kori bustards are not particularly waterproof, care should be taken to avoid the birds becoming wet during any cold conditions.

Even institutions that do not experience extremely cold weather should have a shelter available for times when enclosure repairs are needed, for medical confinement, to house temperature-sensitive chicks, to minimize food loss from wild birds during feeding, or when birds have to be caught and restrained. For the first couple of months of their lives, bustard chicks are sensitive to the cold (T. Bailey, personal communication, 2007). Care is needed to provide sufficient heating, especially to debilitated chicks that are hospitalized. Managers should follow the advice of the referring aviculturalist or veterinarian for temperature guidelines. Under sub-optimal temperature conditions, bustard chicks and even juvenile bustards can suffer from hypothermia (see Chapter 6, section 6.4 for additional information). For more details on the size and design of winter holding facilities, see Chapter 2, section 2.1.

Hot weather: Exhibits should offer some degree of direct sunlight (see section 1.2 for additional information), but areas of shade that all birds within a group can utilize also need to be available, especially in hotter climates. Hyperthermia has caused the death of a number of bustards at the National Avian Research Centre (NARC), and can occur when chicks are moved prematurely from air-conditioned rearing facilities to outdoor aviaries in the summer, without a period of acclimatization (T. Bailey, personal communication, 2007). See Chapter 6, section 6.4 for additional information on hyperthermia.

Humidity: Kori bustards do not thrive in climates that are consistently wet, rainy, and damp. These conditions lead to poor feather condition (bustards do not have a preen gland to oil their feathers) and unhealthy birds. Warm, dry shelters and areas of full sun that allow animals to dry themselves are recommended (see Chapter 2, section 2.1 for additional information).

For both subspecies of kori bustards (*Ardeotis kori kori* and *A. k. struthiunculus*), breeding is closely tied with rainfall in the wild because of the availability of food sources (e.g., arthropods). Breeding in the wild may be greatly reduced or even absent in years with low rainfall (Johnsgard 1991). In zoos, the breeding season is tied more to warmer temperatures, and animals in more southerly climates begin the breeding season earlier (J. Boylan, personal communication, 2006). See Chapter 7, section 7.1 for additional information.

Climate Control Systems: AZA institutions with exhibits and enclosures that rely on climate control systems to provide appropriate temperature and humidity conditions for kori bustards (e.g., heating systems for winter housing; air conditioning for chicks and juveniles) must have critical life-support systems for the animal collection and emergency backup systems available. All mechanical equipment

should be included in a documented preventative maintenance program. Special equipment should be maintained under a maintenance agreement or records should indicate that staff members are trained to conduct specified maintenance (AZA Accreditation Standard 10.2.1). The AZA Gruiformes TAG and Kori Bustard SSP recommend that each institution identify the most appropriate climate control systems suitable for their kori bustard enclosures in order to meet the temperature and humidity recommendations provided above.

AZA Accreditation Standard

(S10.2.1) Critical life-support systems for the animal collection, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

1.2 Light

Careful consideration should be given to the spectral, intensity, and duration of light needs for all animals in the care of AZA-accredited zoos. Kori bustards need areas of full sun to allow them to dry off damp plumage, and to engage in sunning behaviors. Sunning is very important to kori bustards for maintaining good feather condition. Sunning is characterized by the spreading of one or both wings in response to direct sunlight. If exhibits contain multiple birds, multiple sunning spots are necessary to ensure that each individual has access to a sunning area, and that no one individual can prevent another from gaining access to these areas. Data from a behavioral assessment of kori bustards at Smithsonian's National Zoo (Fernandes and Hallager 2007) found that kori bustards exhibit sunning behaviors intermittently from 1100 to 1400 on sunny days. Birds will sometimes sun themselves until they pant heavily, at which point they usually move to a shady area of the enclosure. In the shade, the birds typically then preen for upwards of 20 minutes. Birds demonstrate preferred sunning areas.

The proposed functions of sunning behavior in various bird species includes ectoparasite control, thermoregulation, drying of wet plumage, assistance in molting, soothing of skin irritated by molting, and increasing the flow of preen gland secretions (Simmons 1986). Since kori bustards preen intensely following sunning, there is some evidence that suggests that this behavior is involved in feather maintenance and ectoparasite control. Kori bustards lack preen glands, and so their sunning activity cannot increase the flow of preen gland secretions or aid in vitamin D production. Sunning also does not appear to be a major thermoregulation mechanism for kori bustards, as it is in some other bird species, as kori bustards at the Smithsonian's National Zoo do not sunbathe in the colder months, but do perform sunning once temperatures are above 45°F (7.2°C). Sunning is most prevalent during the summer months, and is performed at a median temperature of 75°F (23.9°C) (Fernandes and Hallager 2007).

As kori bustards should not be kept inside for extended periods, weather permitting, providing artificial UV-emitting lights is not necessary within indoor enclosures. Similarly, artificial seasonal changes in indoor light intensity and duration do not seem to be necessary, as kori bustards are not maintained indoors throughout the year. Changes in temperature may be more important for regulating reproductive behavior than changes in light intensity (see section 1.1). Zoos that bring kori bustards into indoor enclosures for the winter should have outside holding pens available for use by the birds during warm days, in order to provide them with full spectrum lighting.

Chick rearing: Standard incandescent bulbs should not be used for brooding hand-reared, kori bustard chicks, as at least three chicks reared under incandescent bulbs at NARC in 1993 developed cataracts that may have been associated with the use of these bulbs (Bailey et al. 1997b; T. Bailey, personal communication, 2007). No further cases of cataracts were observed at NARC once the lighting was changed, and when the chicks were reared under 60W ceramic dull-emitter bulbs (Bailey et al. 1997b), however further research is needed to investigate possible links between light type during rearing and cataract development.

The relative importance of sunlight for kori bustard chick development is unknown. The Kori Bustard SSP recommends that chicks are provided access to natural light as soon as possible. Popular practice suggests that chicks be exposed to sunlight to some degree on a daily basis starting at day seven. However, the exact day that this exposure should begin is subjective. Some birds that were not exposed to natural light until they were two months of age have developed satisfactorily.

1.3 Water and Air Quality

There are no specific recommendations or regulations specific to air and water quality for kori bustards in zoos. Any clean water source that is considered suitable for livestock is acceptable for kori bustards. Water in bowls and drinkers should be changed minimally once a day, but more frequently if it becomes contaminated. Kori bustards require only small areas of water from which to drink, as they are not heavy drinkers, but they do drink on a daily basis. Heated water dispensers for northern zones are recommended to prevent water from freezing. Kori bustards do not bathe in water (they dustbathe), and so pools are not needed within enclosures other than for aesthetic reasons.

From an air quality perspective, holding areas and indoor or winter enclosures should not be sealed so tightly so that they prevent fresh air from entering the area, as this can adversely affect air quality within these enclosures. A ventilation system, small windows with screens, and/or the ability to open windows, will allow fresh air to enter these areas, and will discourage the formation of fungal spores.

1.4 Sound and Vibration

Consideration should be given to controlling sounds and vibrations that can be heard by kori bustards in their indoor and outdoor enclosures. Kori bustards often become habituated to the routine sounds of normal zoo operation (e.g., trash trucks, nearby construction, leaf blowers), as well as to other environmental sound stimuli (e.g., overhead aircraft, traffic noise, etc.). Unusual sounds, however, can act as stressors, and may cause birds to react negatively by running or crouching. Breeding activities can also be interrupted by novel sounds. Timing of planned construction work near to kori bustard enclosures should coincide with the non-breeding season to minimize stress on the birds (see Chapter 7, section 7.1 for information on reproduction). Workers should be cautioned that their activities may stress the birds. Work should be stopped at once if it is causing obvious stress to the birds (e.g., birds not eating, running within their enclosure, or remaining in the crouch position), and the situation should be re-evaluated. In some cases, birds may need to be temporarily housed or even relocated to another exhibit, although the pros and cons of moving animals should be carefully discussed.

Little is known about the hearing sensitivity of kori bustards, and there is no information available on whether there are certain frequencies of sounds or decibels that will have the greatest negative effect on the welfare of kori bustards, and that can be minimized. Animals should be carefully monitored in any situations where loud, atypical sounds can be heard by animal caretakers around kori bustard enclosures. Additional research on hearing in kori bustards would provide some guidance for creating more objective recommendations for managing sound stimuli for this species.

Chapter 2. Habitat Design and Containment

2.1 Space and Complexity

> **AZA Accreditation Standard**
>
> **(S1.5.2)** Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

Careful consideration should be given to enclosure design for kori bustards so that all animal areas meet the physical, social, behavioral, and psychological needs of the species. Kori bustards should be displayed in exhibits replicating the complexity of their wild habitats in order to provide a wide range of behavioral opportunities, and in numbers sufficient to meet their social and behavioral needs (AZA Accreditation Standard 1.5.2).

Large paddock-like enclosures are the most appropriate type of space for kori bustards, and exhibits ranging up to 50,000ft^2 (4645m^2) have been provided to this species. Kori bustards will thrive more effectively if provided with a few hectares of space (Hallager and Boylan 2004), providing opportunities for their full range of species-appropriate behaviors, and allowing a complex environment to meet their physical and social needs. The recommended minimum space for outdoor enclosures is 42.7' x 65.6' (13m x 20m) per bird (e.g., Siegel et al. 2007). All enclosures should be large enough for bustards to avoid animal caretakers when enclosures are cleaned, re-provisioned, etc., and to maintain their preferred flight distance from animal care staff. Indicators that the size and complexity of the enclosures are not meeting the needs of the birds may include poor physical health, pacing along fence lines, and increased behavioral displacements between females or between males and females.

Kori bustards are mostly terrestrial birds, but do fly. Kori bustards generally move about in a slow walk. Running and flying is generally performed to escape from danger (Mwangi 1988). Unless the enclosure is completely covered, birds will need to be flight restrained (see Chapter 6, section 6.4 for more details). Covered enclosures have the added benefit of keeping out unwanted pest or potential predators species (see section 2.2 for additional information), and can help to minimize the spread of parasites and diseases from wild animals to the kori bustards. As kori bustards are mostly terrestrial, all unnecessary obstacles should be avoided within enclosures. The enclosures should also be as flat as possible to avoid long-term leg and hip problems that may develop if birds are housed in areas with hills, although some low relief provides additional cover, and can serve as courtship display areas for males (see Chapter 7, section 7.1 for more information on courtship displays).

To minimize trip hazards, enclosures should be kept as free as possible from non-plant furnishings (e.g., rocks, tree stumps). There should be ample bare ground as birds generally do not like to walk on turf, especially if it is moist (e.g., from dew), and access to sandy patches can help to promote dustbathing, sunning, and preening behaviors. Kori bustards are not perching birds, lacking a hind toe with which to perch, and so there is no need to provide opportunities for perching within enclosures. If pools are present in enclosures, they should be shallow enough that a bird can walk through the water, and the sides should gradually slope to the deepest portion. The coating on the sides of the pool should be of a non-slip nature. Pools deeper then 2' (60cm) are not recommended. Trauma is an important cause of morbidity and mortality for all bustards in zoos, and so care should be taken to use ‘soft’ materials when enclosures are constructed.

Kori bustards can be housed with a variety of plant furnishings, although there are some considerations to keep in mind. Plants that have large thorns and/or thick flower stems should not be used, as birds can injure themselves. Additionally, bamboo and ornamental grasses with thick, hard stems should be avoided, because birds have impaled themselves on these stems (Hallager and Boylan 2004). Large, soft stemmed grasses and small shrubs scattered throughout an exhibit will provide the birds with ample cover, and with visual barriers for enclosures housing multiple birds. Large shrubs and mature trees, which offer shade as well as limited protection from inclement weather, are also desirable. Kori bustards will also utilize natural plantings to forage for natural fruits, berries, and any associated invertebrate prey. Bustards are omnivores, and will eat small vertebrates and invertebrates from vegetation as they forage through their environments. Plants with edible, non-toxic fruits that can be eaten by the birds can be planted in the enclosure with approval from institutional veterinarians and nutritionists (see Chapter 5, section 5.2 for additional information on the use of browse and browse plants), but nutritional value, fruit size, and attractiveness of the fruit to unwanted pest species should be carefully considered. Plants with fruits large enough to cause an impaction should be avoided. Along with

natural vegetation, the addition of alfalfa beds provides birds with a direct food source, with cover to hide in, and also encourages foraging for invertebrates attracted to the vegetation.

Enclosure substrates: The substrate of all enclosures should be natural and non-abrasive for feet and hock joints of the birds. Kori bustard chicks are coprophagic, and chicks will often ingest feces (T. Bailey, personal communication, 2007). This can lead to the rapid spread of diseases and parasites within a group of birds, and so care should be taken to remove feces from enclosures as soon as possible (e.g., at least daily), especially when chicks are present. Coprophagy in bustards may also be caused by a lack of appropriate environmental stimulation, such as bare floors lacking natural substrates that can be manipulated or that promote foraging (Huchzermeyer 1998). Kori bustards should also be provided with substrates that promote a wide range of species-appropriate behaviors (e.g., dustbathing, preening, foraging, nest building, etc.). Areas that provide the opportunity for dustbathing should be provided in both indoor and outdoor enclosures, as this is a behavior commonly seen in wild birds (Mwangi 1988). These areas can contain sand, mulch, peat moss, or coarse oyster shell.

Indoor substrates: The floor of indoor enclosures can be dirt or sand that is covered with bedding hay (straw). Concrete is not recommended, as birds can slip if startled. Enclosures with concrete floors should be covered with non-slip materials (e.g., indoor/outdoor carpeting).

Outdoor substrates: A natural soil or grass substrate is the most appropriate substrate for outdoor exhibits, although sand and gravel have also been used successfully (T. Bailey, personal communication, 2007). There should be ample bare ground that is not covered with grasses or turf. Impaction does not appear to be a problem with adult bustards in naturalistic aviaries. However, ingestion of foreign bodies including nails, galvanized wire, and pieces of plastic-coated chain-linked fencing is not uncommon in bustards (see section 2.2 for additional information). Damp, marshy areas within enclosures should be avoided.

Minimizing stressors: Attention to the design of facilities and the behavior of staff members working with kori bustards is important to minimize stressors and other trauma-related problems. Bustards are generally nervous and alert when on the ground, and will move into cover in response to aversive stimuli or at the first sign of danger (Hallager and Boylan 2004). Various stimuli within the zoo environment have been reported as potential stressors for kori bustards, including capture and restraint of birds, animal caretakers or other staff working in or near the enclosure (especially with loud machinery such as line trimmers), native birds competing for food, animal introductions, aggressive behavior between birds, feeding time, and the presence of several keepers in visual range of the birds. High visitor levels have also been shown to be stressful to some birds (Brostek et al. 2003). Visual barriers, such as thick shrubs, placed 4.3-8.2' (1.3-2.5m) in from the enclosure perimeter, may provide an increased sense of security for birds housed in enclosures of a minimum size (Hallager and Boylan 2004), and may help mitigate some of the stressors listed above. Ensuring that visitors are kept at least 5' (1.5m) from the perimeter of kori enclosures may also be beneficial (S. Hallager, personal communication, 2006). Using shade-cloth or tension netting on the roof and sides of aviaries can minimize visual stressors, and can cushion any impact resulting from birds flying within an enclosure as a result of stressors in that environment.

Indicators of stress include vocalizations such as growling and barking, although young birds may be generally more vocal even in the absence of specific stressors. Non-vocal indicators include running/chasing, stereotypical pacing (which can also occur naturally prior to egg-laying), fluffing, tail in up/alert position, and tucking (see Hallager and Boylan 2004). Excessive preening in kori bustards may indicate nervousness (Hallager and Boylan 2004). Tucking often occurs when kori bustards are spooked by native birds flying into the exhibit, or when keepers working in the exhibit move too quickly around the birds. Another response to stressors is hiding. Hiding can be induced by high crowd levels, which may cause subordinate birds to seek areas away from visitors. New kori bustard enclosures should limit visitor access to no more than two sides of the enclosure, in order to prevent excessive visitor presence around the enclosure perimeter. Stress can also be potentially decreased by reducing the number of non-essential people who enter kori bustard enclosures, or the off-exhibit areas directly around these enclosures. Kori bustards are shy birds by nature, and should have areas of privacy to retreat to when crowd levels are high (Brostek et al. 2003). These areas can also provide secure nesting spots for females during the breeding season.

The same careful consideration regarding exhibit size and complexity and its relationship to the kori bustard's overall well-being must be given to the design and size all enclosures, including those used in exhibits, holding areas (e.g., winter holding), hospital/treatment rooms, and quarantine/isolation enclosures (AZA Accreditation Standard 10.3.3). The use of kori bustards in conservation/education programs is generally limited due to behavioral and health concerns for the animals (see Chapter 9), and there are no additional recommendations for enclosures specific to animals used in these programs. The design of enclosures for kori bustards should minimize negative stressors, allow for efficient handling and restraint when necessary, provide access for emergency and routine procedures, maximize the potential for social interaction (and separation when needed) and a full range of species-appropriate behaviors, and should effectively integrate enrichment and animal training (see Chapter 8) into the daily husbandry routine.

AZA Accreditation Standard

(S10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

Winter holding areas: Kori bustards are susceptible to frostbite. In climatic zones where temperatures fall below 32°F (0°C), institutions should have winter holding facilities available for housing birds during inclement weather. To avoid frostbite, it is also strongly recommended that these institutions provide their kori bustards with supplemental heat. Kori bustards should not be left outside during periods of freezing rain or snow. For winter holding of two compatible birds, the minimum recommended space per bird is:

- 8' x 10' (2.4m x 3m) for overnight holding
- 8' x 16' (2.4m x 4.9m) for housing up to 7 days
- 10' x 20' (3m x 6.1m) for housing longer than 7 days, and should include an outside holding yard so that birds can be given outside access.

The recommended oblong dimensions provide some exercise space, and allow the birds to distance themselves from keepers during enclosure cleaning. Birds (especially wild caught individuals) will move away from animal caretakers who are closer than 6' (1.8m) away (S. Hallager, personal communication, 2006). These size recommendations are highly dependent on the compatibility of conspecifics. Larger dimensions or separate shelters may be required for birds that have a lower degree of social compatibility. Winter holding areas should have the capability to be divided in the event that birds are not compatible in small areas, as can be especially common when males and females are housed together.

Sheds should be heated to a maximum of 50-60°F (10-15.5°C), and less if heating lamps and/or pads provide warmer areas. Heat bulbs, if used, should be encased in protective wiring to prevent bulb breakage in case a bird makes contact with the bulb. Skylights within the winter holding area can be advantageous for birds that have to be housed for extended periods during the winter, but artificial lights should also be installed to provide adequate light during the day. A small night-light turned on at night will provide some degree of light for the birds. The floor of the shed can be dirt or sand that can be covered with bedding hay (straw). Concrete is not recommended, as birds can slip if startled. Sliding doors, operated from outside of the holding area, are always useful for controlling the location of birds within the shelter.

Species-appropriate behaviors: All kori bustard enclosures and husbandry management programs in zoos should be designed with knowledge of the species' natural behaviors in mind. Appendix B provides a comprehensive ethogram of kori bustard behavior that should be carefully considered from an enclosure design and enrichment perspective (see also Chapter 8, section 8.2 for more information on environmental enrichment). Unpublished information from an ongoing behavioral assessment performed at the Smithsonian's National Zoo (S. Hallager, personal communication, 2006) indicate that kori bustards spend the following proportions of time engaged in various species-appropriate behaviors when visible to observers:

- 46.8% of the time resting
- 18.1% performing comfort behaviors
- 17.5% locomoting
- 8.7% incubating eggs (during the breeding season only)
- 5.7% exhibiting reproductive behavior
- 3.8% eating
- 0.2% on other activities

Data from this research indicate that birds modified their behavior slightly throughout the day, resting less and walking around more in the later afternoon, carrying out comfort behaviors most at midday, and exhibiting breeding behaviors (incubation and other reproductive behaviors) more often in the evening and early morning hours. Activity patterns varied by sex at the Smithsonian's National Zoo, with females spending a greater proportion of time engaged in comfort activities, feeding, and locomoting. Males spent more time resting. Additional behavioral research on these species in wild settings and in zoos will help to provide a better perspective and understanding of the behavioral needs of kori bustards.

2.2 Safety and Containment

Kori bustards housed in free-ranging environments should be carefully selected, monitored and treated humanely so that the safety of these animals and persons viewing them is ensured (AZA Accreditation Standard 11.3.3).

AZA Accreditation Standard

(S11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to the animal collection, free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully selected, monitored, and treated humanely at all times.

Kori bustard enclosures and holding areas in all AZA-accredited institutions must be secured to prevent unintentional animal egress (AZA Accreditation Standard 11.3.1). Enclosure design must be considered carefully to ensure that all areas are secure and particular attention must be given to shift doors, gates, keeper access doors, locking mechanisms and exhibit barrier dimensions and construction.

AZA Accreditation Standard

(S11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

The preferred primary containment boundary for kori bustard enclosures is one-inch (1"/2.5cm) chain link mesh. This size mesh reduces the chances of chicks getting out of enclosures, and large rodents and small predators getting in. The smaller size also eliminates any chance of a bird getting a leg caught in the fence during a capture. If Invisnet® is used, it should be of a strength to withstand a coyote bite. Even though some birds are successfully maintained in exhibits with lower, public-friendly fences, the recommended height of fencing is 10-12' (3-3.7m). Kori bustards are powerful flyers, and even flight-restrained birds can escape an 8' (2.4m) fence on a windy day or when startled. Covered pens, with anti-dig barriers to prevent predators or pests from gaining access to the enclosure, are recommended for facilities where kori bustards are allowed 24/7 access to outside enclosures.

Public barriers/guardrails: To prevent any physical interaction between kori bustards within their enclosures and members of the public outside the enclosure, there must be a guardrail/barrier that separates the two in addition to the primary containment suggested in section 2.2 (e.g., wire mesh) (AZA Accreditation Standard 11.3.6). To prevent physical contact, and to provide birds with a greater sense of security within their enclosures, it is recommended that visitors be kept at least 5' (1.5m) from the perimeter of kori enclosures (S. Hallager, personal communication, 2006).

AZA Accreditation Standard

(S11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

Walk through aviaries containing kori bustards are not recommended, as kori bustards are shy by nature. Hand-reared birds can also be aggressive to their caretakers (aggression can increase during breeding season), and consequently should not be allowed direct exposure to visitors in any situation.

Exhibit safety: Any small holes that develop in the soil within any kori bustard enclosure (either from erosion or rodent activity) should be filled as soon as possible; kori bustard feet are small, and broken toes and legs can result if birds trip or fall as a result of these holes. On a daily basis, keepers should also inspect the areas of the enclosure where birds have the closest access to the public, and immediately remove any foreign materials. Kori bustards will readily ingest objects such as nails, batteries, broken glass, and coins, and there can be serious health consequences associated with ingestion of these items (see Chapter 6, section 6.6). The animals should be regularly monitored for signs of impaction and zinc toxicity. Hand-reared kori bustards may tolerate a metal detector device held against the abdomen to check for the presence of ingested metal, especially if this is part of a husbandry training program (see Chapter 8, section 8.1 for additional information on operant conditioning). Plants in and around enclosures should also be carefully selected to ensure that they do not have any poisonous properties, or do not pose any risk of physical injury to the birds (e.g., from thorns) (see Chapter 5, section 5.2 for additional information on browse selection).

Pest and predator control: Keepers should check enclosures each day for signs of rodent activity. Spilled food should be removed on a daily basis to aid in rodent control. Poison should not be used inside kori bustard exhibits. If snap traps need to be set, they should be covered so that the birds are unable to see or reach the trap. Kori bustards are curious and will investigate a trap if they can see it.

Wild birds and rodents can pose a problem for kori bustards, especially at feeding time, as most bustards will not aggressively defend their food. Keepers may need to compensate for this by using special feeders to discourage wild birds and squirrels, or by providing extra food, although providing extra food may exacerbate the initial problem and attract more pest species. For pelleted food (see Chapter 5, section 5.2 for information on sample diets), feeders that have a platform that closes when a bird (e.g., starling, pigeon) lands on it work very well. For dispensing mice, large metal feeders that can hold a food pan and also close when unwanted birds land on the collapsible platform work well. Where possible, it is advisable to work out a pest control program with a qualified pest control officer.

Predators: Native/feral predators are dangerous for both adult and young kori bustards. Foxes and/or raccoons have attacked adult birds, sometimes fatally, and small chicks left out in unsecured exhibits are at great risk. All enclosures should be built to minimize predator access. Digging predators (e.g., dogs, foxes) can be excluded by burying the base of the boundary 1' (0.3m) in the ground. Surrounding the enclosure with electrical wire can deter climbing predators (e.g., raccoons). For the safety of the chicks, covered pens are strongly recommended if kori bustard hens are allowed to raise chicks naturally, and covered pens may also play a role in minimizing the risk of avian flu transmission – although more research is needed to determine if this is the case. In areas where large predators (e.g., coyote, bobcat, cougar, etc.) are common, birds may need to be housed indoors at night if pens are not covered. Shifting and housing birds indoors each day may negatively impact breeding success (S. Hallager, personal communication).

Emergency protocols: All kori bustard emergency safety procedures must be clearly written, provided to appropriate staff and volunteers, and readily available for reference in the event of an actual emergency (AZA Accreditation Standard 11.2.3).

Staff training for responses to emergencies must be undertaken, and records of such training maintained. Both animal care staff members and security personnel must be trained to handle all emergencies in full accordance with the policies and procedures of the institution and in some cases, may be in charge of the respective emergency (AZA Accreditation Standard 11.6.2).

Transport crates should be readily available to move kori bustards in the event of a fire or other natural disaster that requires their immediate relocation. There should be one crate per bird to ensure that translocation can be performed quickly, if needed. For zoos in hurricane prone zones, birds should be housed in sheds or cement structures (e.g., basements, bathrooms) that can withstand hurricane force winds during the storm. Institutions should develop protocols that provide step-by-step instructions for where birds should be moved, how, when, and by whom. Non-perishable food and sufficient water should be left with the kori bustards in their shelters in the event staff cannot immediately service the birds after the storm.

Emergency drills should be conducted at least once annually for each basic type of emergency to ensure all staff is aware of emergency procedures and to identify potential problematic areas that may require adjustment. These drills should be recorded and evaluated to ensure that procedures are being followed, that staff training is effective and that what is learned is used to correct and/or improve the emergency procedures. Records of these drills should be maintained and improvements in the procedures duly noted whenever such are identified. AZA-accredited institutions must have a communication system that can be quickly accessed in case of an emergency (AZA Accreditation Standard 11.2.4).

AZA Accreditation Standard

(S11.2.3) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

AZA Accreditation Standard

(S11.6.2) Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e., shooting

AZA Accreditation Standard

(S11.2.4) The institution must have a communication system that can be quickly accessed in case of an emergency.

Chapter 3. Transport

3.1 Preparations

Kori Bustard transportation must be conducted in a manner that adheres to all laws, is safe, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11). Safe kori bustard transport requires the use of appropriate conveyance and equipment that is in good working order. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies, such as flight delays, and contingencies that may arise, and the timely execution of the transport.

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(S1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to.

Transport crates: All crates for shipping kori bustards by air should meet International Air Transport Association (IATA) recommendations. Information on specific shipping recommendations related to kori bustards can be found at www.iata.org. Shipping crates can be made specifically for the purpose of transporting kori bustards (typically necessary for transporting adult males); alternatively, it is possible to use a plastic airline dog kennel of appropriate size for shipping females and juvenile males. Crate size will vary according to the sex and age of the bird being shipped (see Table 6).

Crates should not be too large. Kori bustards tend to be nervous during transport, and relatively close confinement will help them to retain their balance and reduce struggling. It is not necessary for a kori bustard to be able to turn around easily within its crate. Regardless of crate type, the inside roof of the crate should be padded to protect the top of the bird's head. In general, it is recommended that a crate that is padded on top, tall enough for the bird to stand upright, and just narrow enough to restrict a large amount of movement.

Table 6: Recommended transport crate sizes for kori bustards

Sex/Age	Crate Type	Crate Dimensions (L x W x H)
Females (all ages)	Large sky kennel or wooden crate	---
Juvenile males (<6 months)	Large sky kennel or wooden crate	---
Adult males (>6 months)	Wooden crate	34" x 21" x 33" (86cm x 53cm x 83cm)

Equipment and supplies: Transport protocols should be developed to ensure the safe transport of kori bustards between shipping and receiving institutions, and both institutions should have appropriate equipment and supplies to care for birds immediately before and after the birds are loaded onto aircraft for transport. Sufficient diet should be shipped with the animal to allow for a gradual transition to a new diet at the receiving institution.

Contingencies: Safe transport also requires the assignment of an adequate number of appropriately trained personnel (by institution or contractor) who are equipped and prepared to handle contingencies and/or emergencies that may occur in the course of transport, such as flight delays. Planning and coordination for animal transport requires good communication among all affected parties, plans for a variety of emergencies and contingencies that may arise, and timely execution of the transport. At no time should the animal(s) or people be subjected to unnecessary risk or danger.

3.2 Protocols

Transport protocols should be well defined and clear to all animal care staff.

Crating animals for transport: Protocols for successfully capturing and crating birds in preparation for transport are described in Chapter 6, section 6.5. The use of operant conditioning to train birds to enter crates without the need for capture is discussed in Chapter 8, section 8.1.

Food and water: Food and water are not needed in the crate unless the bird will be held in the crate for more than 24 hours. Birds should be well fed prior to transport, as they may not eat immediately upon

their arrival at their new destination. Wild-caught birds, even those previously held in zoos, may not eat for several days after shipping. Hand-reared birds will likely eat within a day of arrival (if not sooner). Water should be immediately available once the bird has arrived at the receiving institution.

For transport longer than 24 hours, kori bustards can be offered water in a small bowl placed in the crate. The water should be removed after an hour to prevent the bird from tripping. Pieces of watermelon can also be offered, but the birds may not recognize these as food if watermelon is not part of their usual diet. Mice are appropriate food items during transport. If it is known that transport will take longer than 24 hours, transport crates should be designed to allow food and water to be provided to the bird through appropriate access ports. Doors that slide up and down are recommended for kori bustard shipping crates. This design allows partial opening of the door from the bottom so that food and water can be provided and retrieved without risk of the bird escaping.

Substrate and bedding: The floor of the transport crate should be covered with a non-slip material such as indoor/outdoor carpeting. Hay or straw should be placed on top of non-slip materials, as they do not provide enough traction when placed directly on a plywood or plastic floor. Kori bustards have very small feet for the size of their bodies, and can lose their balance easily. Hay and straw can be used effectively to absorb urates and fecals during transport.

Temperature, light, and sound: Kori bustards are large, and their body heat can increase the interior temperature of crates considerably. This is especially significant for shipping that takes place during summer months. It is recommended that shipments should be carried out early in the day during the warmer summer months, and during times of extreme heat, so that the birds are not subjected to extreme temperatures while in their crates waiting to be loaded onto planes or trucks. Temperatures within the crate should remain within the range of 45-85°F (7.2-29.4°C) to ensure the safety and comfort of the birds. Air holes in crates are necessary to provide sufficient ventilation (IATA 2008), and these can be covered with breathable fabrics (e.g., burlap) if more darkness is required for the bird within the crate, low light conditions may help to minimize the stress associated with transport. The bird within the crate should not be able to see out of the crate easily. The shade-cloth material should not restrict ventilation within the crate.

Animal monitoring: Kori bustards should always be shipped singly in crates. There is no requirement for animal caretakers to accompany kori bustards during shipping, although some zoos have their own requirements for keepers to accompany birds on international flights. Where possible, kori bustards should not be held in a crate longer than 24 hours. Transport crates should not be opened during transport unless there is a medical emergency, and it is recommended that they are opened under the supervision of a veterinarian at the shipping or receiving institution. Doors that slide up and down are recommended for kori bustard shipping crates, as these will reduce the risk of the bird breaking free from the crate if access by a veterinarian or caretaker is needed.

Post-transport release: When recovering from transport (or anesthesia within a crate), it is important to make sure the bird is safe from injury and has recovered completely before it is released, although release should occur as soon as possible after prolonged transport. The release protocol should be similar to the manual release described in Chapter 6, section 6.6, with the crate door directed towards an open space within the bird's new enclosure (e.g., quarantine enclosure) that the bird can see. The bird should be allowed to step out of the transport crate on its own accord. Once the bird has moved away from the crate, this can be removed while the bird continues to be watched for any negative reactions associated with the shipping experience.

Within-institution transportation: For the transportation of kori bustards within an institution, it is generally recommended that the bird be hand-carried, if possible, as this will reduce the problems associated with recapture once the bird is released from its crate (see Chapter 6, section 6.6 for more information on capture and restraint procedures). Kori bustards are not used in conservation and education programs outside of their enclosures, and so internal transfers of kori bustards will be typically limited to medical situations under the supervision of veterinary personnel (see Chapter 6, section 6.6 for additional information).

Chapter 4. Social Environment

4.1 Group Structure and Size

Careful consideration should be given to ensure that animal group structures and sizes meet the social, physical, and psychological well-being of kori bustards, and facilitate opportunities for them to perform a full range of species-appropriate behaviors. By nature, kori bustards are generally solitary animals, except for females with chicks. In some instances, kori bustards in the wild have been observed to form small semi-social groups during the non-breeding season (Hallager and Boylan 2004). In the wild, chicks separate from their mother at the start of the following year's breeding season. In zoos, data are limited, but it is also recommended that young be removed from the enclosure before the onset of the next year's breeding season. In general terms, at least two kori bustards should be housed together to allow for social interactions, but this will be dependent on the sex and temperament of the birds, and the space provided (e.g., during winter housing). Maintaining single birds is not recommended on a long-term basis; optimum group size for kori bustards is 1-2 males and 2-3 females, depending on the enclosure facilities available.

Kori bustards show clear dominance hierarchies within genders. Adult birds (male and females) are dominant over juvenile birds. Kori bustard adult males are always dominant over females. Males generally show stable hierarchies over time. Where multiple males are housed together, the age of the male does not predict the rank of that male (Hallager and Boylan 2004). It is generally recommended that adult males be housed separately at all times (see below for exceptions to this recommendation). Female rank can change with breeding status, and so dominant females during the breeding season may not remain so during the non-breeding season (Hallager and Boylan 2004).

When females are housed together, it is recommended that each bird be provided with at least 2691ft^2 (250m^2) of useable space, and that suitable visual barriers (e.g., thick shrubs) are available within the enclosure. Subordinate females can occasionally receive attacks on the head and neck from dominant birds (Hallager and Boylan 2004). Care should be taken to monitor for actual physical injuries that result from dominance interactions. Areas within enclosures that allow individuals to get out of sight from one another are advantageous (e.g., areas containing bushes, or low relief – see Chapter 2, section 2.1 for additional information), as they allow subordinate birds to hide from more dominant individuals. This will minimize aggressive interactions between the birds.

Breeding season: During the breeding season, multiple females can be housed with a single male, although females may become less compatible with one another during the breeding season. Previously, it was recommended to keep two males in the breeding flock so that they would stimulate each other into breeding behavior, as males do tend to display synchronously. However, recent breeding in flocks of only one male negates this strict recommendation. Animal caretakers should monitor male/male compatibly constantly if males are housed together in the non-breeding season, and it is strongly recommended that adult males (>3 years old) be housed separately during the breeding season (regardless of their compatibility), because dominant males may kill or severely wound subordinate males.

Providing females with the opportunity to choose a mate has been attempted in some institutions by housing females in a central enclosure adjoined by two or more enclosures housing single males (Hallager and Boylan 2004). The males are stimulated to display by the sight and sound of their competitors, and females have the option to select males by passing through a 29.5" x 22.4" (75cm x 57cm) opening to each enclosure with a male inside. The size of the opening is too small for males to pass through, although some males have become stuck in these holes trying to gain access to females, and have injured themselves (Hallager and Boylan 2004). These openings should be used with caution, if at all.

Non-breeding season: The appropriate size and composition of social groupings during the non-breeding season is dependent upon the age, sex, and personality of individual birds. Multiple females and one male can be housed year-round in the same enclosure. Juvenile males (<3 years) that have grown up together are generally compatible, although once they reach sexual maturity aggression tends to escalate and the addition of a female will likely alter the compatibility of the males. In zoos, it is safest to house adult males separately from other males year round, although individual bird personalities, along with specific enclosure size/configurations, may allow certain males to be housed together during the non-breeding season. Animal caretakers should know the personalities of the males involved very well

before the decision is made to allow them access to each other, and any physical aggression between the males should be monitored very closely. Aggressive behaviors observed consist of grabbing/holding on and/or pecking. At the first sign of any aggression, even mild chasing, the males should be separated, as it has been demonstrated that mild aggression quickly escalates to higher levels of aggression. Some aggression is subtler, and care should be taken to ensure that subordinate males are not being chased from food sources and marginalized within the exhibit, as this can lead to the subordinate animal experiencing chronic stress (Hallager and Boylan 2004). Institutions should have the ability to separate males in the event of aggression, and to house them in enclosures providing opportunities for the animals to perform their full range of species-appropriate behaviors. If multiple males are maintained together, they should be housed in a very large area (e.g., >43,550ft^2/4046m^2), as this may allow the subordinate male to escape from the dominant male. However, more research is recommended to determine the appropriate conditions (if any) for housing males together year round.

Winter housing and temporary holding: Winter housing is usually smaller or more behaviorally restrictive than regular housing, although the complexity of the enclosure and the range of behavioral opportunities available to the birds should match that of their primary enclosures (see Chapter 2, section 2.1). Social group options in smaller holding areas are dependent on individual bird personalities. If females are compatible, temporary holding areas that are 8' x 8' (2.4m x 2.4m) are sufficient. However, aggressively dominant females can harm subordinate females, especially when confined in small areas. Adult males should never be housed in the same holding stall together, even if they are considered compatible. However, juvenile males (<3 years) may be housed together depending on individual bird personalities. Multiple females can usually be housed with a single male unless the male is overly aggressive. Aggressive males should always be housed alone. Animal caretakers should rely on their knowledge of each bird's behavior when determining housing arrangements.

4.2 Influence of Conspecifics and Other Species

Animals cared for by AZA-accredited institutions are often found residing with other animals of their species (conspecifics) but may also be found residing with other species. In the case of kori bustards, if two males are housed in adjacent enclosures during the breeding season, a visual barrier may need to be erected to prevent the dominant male from attempting to be aggressive towards the subordinate male through the physical barrier. The visual barrier will prevent the dominant bird from injuring himself, and may enhance a sense of security for the subordinate male. Some subordinate males may be sexually inhibited by the visual presence of the dominant male. In some cases, however, males may need only a physical barrier; some subordinate males have bred successfully within sight of the dominant male. Visual access may even act to stimulate one or both males to display/breed. The dynamics of each pair of dominant-subordinate males in their separate enclosures is different, and management should be adjusted to minimize aggression while promoting breeding. If an adult male is not involved in breeding, it is not recommended to house the bird next to an exhibit containing females, especially when there is no visual barrier between the birds. A male's frustrated attempts to gain access to the females may lead to physical injuries or chronic stress.

Consideration should also be given to the nature of other species housed next to kori bustard enclosures. Species that could injure or kill a kori bustard should not be housed adjacent to kori bustard enclosures if the potential exists for a kori to escape and inadvertently enter a neighboring yard (e.g., an uncovered enclosure). Containment barriers between kori bustards and other species should also prevent any form of physical interaction between the animals.

Mixed-species exhibits: Some species have been housed successfully with kori bustards in mixed-species enclosures. Before integrating other species with kori bustards, it is recommended that AZA institutions with successful mixed-species exhibits be contacted to determine specific exhibit parameters necessary to keep all species involved safe and comfortable. The AZA Kori Bustard SSP Coordinator should also be contacted prior to integrating species for advice on compatibility.

For institutions with small enclosures, it is recommended that flocks of kori bustards be housed by themselves. Breeding is less likely to occur in mixed-species enclosures. Institutions with larger enclosures may be able to house their kori bustards with other suitable species of birds and mammals, although successful reproduction may still be more likely if the kori bustards are housed by themselves.

The table below (Table 7) summarizes a mixed-species survey performed by the AZA Kori Bustard SSP and is designed to be a reference guide to assist managers in their selection of compatible species.

The methodology of this survey can be found in the "Kori Bustard Species Survival Plan (*Ardeotis kori*) Husbandry Manual" (Hallager and Boylan 2004).

Table 7: List of species interacting successfully or aggressively with kori bustards (adapted from Hallager and Boylan 2004).

Species Successfully Housed with Kori Bustards		**Species Where Aggression Has Occurred**	
Bird	*Mammal*	*Bird*	*Mammal*
African spoonbill	Blesbok	East-African crowned crane	Eland
African yellow-billed stork	Dik-dik	Marabou stork	Gerenuk
Demoiselle crane	Duiker	Ostrich	Giraffe
Egret	Gazelle	Saddle-billed stork	Kudu
Egyptian vulture	Hartebeest		Okapi
European white stork	Impala		Pygmy hippo
Flamingo	Nyala		Springbok
Ground hornbill	Rhinoceros		Topi
Guinea fowl			Waterbuck
Hooded vulture			Zebra
Lappet-faced vulture			
Sacred ibis			
Secretary bird			
Waterfowl			

It is strongly recommended that kori bustards not be housed with species that are known to show aggressive behaviors towards the birds. Within mixed-species enclosures, kori bustards should be provided with an area in which they can feel completely secure, and where other animals cannot enter. This is especially important when kori bustards are housed with hoofstock species. A secure area can be accomplished by erecting bars/poles spaced close enough that kori bustards can pass through, but which exclude larger hoofstock. Space, complexity, and design considerations for mixed-species enclosures containing kori bustards should follow the recommendations provided in Chapter 2, section 2.1, and institutions should also contact the TAGs/SSPs for the other species housed within the enclosure to ensure that their behavioral and physical needs are also being met.

4.3 Introductions and Reintroductions

Managed care for and reproduction of animals housed in AZA-accredited institutions are dynamic processes. Animals born in or moved between and within institutions require introduction and sometimes reintroductions to other animals. It is important that all introductions are conducted in a manner that is safe for all animals and humans involved.

Introductions: The best time for introducing new birds together is during the non-breeding season (this varies throughout the United States – see Chapter 7, section 7.1 for additional information). In the non-breeding season, birds are calmer and less aggressive, and long introduction periods are typically unnecessary. New birds should never be introduced to an enclosure occupied by other kori bustards during the breeding season, as levels of aggression are at their highest during this time. Introduction of new birds to a breeding flock will also negatively impact the breeding members of the flock, and the new birds will be unduly subjected to abnormal levels of aggression.

Ideally, an introduction protocol should consist of housing the new bird next to its intended exhibit mates, with a physical barrier that allows for visual contact for at least a few days, before full physical introductions are then attempted. This step-by-step approach is recommended for all introductions. Where this is not possible, a bird may need to be placed directly into the new situation with other animals. Although this procedure is not recommended, when it is used, it is crucial for animal caretakers to know individual bird characteristics so that they can identify which birds will more likely be aggressive towards new arrivals. Sufficient staff members should be present to monitor the initial few days of the introduction, as the dynamics of the social group will change. Specific recommendations for different types of introductions are provided below.

Male/female and female/female introductions: When introducing a new male or female to another female (or group of females), the new animal should be housed in a pen that has visual (but not physical) access to the females for at least a few days prior to complete physical introductions. Males or females should

not be introduced to an existing flock during the breeding season unless the flock is a non-breeding flock (e.g., males are not displaying, and females are not laying). Once new females are added, there will be a re-ordering of the social hierarchy. Animal caretakers should monitor aggression levels, and action may need to be taken if individuals show physical injuries (e.g., bleeding, lacerations), or limping and exhaustion from excessive chasing. The same approach can be taken when introducing a new female to a male. The new female should be housed in a pen so that she has visual (but not physical) access to the male for at least a few days, and introductions should not take place during the breeding season.

Introduction of a male to a male: Males should be introduced by visual contact only during the non-breeding season. If physical introductions are attempted, an extended period (7-10 days) of visual contact is recommended, and a physical introduction should not be attempted if one male is persistently seen trying to be aggressive to the other male during the visual contact period. Some males are compatible during breeding season, but most are not. The safest situation is to house adult males separately even during the non-breeding season. With the absence of females, males are less likely to fight. However, keepers should always watch for signs of aggression, and should separate males to avoid injury (see section 4.1).

Introduction of juvenile birds (1-3 years) to adult birds: When introducing young birds (male or females) to an existing flock, the new birds should be housed in a pen so that they have visual (but not physical) access to the other birds for at least a few days. Young birds should not be introduced to an existing flock during the breeding season unless the flock is a non-breeding flock. Young birds entering an established flock will likely be the most subordinate members of the flock, and so it is important that these birds be monitored closely for overly aggressive actions by other birds. Animal caretakers should expect some aggression to occur as the flock sorts out its new hierarchy, but this should decrease over time.

Introduction of hand-reared chicks to other chicks: At 5 days, chicks can be placed with other chicks provided that the older chick is less than two weeks old. Before 7 days of age, chicks should not be placed with chicks older than 2 weeks of age, as the older chick has the capacity to injure severely (and possibly fatally) the younger chick (Hallager and Boylan 2004). Chicks can eventually be placed together when the youngest chick is 3 weeks old. When introducing young chicks together, the older chick will typically be aggressive towards the younger chick, but the period of aggression is usually limited to the first few hours after the introduction (Hallager and Boylan 2004). Chicks should be observed carefully during the brief introduction period.

Introduction of birds to mixed-species enclosures: If birds are to be placed in a mixed-species enclosure, the ideal approach would be to allow the kori bustards to set up residency in an empty enclosure first, and then slowly introduce other appropriate species to that enclosure.

Chapter 5. Nutrition

5.1 Nutritional Requirements

A formal nutrition program is recommended to meet the behavioral and nutritional needs of all kori bustards (AZA Accreditation Standard 2.6.2). Diets should be developed using the recommendations of veterinarians as well as AZA Taxonomic Advisory Groups, Species Survival Plans, and Nutrition Advisory Group (www.nagonline.net/feeding_guidelines.htm). Diet formulation criteria should address the animal's nutritional needs, feeding ecology, as well as individual and natural histories to ensure that species-specific feeding patterns and behaviors are stimulated.

AZA Accreditation Standard

(S2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

There are no established daily energy requirements or energy requirement calculations/equations that can be utilized for kori bustards at this time beyond the general nutrition information provided below and sample diet information provided below in section 5.2. Additional research that focuses on exact daily food intake and energy expenditure for this species, and that covers all life stages (e.g., chick, juvenile, reproductive adult, senescent adult), will be important to perform so that more specific nutritional requirements and recommendations can be developed for kori bustards.

Kori bustards are generally considered to be omnivorous – opportunistically taking prey items and plants when they are locally abundant (Bailey and Hallager 2003). In some local environments, insects make up a large proportion of the kori bustards' diet (see Bailey and Hallager 2003). Information on the gastro-intestinal tract of various bustard species is described in detail by Bailey et al. (1997a), and includes a discussion of the functional elements of the GI tract for kori bustards as opportunistic omnivores. Kori bustards lack a crop, although their long esophagus and longer proventriculus and ventriculus may serve a functional role of food storage (Bailey et al. 1997a). Bustards are commonly found with stones in their ventriculi, and these may be purposefully ingested and play a role in grinding up food within the ventriculus (Bailey et al. 1997a). Although the GI tract of the kori bustard is typical of an insectivorous bird (Maloiy et al. 1987), they have been historically fed in zoos as "primarily carnivorous" omnivores (Hallager and Boylan 2004).

Based on ecological studies and GI tract morphology, the recommended diet for kori bustards should include nutritionally complete feeds, whole prey (vertebrate and invertebrate), and produce. Diets in zoos typically include fruits (e.g., apple), vegetables (e.g., cabbage), invertebrates (e.g., mealworms and crickets), whole vertebrate prey (e.g., mice), processed meats (e.g., beef, horsemeat), and some form of nutritionally balanced pelleted food (e.g., game bird pellets – see Table 10) (Bailey and Hallager 2003).

The target nutrient levels established for kori bustard diets were derived from several domestic and exotic species (e.g., pheasants, quail, geese, and cranes; NRC 1994; Anderson 1995). In cases where these target values are expressed as ranges in the table below (Table 8), the low end represents a maintenance requirement, the high end (marked by a double asterisk) represents a breeding requirement, and the growth requirement tends towards the high end of the range.

Table 8: Proposed nutrient guidelines for kori bustards on a dry matter basis*

Nutrient	Proposed Nutrient Guidelines 2004
Protein, %	16.5-30.0**[1]
Fat, %	---
Crude Fiber, %	---
Ca, %	0.66-2.75**
P, %	0.33-1.0**
Ca:P	---
K, %	0.44-0.72
Na, %	0.13-0.18
Mg, %	0.05-0.06
Cu, mg/kg	5.5-8.8
Fe, mg/kg	55-77
Zn, mg/kg	55-70.1
Mn, mg/kg	66-72
Se, mg/kg	0.2

Nutrient	Proposed Nutrient Guidelines 2004
I, mg/kg	0.33-0.44
Vitamin A, IU/g	1.65-5.5
Vitamin D3, IU/g	0.22-1.2
Vitamin E, IU/kg	11.0-27.5
Thiamin, mg/kg	2.2
Riboflavin, mg/kg	2.75-4.4
Pyridoxine, mg/kg	3.3-5.0
Vitamin B12, mg/kg	0.003-0.01
Biotin, mg/kg	0.11-0.25
Choline, mg/kg	990-1650
Folacin, mg/kg	0.8-1.1
Niacin, mg/kg	22-71.5
Pantothenic acid, mg/kg	10.5-17.6

* Target values based on NRC (1994) and Anderson (1995).
** Values at high end of range for breeding only.
[1] Available data indicate that breeding diets for kori bustards that contain 26.4% crude protein on a dry matter basis should be adequate (Hallager et al. 2002). Recommendations for dietary crude protein levels of no more than 24% on a dry matter basis for growing sandhill cranes (Serafin 1982) may also be appropriate for growing kori bustards. A target of 30% crude protein in breeding diets represents a starting point.

Factors influencing nutritional requirements: The following factors affect the nutritional requirements of kori bustards, and should be carefully considered when formulating appropriate diets.

Hand-reared chicks: Limited published data are available regarding successful hand-rearing diets for kori bustard chicks (Maslanka and Ward 2003; Hallager 2005). However, nearly all hand-reared chicks prior to 2008 have developed angel wing, a condition linked to high protein diets in waterfowl and cranes (Serafin 1982; Kear 1986). Growth rates of previously hand-reared chicks that developed angel wing ranged from 5.7-8.1% of body weight on a daily basis (mean = 6.8; Hallager et al. 2002). Whereas fast growth is important for production birds with significant muscle mass, it is not the goal for exotic birds housed in zoos. Angel wing in waterfowl and cranes can be successfully "treated" by reducing the crude protein content of the diet offered. For hand-reared kori bustards, it may be more appropriate to maintain dietary protein levels that allow normal growth in waterfowl and cranes. It is recommended that diets for hand-reared kori chicks contain between 18-22% crude protein on a dry matter basis, and growth should not exceed 5% of body weight per day, in an attempt to avoid angel wing.

Reproductive status: Breeding females should be given supplemental calcium at least one month prior to the beginning of egg laying. Appropriate vitamin E levels are essential for successful reproduction in most bird species, and deficiency of this vitamin has been associated with both low fertility and low hatchability (Dierenfeld 1989). Chicks and juvenile birds may also have a higher requirement for vitamin E, as researchers have found plasma concentrations of vitamin E to be lower in juvenile birds despite a higher vitamin E intake by these juveniles from their diets (Anderson et al. 2002).

Seasonal changes in nutrition: In northern latitudes, where temperatures regularly fall below 32ºF (0ºC), birds should be offered more food in colder months than in warmer months to accommodate a higher rate calorie requirement. Foods high in fat (e.g., peanuts or peanut butter) can be offered as occasional enrichment items during winter months. Increases in diet amounts may be based on observed behavior changes or increased consumption, but should be made in coordination with institution veterinarians and nutritionists. As with most birds, protein requirements for kori bustards increase during the breeding season, and birds should be placed on a breeder pellet instead of a maintainer pellet. Females should be provided with additional calcium in the form of oyster shell.

AZA Accreditation Standard

(S2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

5.2 Diets

The formulation, preparation, and delivery of all kori bustard diets must be of a quality and quantity suitable to meet the animal's psychological and behavioral needs (AZA Accreditation

Standard 2.6.3). Food should be purchased from reliable, sustainable, and well-managed sources. The nutritional analysis of the food should be regularly tested and recorded.

Sample diets: Based on the reported foraging strategy of free ranging kori bustards, proposed diet proportion guidelines are presented in Table 9. These guidelines can assist with diet formulation by proportion, in order to ensure that nutrient needs are met and levels of specific nutrients are not grossly exceeded (i.e., protein). Diets can be formulated by using the table to select the desired proportions of items present in smaller amounts (e.g., vertebrate prey, invertebrate prey, and produce), and then a nutritionally complete food (see Table 10) can be used to round out 100% of the total diet. The nutritionally complete items included in the diet should provide the nutrient backbone of the diet.

Table 9: Kori bustard recommended diet proportion guidelines (as fed basis).

Item	Minimum % of Diet	Maximum % of Diet
Vertebrate prey	0	25
Invertebrate prey	5	30
Nutritionally complete feeds*	40	55**
Produce	10	20

* Nutritionally complete feeds are those designed to meet specific recommended nutrient levels. Specifications are provided in section 5.1 (Table 8).

** Diets which exceed 55% complete feeds can be considered. A diet comprised of 75% complete feed has successfully maintained kori bustards in zoos and aquariums (Anderson 1995).

There are a range of nutritionally complete foods that are capable of meeting the nutritional requirements of kori bustards, and that can be successfully included within their diets with approval from institutional veterinarians and nutritionists. See Table 10 for examples of nutritionally complete feeds capable of meeting target nutrient values within the framework provided by the recommended diet proportions listed in Table 9 above.

Table 10: A sample of nutritionally complete feeds suitable for kori bustard diets (as recommended by institutional veterinarians and nutritionists) as part of the overall diet (values on a dray mater basis).

Nutrient	Mazuri Exotic Gamebird Maint [1]	Zeigler Avian Maint [2]	Mazuri WF Maint	Mazuri Ratite	Zeigler Ratite Gr/Mai	Zeigler Crane Breeder	NARC Production Pellet [3]	Kock Pellet [4]
Protein, %	13.9	13.9 mi	15.6	16.7	17.8 mi	24.4 mi	24.3	17.8-22.1
Fat, %	3.6	2.2 mi	4.1	4.6	4.4 mi	5.6 mi	-	-
Crude Fiber, %	4.7	5.5 ma	4.6	18.0	15.6 ma	5.6 ma	-	5.0-4.5
Ca, %	0.9	0.9	1.3	1.8	1.0	3.1	3.7	1.4-3.9
P, %	0.3	0.6	0.4	0.9	0.8	0.9	0.9	0.9-1.9
Ca:P	3.0	1.5	3.2	2.1	1.25	7.8	4.6	1.7-2.1
K, %	0.6	0.6	0.6	0.8	1.3	0.8	0.9	0.9-1.0
Na, %	0.1	0.1	0.2	0.3	0.2	0.3	0.2	0.4-0.5
Mg, %	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.3-0.4
Cu, mg/kg	10.0	11.5	10.0	20.0	24.4	16.8	16.6	9.6-9.5
Fe, mg/kg	144.4	158.9	155.6	455.6	282.4	348.2	442.9	131.1-191.8
Zn, mg/kg	100.0	49.1	101.1	142.2	175.7	136.9	72.8	69.5-167.2
Mn, mg/kg	111.1	48.5	108.9	122.2	192.1	147.1	80.6	70.7-139.4
Se, mg/kg	0.5	0.4	0.5	0.6	0.6	0.5	0.3	0.2
I, mg/kg	1.2	0.6	1.3	1.2	0.6	0.4	0.9	1.4-2.3
Vitamin A, IU/g	6.7	8.2	10.8	11.3	24.6	19.2	13.8	6.6-7.1
Vitamin D3, IU/g	2.5	0.6	2.5	1.7	1.5	2.1	3.3	1-3
Vitamin E, IU/kg	138.9	140.5	133.3	188.9	173.8	78.6	37.2	75.6-222.0
Thiamin, mg/kg	11.0	6.7	6.9	9.6	12.3	16.3	5.9	12.4-16.2
Riboflavin, mg/kg	6.1	5.7	3.4	11.1	9.4	14.3	8.4	8.6-13.8

Nutrient	Mazuri Exotic Gamebird Maint [1]	Zeigler Avian Maint [2]	Mazuri WF Maint	Mazuri Ratite	Zeigler Ratite Gr/Mai	Zeigler Crane Breeder	NARC Production Pellet [3]	Kock Pellet [4]
Pyridoxine, mg/kg	6.4	10.1	5.4	6.7	126.3	15.2	8.8	9.2-13.7
Vitamin B12, mg/kg	16.7	^	0.01	0.02	^	^	0.02	0.04-0.05
Biotin, mg/kg	0.4	0.4	0.3	0.5	0.5	0.7	0.2	0.3-1.2
Choline, mg/kg	7888.9	1751.7	1133.3	1555	1637.6	2188.7	896.4	976-1494
Folacin, mg/kg	3.0	2.0	1.7	6.3	5.4	5.3	1.1	2.5-9.4
Niacin, mg/kg	103.3	88.3	86.7	121.1	126.3	136.2	68.2	75.5-88.4
Pantothenic acid, mg/kg	11.1	29.1	20.0	28.9	41.1	40.2	25.1	34.7-50.8

[1] PMI Nutrition International, LLC. Brentwood, MO 63144
[2] Zeigler Brothers, Gardners, PA 17324
[3] Production Pellet (Anderson 1995).
[4] Richard A. Kock Pelleted Diets (Kock 1990). Values expressed as a range of maintenance-breeder.
^ Missing values unavailable from manufacturer.

The diets listed in Table 11 (see Table 12 for nutrient analyses of the example diets) are not recommended diets, but examples of how the proportions listed in Table 9 can be used to formulate diets that meet nutrient guidelines. A variety of ingredients can be chosen based upon availability, palatability, and management needs.

Table 11: Examples of kori bustard diets using recommended diet proportions

Diet	Vertebrate Prey	Invertebrates (Crickets)	Nutritionally Complete Foods	Produce
1	25% (mice)	25%	35% (Zeigler Avian Maintenance[1])	15%
2	15% (mice)	25%	40% (Mazuri Waterfowl Maintenance[2])	20%
3	0%	25%	55% (Zeigler Ratite Grower/Maintenance[1])	20%
4	20% (mice)	25%	55% (Mazuri Exotic Gamebird Maintenance[2])	0%
5	10% (beef)	0%	75% (Kock Kori Production Pellets[3])	15%

[1] Zeigler Brothers, Gardners, PA 17324
[2] PMI International, LLC, Brentwood, MO
[3] Kock 1990

The following table (Table 12) provides a nutrient analysis of each of the example diets listed in Table 11 above, with a comparison to the proposed nutrient guidelines (Table 8) listed in section 5.1.

Table 12: Example diets (see Table 11) that meet proposed nutrient guidelines (as of 2004) for kori bustards (analysis on a dry matter basis).

	Example Diets[1]					Proposed Nutrient Guidelines 2004[2]
Nutrient	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	
Protein, %	29.1	27.9	24.3	21.2	23.6	16.5-30.0**
Fat, %	7.5	7.6	5.5	4.7	2.8	-
Crude Fiber, %	5.3	5.0	14.4	5.3	4.3	-
Ca, %	1.1	1.2	0.9	0.8	3.6	0.66-2.75**
P, %	0.9	0.8	0.9	0.7	1.8	0.33-1.0**
Ca:P	1.2	1.5	1.0	1.1	2.0	-
K, %	0.6	0.7	1.4	0.7	1.1	0.44-0.72
Na, %	0.1	0.1	0.2	0.1	0.5	0.13-0.18
Mg, %	0.1	0.2	0.3	0.2	0.4	0.05-0.06
Cu, mg/kg	13.1	13.8	25.6	14.2	8.9	5.5-8.8

	Example Diets[1]					Proposed Nutrient Guidelines 2004[2]
Nutrient	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	
Fe, mg/kg	187.4	107.7	291.0	264.4	182.0	55-77
Zn, mg/kg	93.2	121.6	194.9	114.7	158.5	55-70.1
Mn, mg/kg	42.7	83.4	183.1	5.3	127.1	66-72
Se, mg/kg	0.3	0.3	0.8	0.4	0.2	0.2
Vitamin A, IU/g	7.9	11.4	5.5	8.8	7.8	1.65-5.5
Vitamin D3, IU/g	0.5	1.8	1.4	2.1	2.7	0.22-1.2
Vitamin E, IU/kg	105.8	96.1	162.3	118.0	203.8	11.0-27.5
Thiamin, mg/kg	5.1	5.1	11.5	8.5	15.1	2.2
Riboflavin, mg/kg	4.4	2.7	8.9	5.3	13.0	2.75-4.4
Pyridoxine, mg/kg	7.6	4.0	11.9	5.5	12.8	3.3-5.0
Vitamin B12, mg/kg	0.01	0.01	0.02	0.01	0.003	0.003-0.01
Biotin, mg/kg	0.3	0.2	0.4	0.4	1.1	0.11-0.25
Folacin, mg/kg	1.6	1.5	5.4	2.8	0.1	0.8-1.1
Niacin, mg/kg	66.8	63.0	118.7	88.1	88.8	22-71.5
Pantothenic acid, mg/kg	22.1	14.8	38.8	9.8*	47.3	10.5-17.6

[1] See Table 11
[2] See Table 8
* Values generated as a result of missing values in database.
** Values at high end of range for breeding only.

Kori bustards at the National Avian Research Center (NARC) in Abu Dhabi, U.A.E. were offered the following rations on a daily basis (Anderson 1998a):

Table 13: Quantity of food provided to kori bustards (Anderson 1998a)

Food Item	% of Diet	Quantity Per Bird (g)
Bustard pellet	75.0	292.5
Minced meat	9.7	37.80
Apple	9.7	37.80
Cabbage	4.8	18.90
Calcium carbonate	0.8	3.00
Total		**390.00**

While the above diet is not representative of diets fed in the United States, it does give an estimate of the approximate amount of food a kori bustard needs to consume on a daily basis. Kori bustard activity level remains fairly stable year round, and food amounts are likely to remain stable throughout the year. Seasonal changes (see section 5.1) will influence food changes more than other factors.

Diet type and presentation: Kori bustards are omnivorous. General observations of free-ranging kori bustards indicate that although they consume mainly insects, they also consume lizards, leaves, seeds, acacia gum, and flowers (Osborne 1998; Osborne and Osborne 1999). Mwangi (1988) recorded kori bustards in East Africa mainly consuming flowers, seeds, fruits, and pods. Produce items included in kori bustard diets in zoos can range from fruits to leafy greens and vegetables. Insect prey consumed by wild kori bustards consisted of Hymenoptera, Orthoptera, Coleoptera, and Lepidoptera. Non-insect prey consumed included Chilopoda, Diplopoda, Annelida, and Reptilia.

The staple of most kori bustard diets in zoos is a combination of mice, beef or horsemeat, and avian pellets (e.g., gamebird or crane pellets), along with a variety of produce items and insects. All food items provided within the diet should be included in the nutritional analysis of the complete diet. Whereas free-ranging insectivores have a myriad of insect prey choices, the variety of commercially available insects is limited. It is important that the nutrient content of the insects chosen is known. There are excellent references that provide the nutrient content of invertebrate prey (e.g., Bernard and Allen 1997), and these should be carefully reviewed when formulating diet for kori bustards. 'Gut-loading' has been shown as the method of choice to improve the nutrient profile of commercially available insects (Bernard and Allen

1997). For mother-reared chicks, insects are always the preferred food item, although dams will also feed pinkies and meatballs (beef or horsemeat mixed with avian pellets) to chicks. Pinky mice should be used instead of full-grown mice in the mother's diet, until the chick weighs 2.2lb (1kg), as chicks that ingest too much mouse fur can experience gut impaction. Giant mealworms should also be removed from the adult's diet to prevent them from being fed to the chicks, and the back legs of any crickets that are provided should be removed.

When the diet is provided to kori bustards, food items can be offered in pans, tubs, buckets, platforms, etc, or hand-fed to individual birds in a group. Kori bustards will consume pelleted foods, and so pellet dispensers should be placed in pens to encourage the consumption of appropriate dry, nutritionally complete feeds. Dispensers and other feeding approaches should be designed to minimize the consumption of the kori bustard food by pest species (Hallager and Boylan 2004). During feeding sessions, dominant birds may displace subordinate birds from the food with short chases, and sometimes even biting. During the breeding season, subordinate females can be displaced from food dispensers by the dominant female and/or dominant male. Such displacements can involve growling by the dominant birds prior to chasing, barking by the subordinate birds, and will end with both birds fluffing their feathers. It may be necessary to provide several, well-spaced feeders to allow all birds to have access to the complete diet.

Generally, kori bustards are easy to medicate by putting a pill or liquid inside a dead mouse. There are times when birds will refuse the medicated item, however, and alternative approaches need to be considered such as: peanuts in the shell (see Table 14), cherry tomatoes, earthworms (work well for thin liquid medications), large mealworms, banana, grapes, horsemeat meatballs, or a compounded, flavored medication (when possible). It is recommended that animal caretakers become familiar with favored food items before a bird becomes ill, so that appropriate food that will be readily accepted by sick/injured birds can be provided, and to increase the likelihood that medication will be taken successfully.

AZA Accreditation Standard

(S2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

Kori bustard food preparation must be performed in accordance with all relevant federal, state, or local regulations (AZA Accreditation Standard 2.6.1) and an appropriate hazard analysis and critical control points (HACCP) food safety protocols for the diet ingredients, diet preparation, and diet administration should be established. Diet preparation staff should remain current on food recalls, updates, and regulations per USDA/FDA. As kori bustards do eat meat, any meat processed on site should be processed following all USDA standards. Kori bustard diets containing raw meat need careful consideration in terms of preparation, handling, and provision; meat is a perishable food item, and spoilage can occur for a variety of reasons, including growth and activity of micro-organisms, insects or parasites, natural enzyme action in meat, chemical reactions, and physical changes (Hallager and Boylan 2004).

The potential for spoilage is based on the type/number of micro-organisms present on the meat, in the storage and preparation areas, or transferred by the handler or by 'pest' species with access to the kori bustard enclosures (Frazier and Westhoff 1988). Meat and whole prey items should be held at appropriate temperatures during periods of thawing, preparation, and storage, and meat items should not remain at temperatures capable of promoting excessive microbial growth for excessive periods of time once fed to the animals (Crissey et al. 2001). Uneaten meat should be disposed of according to local or state requirements.

Feeding schedules: Observations by Osborne and Osborne (1998) show that kori bustards in Etosha National Park feed around 0900h and again around 1700h, resting during the heat of the day. In zoos, kori bustards should be fed twice per day, but additional feedings should be considered to allow for necessary husbandry management and to promote behavioral opportunities for foraging and feeding throughout the day. As long as birds have adequate time to consume the diet, the period of access to diet can range from several hours to all day. Minimizing the presence of pest species, and their consumption of the diet, may shorten the periods of time when the diet is offered to the birds, unless pest-proof feeders are provided (see Chapter 2, section 2.2 for additional information). The presence of pests should always be considered when determining the period of time the kori bustards have access to the diet.

Species-appropriate feeding and foraging: Kori bustards are curious, intelligent animals. Table 14 lists a range of food items that can promote foraging behavior (see Hallager and Boylan 2004 for a complete list). Most of the items can be scattered around enclosures to encourage foraging/searching and object

manipulation behaviors. It is important to note that different individuals in a group of kori bustards will respond differently to different items, and observations on preferred items that promote species-appropriate behaviors should be recorded for each individual. Approval from area veterinarians, managers, and nutritionists should be obtained if the following feeding approaches are considered.

Table 14: List of enrichment initiatives to promote foraging behaviors (adapted from Hallager and Boylan 2004).

Food Item	Description
Live Insects	Kori bustards respond well to live insects, such as super worms, crickets, regular mealworms, and waxworms. Birds that are off their food for various medical reasons will often start eating again if live insects are offered.
Whole peanuts in the shell	Whole peanuts are also useful for medicating birds. A small portion of the top of the peanut can be taken off, the nut inside removed, and a pill inserted in its place. The peanut shell can be replaced and secured with peanut butter. Peanuts covered with peanut butter work well for medicating birds when individuals become suspicious of medicated mice.
Peanut butter	A few tablespoons of peanut butter can be spread on the trunks of trees in the wintertime as a source of extra calories. The behavior required by the birds to obtain this food item replicates the behavior of wild birds eating sap from acacia trees.
Knucklebones	Kori bustards will also feed on knucklebones, pulling off and consuming any accessible meat. The bones should be large enough that there is no risk of the bird consuming the whole bone.
Live prey	If available, live mice will be relished by kori bustards. The birds are also good at capturing and consuming small snakes, lizards, toads, and small birds that make their way into their pens.
Alfalfa	Hanging bunches of alfalfa or other browse items from trees or other enclosure structures can also promote foraging.

While it is recommended to obtain approval from area veterinarians and nutritionists, the following food items can also be provided to kori bustards (e.g., hidden or scattered throughout the enclosure) to promote foraging behavior:

- Apple
- Banana
- Cherry tomatoes
- Chopped cantaloupe
- Chopped fruit/berries
- Cooked sweet potato
- Grapes (bunches or scattered)
- Mixed vegetables (e.g., peas, carrots, and corn)
- Watermelon

Many plant species have been observed in fecal samples from wild kori bustards (Mwangi 1988). If browse plants are used within the animal's diet or for enrichment, all plants should be identified and assessed for safety (from an ingestion and physical trauma perspective). Kori bustards have physically injured themselves on naturally growing browse in or around the perimeter of their enclosures. In one case an individual bird experience recurring injuries from barberry (*Berberis sp*.) thorns, from a plant that had grown into the enclosure (Hallager and Boylan 2004).The responsibility for approval of plants and oversight of the program should be assigned to at least one qualified individual (AZA Accreditation Standard 2.6.4). The program should identify if the plants have been treated with any chemicals or near any point sources of pollution and if the plants are safe for the species. If animals have access to plants in and around their exhibits, there should be a staff member responsible for ensuring that toxic plants are not available.

AZA Accreditation Standard

(S2.6.4) The institution should assign at least one person to oversee appropriate browse material for the collection.

Kori bustards are not browsers however individual institutions housing them may have appropriate locale-specific lists of browse materials used for enrichment. Any browse items known to have lead to an adverse reaction in kori bustards should be reported to the AZA Kori Bustard SSP Coordinator so that these can be formally documented and widely disseminated. It is also important that institutions

determine the nutrient content of any plant material and produce offered, and these data should be incorporated into the nutrient analysis of the entire diet (Hallager and Boylan 2004). There are several resources available which report nutrient content of readily available produce items (e.g., NRC 2003) and a number of laboratories are also equipped to perform nutrient assays.

5.3 Nutritional Evaluations

At the Smithsonian's National Zoo, kori bustards are weighed on a monthly basis to determine accurate body weight measures. The birds are scale trained and step onto a scale loaded with mealworms. Using this approach, Hallager (2005) has identified that males increase in body mass during the breeding season (Table 15), with the alpha male showing a significantly greater body weight increase than the beta male. This phenomenon is currently being confirmed at other institutions (S. Hallager, personal communication, 2007). Monitoring weight increase in males is one way to determine when reproductive hormones are beginning to increase (see Chapter 7, section 7.1). Body weight evaluations are important, especially for zoos that house multiple males in the same enclosure during the non-breeding season, as weight increase in the alpha bird signify that it is time to separate the males prior to the breeding season.

Table 15: Breeding and non-breeding weights (kg) for male kori bustards at National Zoo

Dominant Male						
	1999*	**2000**	**2001**	**2002**	**2003**	**Ave.**
Jan.	---	---	---	14.4	---	14.4
Feb.	10.6	---	---	15.0	14.6	13.4
Mar.	11.1	14.5	14.2	15.1	14.8	13.9
Apr.	11.8	14.4	16.3	16.6	15.8	15.0
May	14.3	14.4	17.5	17.6	18.6	16.5
June	14.1	16.2	18.5	18.0	18.8	17.1
July	15.1	16.1	18.0	17.4	18.2	16.9
Aug.	15.1	17.3	16.3	14.8	18.6	16.4
Sep.	16.2	14.3	16.7	14.2	18.9	16.0
Oct.	15.3	14.6	15.3	14.2	18.0	15.5
Nov.	15.2	---	15.2	15.4	16.0	15.4
Dec.	13.8	---	15	15.4	14.8	14.7
Subordinate Male						
	1999	**2000**	**2001**	**2002**		**Ave.**
Jan.	---	---	---	11.4	---	11.4
Feb.	10.3	12.1	---	11.9	---	11.4
Mar.	11.3	12.9	12.5	12.5	---	12.3
Apr.	11.3	12.5	13.4	12.6	---	12.4
May	11.3	13.5	14.1	11.0	---	12.5
June	12.1	14.5	---	11.6	---	12.7
July	13.0	14.7	14.5	11.8	---	13.5
Aug.	13.3	12.0	---	13.2	---	12.8
Sep.	12.7	-	---	13.2	---	12.9
Oct.	12.3	11.8	---	13.3	---	12.4
Nov.	12.6	---	11.5	11.0	---	11.7
Dec.	---	---	11.3	10.4	---	10.8

* The dominant male in 1999 was different than in the other years.

Other than body weight evaluations, there are currently no clinically valid nutritional evaluations that have been developed for kori bustards to assess growth, seasonal changes, etc. Body condition scores and fecal condition scores have not been used in assessments of these birds, but these scores should be developed.

Health issues: One of the most common signs of stress in kori bustards is decreased food consumption. Decreased food consumption should be monitored very closely, as it may not only be caused by environmental stressors, but also by impaction or illness. If a bird does not eat for more than one day, a veterinarian should be notified immediately. Encouraging birds to eat by providing favorite food items, or food items not normally part of the diet, may be needed after consultation with area veterinarians.

Parent-reared chicks in large naturalistic aviaries should be regularly checked for signs of metabolic bone disease, as this has been commonly seen at NARC (T. Bailey, personal communication, 2007). Kori bustards seem to be especially susceptible to nutritional bone disease (NBD), based on clinical findings of angular deformities of the metatarsi and laxity and swelling of the hock joint in animals housed in zoo conditions (Bailey et al. 1996). Careful monitoring of calcium and vitamin D levels in the diets of growing bustards has been shown to decrease the incidence of this musculoskeletal disorder (Bailey et al. 1996). In general, birds that are not provided with appropriate levels of nutrients may also show poor feather conditions, low weights, and lack of reproductive activity.

For hand-reared chicks, it is strongly recommended that individual food items be weighed when diets are prepared, so that a more accurate determination of nutrient content can be made when assessing the diet during the early growth period of the chicks. This is an important approach for hand-reared chicks, as nutrient content and growth rate need to be carefully monitored to minimize the occurrence of ‘angel wing’ (see section 5.1 for additional information).

Target serum and tissue nutrient evaluations: Currently, there are insufficient data available to develop valid target serum and tissue nutrient values for kori bustards managed in AZA-accredited zoos. There are also no known model species that can be used to develop appropriate target serum and nutrient values for kori bustards. Additional information is needed and should be obtained from opportunistic blood samples taken from clinically ‘normal’ animals (e.g., during routine physicals) and standardized nutrient assays. A robust dataset will need to be developed before target values and related recommendations can be made. The Kori Bustard SSP Nutrition and Veterinary Advisors can be consulted for information on institutions with laboratories that are able to perform nutrient assays suitable for these evaluations.

Chapter 6. Veterinary Care

6.1 Veterinary Services

Veterinary services are a vital component of excellent animal care practices. A full-time staff veterinarian, able to care for the avian collection, is recommended. However, in cases where this is not practical, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the kori bustard collection and to any emergencies (AZA Accreditation Standard 2.1.1). Veterinary coverage must also be available at all times so that any indications of disease, injury, or stress may be responded to in a timely manner (AZA Accreditation Standard 2.1.2). All AZA-accredited institutions should adopt the guidelines for medical programs developed by the American Association of Zoo Veterinarians (AAZV) www.aazv.org/associations/6442files/zoo_aquarium_vet_med_guidelines.pdf, and apply these guidelines to the daily care and management of kori bustards. The AZA Gruiformes TAG and Kori Bustard SSP have Veterinary Advisors knowledgeable about veterinary care and management specifically applicable to kori bustards, as well as any additional veterinary research that is still needed to address current knowledge gaps. Generally, no specific training programs are necessary for veterinarians planning to work with kori bustards, as most general avian principles apply. However, it may be beneficial for first-time kori bustard veterinarians to contact the SSP Veterinary Advisor or another experienced kori bustard veterinarian with any questions prior to performing a procedure. The AZA Gruiformes TAG Chair and AZA Kori Bustard SSP Coordinator can be contacted to obtain contact information for these Veterinary Advisors.

AZA Accreditation Standard

(S2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

AZA Accreditation Standard

(S2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animal collection 24 hours a day, 7 days a week.

Daily assessments of activity, attitude, appetite, fecal output, and new concerns should be made by animal keeper staff. Routine veterinary health assessments should be performed every 2-3 years for each individual, or when otherwise indicated by signs of illness. These assessments may include: physical examination, blood collection for a complete blood cell count, chemistry panel and plasma/serum banking, radiographs, fecal parasite screen, and fecal culture. No unique equipment or technologies are necessary for performing routine health assessments in kori bustards. Additionally, regular body weights should be obtained to enable more sensitive monitoring of possible disease.

Protocols for the use and security of drugs used for veterinary purposes must be formally written and available to animal care staff (AZA Accreditation Standard 2.2.1). Procedures should include, but are not limited to: a list of persons authorized to administer animal drugs, situations in which they are to be utilized, location of animal drugs and those persons with access to them, and emergency procedures in the event of accidental human exposure. The AZA Gruiformes TAG and Kori Bustard SSP recommend that veterinarians at each institution be involved in formulating their own institutional protocols for the storage and use of drugs that could be used in the care and management of kori bustards. Given the wide variation in veterinary practices, veterinary staff, and equipment available to veterinarians at different institutions, no kori bustard-specific recommendations can be made. Institutional veterinarians will also need to determine which drugs and medications are important for the treatment of kori bustard groups and individual animals. Recommendations for drugs used in parasite control, vaccinations, and anesthesia are provided in the sections within this chapter. Other commonly used drugs include: Anthelmitics (Fenbendazole, ivermectin, pyrantel); analgesics (NSAIDS and steroids); and antibiotics (cephalosporins, Beta-lactams, fluroquinolones, aminoglycosides).

AZA Accreditation Standard

(S2.2.1) Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes and appropriate security of the drugs must be provided.

Animal recordkeeping is an important element of animal care and ensures that information about individual animals and their treatment is always available. A designated staff member should be responsible for maintaining an animal record keeping system and for conveying relevant laws and

regulations to the animal care staff (AZA Accreditation Standard 1.4.6). Recordkeeping must be current and documented on a daily basis (AZA Accreditation Standard 1.4.7). Complete and up-to-date animal records must be duplicated and retained in a fireproof container within the institution (AZA Accreditation Standard 1.4.5) as well as be duplicated and stored at a separate location (AZA Accreditation Standard 1.4.4).

AZA Accreditation Standard

(S1.4.6) A staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

AZA Accreditation Standard

(S1.4.7) Animal records must be kept current, and data must be logged daily.

AZA Accreditation Standard

(S1.4.5) At least one set of the institution's historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

AZA Accreditation Standard

(S1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

All pertinent health information for kori bustards should be recorded in ARKS and MedARKS as required by institutional animal recordkeeping protocols. When the new Zoological Information Management System (ZIMS) becomes widely available, it is recommended that institutions make full use of this resource. ZIMS provides the opportunity to record key animal behavior information along with health records, including data collected on aggressive or abnormal behavior, and responses to enrichment initiatives, conspecifics, or heterospecifics.

Animal development recordkeeping is an important part of an on-going effort to increase knowledge of kori bustard biology. Body measurements for each kori bustard should be recorded within the animals' medical records, as these can be used to add to the scientific knowledge base, and will continue to play an important role in taxonomic and eco-morphological investigations. Measurements that should be recorded for all kori bustards include (Hallager and Boylan 2004):

- Wing length: Measure from the "wrist" to the tip of the longest primary.
- Tail length: Insert a ruler centrally between the longest tail feathers and the under-tail coverts until the ruler stops.
- Tarsus length: Measure on the front of the leg from the joint of the tibiotarsus with the tarsometatarsus to the lower end at the foot (last scute).
- Skull: Maximum length from the rear of the skull to the tip of the bill should be recorded, and the skull width (across the postorbital bones) should also be measured.
- Culmen length: Measure from the tip of bill to base of skull
- Toe length (inner, middle, and outer): Measure from the tip of the nail to the joint of the toe with the tarsometatarsus.

The morphometric measures listed above should be taken from birds throughout their development, beginning with chicks from the second day after hatching, and using the methods described by Hallager and Boylan (2004). Diagrams for how to take these body measurements properly can be found in Appendix C. Measurements should be recorded within the animals' institutional records, and should also be sent to the AZA Kori Bustard SSP Coordinator for every chick born. Information on each animal's sex, age, collection date, sexual condition, and weight should also be recorded and sent to the AZA Kori Bustard SSP Coordinator. Records for the entire life of each bird should be kept within institutional records, and should include information on:

- Diet: Dietary components, amount of food fed, and method of feeding.
- Housing: Dates when birds are moved indoors, outdoors, or to new enclosures.
- Egg production and reproduction: Yearly onset of egg laying, male display, copulation observations, egg fertility, egg measurements.
- Weight of adult birds: Weights can be taken from adult birds using the scale training method described in Chapter 8, section 8.1 (see also Hallager and Boylan 2004).
- Behavior: Observations of aggressive behavior and animals involved.
- Medical problems: As required by institutional veterinary programs
- Cause of death

Additionally, any other information which animal caretakers at an institution consider to be pertinent, and which may improve husbandry standards for the species, should be included within each individual's

medical record. No specific permits, titles, or other formal documentation is commonly associated with this taxa.

6.2 Identification Methods

Ensuring that kori bustards are identifiable through various means increases the ability to care for individuals more effectively. All kori bustards must be identifiable and have corresponding ID numbers whenever practical, or a means for accurately maintaining animal records must be identified if individual identifications are not practical (AZA Accreditation Standard 1.4.3).

AZA Accreditation Standard

(S1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

A basic requirement for successful research and management of kori bustards in zoos is individual animal identification. Techniques used to identify kori bustards include leg bands and passive induced transponders (PIT). Colored, metal leg bands placed above the hock are recommended for those zoos with multiple birds, to aid in fast, easy identification. Bands should be placed above the hock to reduce ice buildup under the band in climatic zones that experience snow and ice during the winter. Plastic wrap-around bands are not recommended, as curious birds can remove and possibly ingest them. Transponders can be injected by syringe under the skin where they can be detected and read by an electronic scanner. For kori bustards, passive induced transponders can be placed in the inner crural region of the leg (Bailey and Hallager 2003). Kori bustards can be banded immediately after hatching. Transponders can be inserted when birds are one month old or even sooner depending upon the preferences of the attending veterinarians at each institution.

AZA member institutions must inventory their population at least annually and document all animal acquisitions and dispositions (AZA Accreditation Standard 1.4.1). Transaction forms help document that potential recipients or providers of the animals should adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy (see Appendix D), and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities. All AZA-accredited institutions must abide by the AZA Acquisition and Disposition policy (Appendix D) and the long-term welfare of animals should be considered in all acquisition and disposition decisions. All kori bustards owned by an AZA institution must be listed on the inventory, including those animals on loan to and from the institution (AZA Accreditation Standard 1.4.2). All kori bustard births and deaths should be reported to the AZA Kori Bustard SSP. All kori bustard shipments between institutions should be determined by the recommendations of the SSP, and all breeding efforts should be based on the AZA Kori Bustard SSP and AZA Gruiformes TAG Regional Collection Plan (RCP).

AZA Accreditation Standard

(S1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

AZA Accreditation Standard

(S1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

6.3 Transfer Examination and Diagnostic Testing Recommendations

The transfer of kori bustards between AZA-accredited institutions or certified related facilities due to SSP or PMP recommendations occurs often as part of as concerted effort to preserve these species. These transfers should be done as altruistically as possible and the costs associated with specific examination and diagnostic testing for determining the health of these animals should be considered. Pre-shipment and transfer examinations and diagnostic tests should include a physical examination, blood collection for a complete blood cell count, chemistry panel and plasma/serum banking, radiographs, fecal parasite screen, and fecal culture.

AZA Accreditation Standard

(S2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

6.4 Quarantine

AZA institutions must have holding facilities or procedures for the quarantine of newly arrived kori bustards and isolation facilities or procedures for the treatment of sick/injured kori bustards (AZA Accreditation Standard 2.7.1). All kori bustard quarantine, hospital, and isolation areas should be in compliance with AZA

standards/guidelines (AZA Accreditation Standard 2.7.3; Appendix E). All quarantine procedures should be supervised by a veterinarian, formally written and available to staff working with quarantined animals (AZA Accreditation Standard 2.7.2). If a specific quarantine facility is not present, then newly acquired animals should be kept separate from the established collection to prohibit physical contact, prevent disease transmission, and avoid aerosol and drainage contamination. If the receiving institution lacks appropriate facilities for quarantine, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applicable. Local, state, or federal regulations that are more stringent than AZA Standards and recommendation have precedence.

AZA Accreditation Standard

(S2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

AZA Accreditation Standard

(S2.7.2) Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

Quarantine protocols: Upon arrival at the receiving institution, kori bustards should be let out of the shipping crate as soon as possible into the quarantine area, and a visual inspection of the bird performed to ensure that there are no obvious injuries or trauma. Water should be immediately available within the quarantine enclosure. When newly arrived bustards are placed in quarantine after shipping, they may initially refuse to eat; privacy and a continuous abundance of live insects and baby mice are recommended to promote feeding (Siegel et al. 2007). Wild caught birds, even those previously held in zoos, may not eat for several days. Hand-reared birds will likely eat within a day of arrival, if not sooner.

Quarantine facilities should consist of at least a 12' by 12' fully enclosed stall (with outside access if possible), with a soft substrate (e.g., hay) and a shelter large enough for the bird to hide within. The stall should be cleaned daily by a dedicated staff member who will ideally not be interacting with other birds throughout the day. Staff should change clothes (i.e. scrubs and booties) before and after they enter the quarantine area. Additionally, there should be a disinfectant foot bath to minimize carrying potential disease into or out of the quarantine area.

The recommended quarantine period for kori bustards is 30 days (unless otherwise directed by the staff veterinarian). If additional birds are introduced into the quarantine area containing kori bustards during the 30-day quarantine, the minimum quarantine period should begin over again for all individuals. During the quarantine period, kori bustards should be given a full physical examination and tested/treated for fecal parasites. The AZA Gruiformes TAG and Kori Bustard SSP recommend that all institutions follow AZA quarantine guidelines (Appendix E), and that veterinarians should develop appropriate quarantine testing protocols for their kori bustards. The birds should be evaluated for endoparasites and ectoparasites and treated accordingly. Endoparasites can be treated with pyrantel, ivermectin, or fenbendazole. Ectoparasites can be treated with dilute pyrethrin spray topically or systemic ivermectin. Blood should be taken for a complete blood count (CBC) and chemistry panel. Blood should also be collected, analyzed, and then both heparinized plasma and serum banking should be performed, when feasible, and stored in a -80ºC freezer or a frost-free -20ºC freezer for possible future analysis and retrospective evaluation. Preliminary work to assess nutritional status and disease exposure is underway, and banked blood samples could help supplement these projects. Several publications provide hematological reference values for mature and growing kori bustards and are summarized in Appendix F, which should be consulted and compared with values taken during quarantine assessments.

When there is an indication, viral testing may also be appropriate (see section 6.7 – viral diseases in kori bustards). Vaccinations should be updated as appropriate during quarantine, and if the vaccination history is not known, the animal should be treated as immunologically naive and given the appropriate series of vaccinations. There are currently no recommended kori bustard-specific vaccination protocols or regulations to follow. Birds can also be anesthetized for radiographs in order to establish a “normal” radiograph baseline, but also to check for any abnormalities, including the presence of a foreign body that the birds may have ingested in their previous environment. While birds are anesthetized for their physical assessment, they should also be permanently identified (see section 6.2), if this has not been done before.

Hand-reared kori bustards are generally more tolerant of quarantine conditions than wild-caught birds, and are less prone to developing social or behavioral problems during the quarantine period. The most commonly observed behavioral problems (e.g., pacing, low appetite, barking) arise when birds are responding to perceived stressors in the environment. Common stressors include loud noises, sudden

noises, excessive vibrations, and separation from exhibit mates. Hand-reared birds may benefit from increased visits by keepers, installation of a mirror within the quarantine enclosure, an increase in favored food items, and quiet surroundings. Wild-caught birds may benefit from a reduction in keeper presence and environments as free from noise and disruption as possible.

Release from quarantine should be contingent upon normal results from diagnostic testing and two negative fecal tests that are spaced a minimum of two weeks apart. Medical records for each animal should be accurately maintained and easily available during the quarantine period.

AZA institutions must have kori bustard zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals, including those newly acquired in quarantine. Keepers should be designated to care only for quarantined animals if possible. If keepers care for both quarantined and resident animals of the same class, they should care for the quarantined animals only after caring for the resident animals. Equipment used to feed, care for, and enrich animals in quarantine should be used only with these animals. If this is not possible, then all items should be appropriately disinfected, as designated by the veterinarian supervising quarantine before use with resident animals.

AZA Accreditation Standard

(S11.1.2) Training and procedures must be in place regarding zoonotic diseases.

A tuberculin testing and surveillance program must be established for animal care staff as appropriate to protect both the health of both staff and kori bustards (AZA Accreditation Standard 11.1.3). Depending on the disease and history of the animals, testing protocols for kori bustards may vary from an initial quarantine test to yearly repetitions of diagnostic tests as determined by the veterinarian. There is currently no tuberculin testing and surveillance program specific to kori bustards.

AZA Accreditation Standard

(S11.1.3) A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

Although every living organism dies at some point, kori bustards which die during the quarantine period should have a necropsy performed to determine the cause of death and the subsequent disposal of the body must be done in accordance with any local or federal laws (AZA Accreditation Standard 2.5.1). Kori bustard deaths during quarantine are a very rare occurrence. Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples from the body organs should be submitted for histopathological examination. Facilities without access to avian pathology labs should contact the Kori Bustard SSP Pathology Advisor for assistance with analysis of histopathological samples. See Appendix G for the AZA Kori Bustard SSP standardized necropsy protocol. Information on the gastro-intestinal tract of various bustard species is described in detail by Bailey et al. (1997a), and can be used for comparison with institutional data collected from bustard necropsies.

AZA Accreditation Standard

(S2.5.1) Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

6.5 Preventive Medicine

AZA-accredited institutions should have an extensive veterinary program that must emphasize kori bustard disease prevention (AZA Accreditation Standard 2.4.1). The American Association of Zoo Veterinarians (AAZV) has developed an outline of an effective preventative veterinary medicine program that should be implemented to ensure proactive veterinary care for all animals (www.aazv.org/associations/6442/files/zoo_aquarium_vet_med_guidelines.pdf).

AZA Accreditation Standard

(S2.4.1) The veterinary care program must emphasize disease prevention.

Parasite screening: Kori bustards should be screened biannually for parasites and de-wormed if necessary. A saline swab of the oropharynx and upper esophagus can be effective for cytology/parasitology testing (T. Bailey, personal communication, 2007). Anthelmintic and antiprotozoal medication can be given in the water or food when needed (Bailey and Hallager 2003). See section 6.6 for a description of common parasites for kori bustards. It is recommended that parasite screenings be performed during health-assessment catch-ups that are scheduled for 1-2 months prior to the start of the breeding season (Bailey and Hallager 2003).

Vaccinations: Vaccination policies for kori bustards depend upon individual institution policies that are generally based on a risk/benefit analysis. This analysis usually involves the prevalence of the specific disease, subsequent threat of exposure, efficacy and safety of a vaccine, and the risk to the bird. Studies evaluating the susceptibility of kori bustards to West Nile virus (WNV) have not yet been conducted, and given the relatively low incidence of reported morbidity and mortality of WNV in kori bustards, this may not be a necessary vaccination. Annual vaccination with inactivated Newcastle disease vaccine and live canary pox vaccine is provided in animal holding facilities in the Middle East (Bailey and Hallager 2003), but typically not in zoos in the United States. When vaccinations are provided, it is recommended that they be given during health-assessment catch-ups performed 1-2 months prior to the start of the breeding season (Bailey and Hallager 2003).

Blood sampling: Blood can be taken from kori bustards when they are appropriately restrained (see section 6.5), and blood sampling plays an important role in assessing the overall health of individual animals. If blood samples are taken from the leg of birds when the temperature is below 40°F (4°C), it is recommended that birds first be housed in a warm area for a minimum of 30 minutes to allow their legs to warm up. The increased temperature will allow veins to dilate and will facilitate blood collection. Blood samples may also be collected from the jugular or ulnar veins, but this requires a greater degree of skill and expertise in safely restraining the bird and locating the vessels. The table below (Table 16) lists normal kori bustard blood values. Additional hematological reference values for mature and growing kori bustards can be found in Appendix F and should be consulted to compare them with the current health status of birds as part of each institution's preventative veterinary health program.

Table 16: Reference ranges for physiological data values (adapted from ISIS 1999)

Test	Units	Mean	St. Dev.	Minimum value	Maximum value	Sample size	Animals
White blood cell count	$*10^9$/L	16.47	5.709	5.700	28.60	33	23
Red blood cell count	$*10^{12}$/L	2.42	0.57	1.12	3.05	19	15
Hemoglobin	g/L	129	19	97	153	10	8
Hematocrit	L/L	0.439	0.038	0.360	0.500	33	23
MCV	fL	190.6	50.5	137.6	321.4	19	15
MCH	pg/cell	65.2	25.0	36.9	116.1	7	5
MCHC	g/L	304	39	220	361	10	8
Heterophils	$*10^9$/L	9.073	4.281	3.640	18.70	29	19
Lymphocytes	$*10^9$/L	6.342	3.525	0.485	16.60	31	21
Monocytes	$*10^9$/L	1.028	0.728	0.100	2.300	25	18
Eosinophils	$*10^9$/L	0.434	0.387	0.021	1.540	20	16
Basophils	$*10^9$/L	0.428	0.422	0.099	1.480	13	9
Calcium	mMol/L	2.78	0.53	2.15	4.23	19	15
Phosphorus	mMol/L	1.45	0.45	0.68	2.49	16	12
Sodium	mMol/L	152	6	141	160	9	9
Potassium	mMol/L	3.2	0.6	2.5	4.5	9	9
Chloride	mMol/L	107	7	94	117	8	8
Carbon dioxde	mMol/L	34.0	0.0	34.0	34.0	1	1
Creatinine	µMol/L	9	9	9	18	4	3
Uric acid	mMol/L	0.434	0.214	0.190	1.142	19	15
Total bilirubin	µMol/L	2	2	0	5	7	7

Test	Units	Mean	St. Dev.	Minimum value	Maximum value	Sample size	Animals
Glucose	mMol/L	14.82	1.887	10.60	17.76	17	14
Cholesterol	mMol/L	4.325	.4403	3.522	4.817	7	5
Creatine phosphokinase	U/L	622	722	191	2310	11	9
Lactate dehydrogenase	U/L	1117	800	720	3208	9	7
Alkaline phosphatase	U/L	49	41	19	129	6	6
Alanine aminotransferase	U/L	26	2	24	27	2	2
Aspartate aminotransferase	U/L	296	72	193	478	17	14
Total protein (colorimetry)	g/L	34	7	18	50	19	15
Globulin (colorimetry)	g/L	19	7	4	25	10	10
Albumin (colorimetry)	g/L	16	4	11	26	11	11
Fibrinogen	g/L	1.820	1.170	0.0000	4.000	11	9

Medical management of neonates: Bailey et al. (1997b) show that 45% of chick morbidity and 50% of chick mortality generally occur within the first 30 days after hatching. Bacterial, musculoskeletal, and gastrointestinal causes of mortality were most common in the chicks studied (Bailey et al. 1997b). The mortality of female chicks within the first year (40%) has been found to be higher than mortality rates for males (27%) (Hallager and Boylan 2004). Further research is needed to determine if this is a species-specific phenomenon, or if sub-optimal husbandry and management may be a contributing factor.

Information on some of the main issues encountered in the veterinary management of parent- and hand-reared chicks in zoos is provided below:

- Dehydration: Newly hatched chicks are prone to dehydration for the first 2-3 days of life. Hand-reared chicks can be properly hydrated by feeding watermelon or dipping food items in water immediately prior to feeding. Subcutaneous fluids may need to be administered if oral hydration is not sufficient. When the female is feeding parent-reared chicks, she salivates copiously, and this may potentially be a source of water for the chicks.
- Curled toes: Chicks may hatch with inward pointing toes. This condition typically corrects itself over time. Taping the toes into the correct position is only necessary in cases where the condition is severe or worsens with time.
- Angel wing: This condition begins between days 7-11 (see Chapter 5, section 5.1 for additional information). Taping of the affected primaries in a natural position at the first sign of outward turning will permanently correct the deformity. Although parent-reared chicks seem to have higher growth rates than hand-reared chicks during the first week of life, parent-reared chicks do not usually develop angel wing. More research is needed to determine why parent-reared chicks do not develop angel wing.
- Ingestion of foreign objects: Chicks normally eat small pebbles to aid in digestion. When exercising on natural substrates, chicks should be monitored closely to ensure that they do not consume too large or too many pebbles, leading to impaction. Hand-reared bustards should be provided with some grit or small gravel particles, as “overload ventriculus” has been identified as a cause of death in great bustard hand-reared chicks that were fed without grit (Siedel 1995).
- Eye pecking: Occasionally, one chick may peck at the eyes of another bird, leading to physical injuries. The aggressor should be removed until the eyelid of the injured bird has completely healed. Providing the birds with food items to pick at (e.g., watermelon, tomatoes etc.) may reduce this behavior, as it may be a form or redirected or displaced foraging behavior.
- Weighing and handling: After hatching, parent-reared chicks should be weighed on the 2nd, 4th, and 6th day, and then every four days until the chick becomes too large for the scale (Hallager and Boylan 2004). Unless an operant conditioning program includes scale-training for the birds,

healthy chicks should not be weighed daily, as increased injuries may result from frequent handling. Hand-reared chicks should be weighed daily. In the first two days, chicks may lose 10% of their body weight, but should gain 2-18% per day from then onwards (Hallager and Boylan 2004). If chicks show continued weight loss, then supplemental feedings or medical treatment may be needed. By the time that chicks reach one-month of age, males can usually be distinguished from females by their larger size; based on zoo data, chicks greater than 4.9lb (2200g) at 65 days of age are likely to be males, and individuals less than 4.9lb (2200g) are likely to be females (Hallager and Boylan 2004). If necessary for social housing considerations, earlier determination of sex can be determined by taking a small amount of blood for DNA sexing.

- Hypothermia: For the first couple of months after hatching, bustard chicks are sensitive to the cold. Care should be taken to provide sufficient heating, especially to debilitated chicks that are hospitalized. Managers should follow the advice of the referring aviculturalist or veterinarian for temperature guidelines. Under sub-optimal temperature conditions, bustard chicks and even juvenile bustards can suffer from hypothermia. Hypothermic bustards will not feed until their body temperature has returned to normal again (T. Bailey, personal communication, 2007).
- Hyperthermia: Hyperthermia has caused the death of a number of bustards at the National Avian Research Centre (NARC). Hyperthermia occurred in a group of white-bellied bustard chicks that were moved prematurely from air-conditioned rearing facilities to outdoor aviaries in the summer, without a proper period of acclimatization (T. Bailey, personal communication, 2007).

Medical management of molt: The molt cycle of kori bustards has not been closely studied. However, feathers do tend to be shed mainly in the spring (before breeding season) and fall (after breeding season). Males often (but not always) molt out their neck feathers during these periods. Given the visual importance of the throat area in male courtship displays, the replacement of new feathers may be critical to the breeding success of the male. Naturally molted feathers should be picked up and recorded as they are discovered so that the normal molt pattern of kori bustards can be understood, and this includes all primaries (note whether left or right), secondaries, tail, alular quills, greater and secondary coverts, underwing, and undertail feathers (Hallager and Boylan 2004). Smaller feathers such as the neck, crest, and very small coverts, are too numerous to record, and can simply be noted when found. Information on molt patterns should be recorded with the animal's medical records, and a summary provided to the AZA Kori Bustard SSP Coordinator on an annual basis.

Medical management of geriatrics: The greatest recorded longevity of a kori bustard in zoos to date is a wild caught female who has been managed in a zoo for 32 years. This species may be capable of living longer given their delayed sexual maturity and low reproduction rate. Recent improvements in husbandry should yield longer life spans.

Older birds may need to be housed inside more often than younger birds during inclement weather, and may need to be supplied with supplemental heat earlier and later in the season. Assessments of the behavioral response of older birds to changing temperatures should be used to evaluate the needs of the animals. When catching or herding older birds, they should be moved slowly, as some may experience arthritic symptoms in their legs. Older birds may benefit from a daily supplement of neutraceuticals such as cosequin (a patented combination of glucosamine, purified chondroitin sulfate, and manganese ascorbate). Cosequin is considered an adjunctive therapy for osteoarthritis in many species, but its use should be based on recommendations made by veterinarians. Some older birds may also be partially or totally deaf. If this is the case, animal caretakers should ensure that these birds are not startled during daily management by maintaining visual contact with the birds when working within or near to the enclosure. Geriatric females may need to be isolated from breeding males during the breeding season, as overly aggressive males may harass them in an attempt to copulate.

Flight restraint: The three main methods of flight restraint for kori bustards are pinioning (only recommended for chicks), routine feather clipping, and the use of covered enclosures. Each method poses some risk to the birds. Pinioning kori bustards may make them more prone to injury. Frequent feather clipping requires that birds be captured and restrained on a regular basis, and can lead to physical injuries and trauma (see section 6.5). Allowing fully winged birds to be housed in completely covered aviaries may also result in injuries if birds attempt to fly within the restricted space, and impact the containment barriers of the enclosure.

It is currently left to the discretion of the owning institution as to whether or not kori bustard chicks should be pinioned. If they are pinioned, the procedure should be carried out no later than 3 days of age. Research has shown that reproduction is not compromised by pinioning, as copulation in the species occurs on the ground (Hallager and Boylan 2004). However, it is the recommendation of the AZA Kori Bustard SSP that adult, full-winged kori bustards should not be pinioned. Unlike for chicks, the procedure in adult birds is very difficult, stressful, and can lead to complications from the surgery and further injury as birds learn to adapt to an altered wing. Regular feather clipping is the recommended procedure for rendering non-pinioned adult birds flightless. Educating handlers on the proper techniques of catching adult birds is necessary to minimize trauma to the birds during feather clipping (see section 6.5). Additional research on the welfare of flight restricted kori bustards is still needed in order to develop the most effective animal care recommendations for housing these animals in zoos.

As stated in Chapter 6.4, AZA institutions must have zoonotic disease prevention procedures and training protocols established to minimize the risk of transferable diseases (AZA Accreditation Standard 11.1.2) with all animals. Keepers should be designated to care for only healthy resident animals, however if they need to care for both quarantined and resident animals of the same class, they should care for the resident animals before caring for the quarantined animals.

Bustards can be carriers of *Salmonella* within their digestive tract, and *E. coli* is the most prevalent bacterial organism within bustard feces and cloacae (D'Aloia et al. 1996a). Both of these bacteria represent potential hazards to human caretakers.

The AZA Gruiformes TAG and Kori Bustard SSP recommend that veterinarians at each institution develop their own specific zoonotic disease and disinfection protocols for animal caretakers, animal management equipment, and enrichment initiatives provided in quarantine and hospital facilities. Care should be taken to ensure that those keepers working with sick or quarantine animals are "decontaminated" before caring for the healthy resident animals again. Equipment used to feed, care for, and enrich the healthy resident animals should only be used with those animals. Effective measures that help prevent the transmission of diseases between animals include (as designated by veterinarians at each institution): 1) washing hands between and after handling animals, fecals and urates, other bodily fluids or secretions, or animal diets; 2) wearing gloves, goggles, and a mask when cleaning animal enclosures; and 3) wearing gloves when handling any animal tissues. Disinfection protocols should take into consideration the material to be disinfected, and should ensure that disinfectants are thoroughly rinsed off or neutralized before the equipment or enrichment initiative is used again with the birds.

AZA Accreditation Standard

(S1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the collection from exposure to infectious agents.

Kori bustards that are taken off zoo grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution's healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5).

6.6 Capture, Restraint, and Immobilization

The need for capturing, restraining and/or immobilizing kori bustards for normal or emergency husbandry procedures may be required. All capture equipment must be in good working order and available to authorized and trained kori bustard care staff at all times (AZA Accreditation Standard 2.3.1).

AZA Accreditation Standard

(S2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

Capture: Kori bustards, especially adult males, are very powerful birds, and require somewhat different handling skills from other long-legged birds of similar size. There are three important characteristics of kori bustards that should be considered when handling these animals:

- The physical strength of the birds, especially adult males, which can weigh as much as 44.1lb (20kg) during the breeding season.
- The thinness of their skin. Bustard skin is very thin and rips easily when a bird is struggling. Torn skin will result in the need for further handling for veterinary treatment (e.g., sutures, etc), and can also lead to maggot infestation.
- Their inherent nature to shed feathers when captured. Kori bustard feathers are very loosely embedded in the follicles, and even the best handling will result in some feather loss. Improper handling can cause major feather loss. The wings or tails of the birds should never be grabbed

during a capture attempt, as this will lead to significant feather loss and an increasingly fearful bird.

Kori bustards are highly sensitive to stress. In addition to the considerations listed above, poorly planned capture events and incorrect handling can also lead to (Siegel et al. 2007):

- Temporary or permanent neural damage.
- Hyperthermia.
- Fractures of legs or wings.
- Skin lacerations, bruising, and feather loss.
- Luxation of the tibiotarsal bones.
- Dislocation of the cervical vertebrae.
- Compression of the trachea and internal organs.
- Capture myopathy.
- Stress and the progression of a disease process and even death.

Capture protocol: A specific plan for the capture and release of kori bustards, and the personnel and equipment needed, should be discussed prior to the actual capture event. In order to avoid injuries to birds and personnel, it is recommended that two people are involved in the capture and restraint of kori bustards, and this is very strongly recommended when capturing a male. Equipment such as hoods for bird, protective eyewear, and gloves should be readily available for animal caretakers. The pre-capture planning should also consider where and when captures take place. Important issues to consider for a capture event include:

- Temperature: Capturing the birds in the early morning hours (especially at southern latitudes during the summer months) is recommended in order to reduce the risk of heat stress to the birds.
- Preferred capture site: It is recommended that captures be performed in a small, darkened and enclosed area, such as a shed or holding stall with solid walls, so that the chance of the animals evading capture is greatly reduced. Cornering a bird against chain-link or welded-mesh fences is not recommended, as the birds are more likely to receive trauma to their beaks, heads, carpal joints, and feet if they try to “climb” the see-through barriers. Padded walls may be beneficial in a capture area to reduce the chance of trauma. Fixing corrugated cardboard to the walls of a capture area can also be beneficial, although there are plastic padding alternatives available for more permanent use. In the absence of a recommended indoor capture area, a small area with either trees or brush can be used to assist in directing the animals into a catch area. A funneling system or the boundaries of the exhibit (such as fences or walls) can also be used to direct the animal to the catch area.
- Containment: If birds are to be captured in an outside enclosure, then the fence line at the capture area should be at least 7' (2.1m) high, preferably higher. When kori bustards are cornered against a solid wall, most birds will generally attempt to leap into the air, and even a pinioned bird can jump at least 6' (1.8m). Ideally, the bird should be caught before it takes a leap. If it does leap upwards, the bird should be caught as soon as its feet get back onto the ground, and before it can leap again.
- Safety of caretakers: The main potential cause of injury to caretakers during restraint of a kori bustard will be from the bird’s feet, as they are very strong-legged birds. Two caretakers are generally needed to ensure proper safety of the bird as well as the keepers involved. When two people are involved, one person captures the bird, while the other takes control of the legs and wings. Goggles can be worn as an added safety measure to protect the eyes of the animal care staff, as kori bustards do occasionally peck at their holder’s face.
- Capture techniques: The ease of capture will vary widely, depending on exhibit design and the temperament of the birds. If the birds are accustomed to coming into a shed or holding stall on a daily basis for their food, then this can reduce the stress of a capture, as the birds can be moved into the capture area using food reinforcement. Once birds are in the containment area, it is very important that they be caught quickly. The less the bird struggles and attempts to avoid capture, the less it will be stressed and the less the chance of resulting injury. The use of nets is not recommended to capture kori bustards, as the risk of injury to the birds escalate greatly with this capture technique. Injuries will be greatly reduced if birds can be guided into darkened areas and

then caught by hand, as described above. Once the bird has been captured, and the body and legs are controlled, it is necessary to lift or walk the bird to the area of the husbandry or veterinary procedure. If this is at an off-site area, the bird may need to be crated (see below).

Although kori bustards are generally silent (outside of male courtship displays), both sexes produce a barking sound when they are alarmed, and individuals can make loud, roaring noises during capture (Hallager and Boylan 2004).

Restraint: The preferred method of restraint for kori bustards is to tuck the body of the bird under one arm with the head facing back. The weight of the bird should rest primarily on the holder's forearm, while the other hand is used to restrain the legs. The legs should generally not be tucked up under the bird's body, as it is possible for a bird to break its leg if it struggles when tightly restrained. The legs should be restrained at the tarsal joint with at least one finger keeping the legs apart so that they do not abrade the joints against each other. Kori bustards also have powerful wings, and it is important to ensure that the wings are tucked firmly against the body of the bird so that they cannot flap them. Once the bird is secured, a second handler should immediately cover the eyes of the bird, without blocking the nares or holding the beak shut, as this can have a calming effect. Cotton bags can be used to cover the heads of kori bustards, but these bags should have an opening over the nostrils to allow breathing. Hand-reared birds often prefer to remain un-hooded (S. Hallager, personal communication, 2007). While it is not necessary to restrain the head of kori bustards, it may be in the best interest of the restrainer to have the head under control.

During the first 7 days, hand-reared kori bustard chicks are less stressed by restraint if handling by animal caretakers simulates brooding. Chicks can be cupped in one hand and covered with the other hand, kept in a "nest" with a feather duster placed on top, or covered with a breathable cloth. When restrained, care should be taken to keep the chicks' feet away from their bodies, as they have very sharp nails, and can inflict injuries to themselves (e.g., a ripped neck) if they are able to kick with their feet (Hallager and Boylan 2004).

When moving restrained kori bustards within an institution, it is better if the bird can be hand-carried to the destination. If crates are used, the birds will need to be recaptured once they are released from the crate, and this can increase the chance of injury. If there are more birds being caught than can be hand-carried, the use of crates will be necessary (see Chapter 3, section 3.1 for more details). Crates can work very well for transporting birds even over short distances, but removing a bird from a crate so that it can be handled can be challenging. If kori bustards do need to be recaptured once released from a crate, it is recommended that the bird first be released into a small, darkened area to let it calm down, before recapturing it again using the techniques described above. If a bird is being captured and restrained for a procedure that will involve anesthesia, it may be helpful to anesthetize the bird at its enclosure to decrease the stress involved during transport from the enclosure to the clinic when the bird is awake. The effectiveness of this approach depends upon a variety of factors, including the veterinarian's comfort level with this technique, available monitoring and portable anesthetic equipment, proposed time under anesthesia, length of travel time to the clinic, training of animal care staff, and the bird's presenting complaint. In some situations, this approach can reduce the stress on the bird. The final decision regarding which approach to use rests with the attending veterinarian.

When manually restrained kori bustards are released, it is important that the bird be stabilized before it is released. The bird should be positioned so that it legs are touching the ground, keeping in mind they can jump with power, and it should be facing a clear area. Birds should be released in the direction of a clearing that allows it time to gain its balance and get its bearings. Once the bird is stabilized, the restrainer should simply release the bird from their control and slowly step back. The bird will most likely move away, but individuals can remain standing, looking at the caretakers. In either case, the best practice is for caretakers to move towards the exit in a slow and deliberate manner.

Immobilization: The oral sacs of males in breeding condition can occlude the glottis during anesthesia, potentially leading to anoxia and death (T. Bailey, personal communication 2007). The use of an endotracheal tube during anesthesia in these birds is essential. Anesthesia techniques for kori bustards have also been described in Naldo et al. (1997, 1998a) and Bailey et al. (1999). Bailey et al. (2001) used a combination of isoflurane (5% with mask for induction, and 3-3.5% with endotracheal tube for maintenance) and oxygen (3L per minute). It is recommended that institution-specific anesthesia

protocols be developed for kori bustards by veterinarians at each institution, and that effective protocols should be shared with the AZA Gruiformes TAG and AZA Kori Bustard SSP for wider dissemination.

Release/recovery: When recovering a bird from anesthesia, it will be necessary to restrain the bird for a longer period of time than after periods of manual restraint. Birds recovering from anesthesia should be manually restrained using firm, constant pressure, and the body and legs of the animals should be carefully controlled to restrict any sudden outbursts of energy. Covering the eyes of the bird with a hood or towel will help in reducing this reaction (ensuring that the nares are not covered). Once the animal has fully recovered from anesthesia, it can be released as described above, ensuring that the bird has regained sufficient control of its legs to be stable. After prolonged capture, restraint, or immobilization, it is recommended to treat bustards with fluids, vitamin E, selenium, and physiotherapy, to help the birds recover (Siegel et al. 2007). Some pre-capture treatments of vitamin E and selenium may also be beneficial. It is also important to reduce those conditions that increase the likelihood of capture myopathy occurring, such as extended pursuit times, transport, excessive handling, and over-exertion during times of high heat.

6.7 Management of Diseases, Disorders, Injuries and/or Isolation

AZA-accredited institutions should have an extensive veterinary program that manages kori bustard diseases, disorders, or injuries and has the ability to isolate these animals in a hospital setting for treatment if necessary. Staff involved in the daily management and care of kori bustards should be trained for meeting the animal's dietary, husbandry, and enrichment needs, as well as in restraint techniques, and recognizing behavioral indicators animals may display when their health becomes compromised (AZA Accreditation Standard 2.4.2). Protocols should be established for reporting these observations to the veterinary department. Hospital facilities should have x-ray equipment or access to x-ray services (AZA Accreditation Standard 2.3.2), contain appropriate equipment and supplies on hand for treatment of common kori bustard diseases, disorders or injuries, and have staff available that are trained to address health issues, manage short and long term medical treatments and control for zoonotic disease transmission.

AZA Accreditation Standard

(S2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not evaluate illnesses nor prescribe treatment.

AZA Accreditation Standard

(S2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

The following information describes common diseases and disorders experienced by kori bustards in zoos, and diagnosis and treatment options for these medical concerns. New knowledge gained should be reported to the Kori Bustard SSP for dissemination.

Trauma: Most large bustards are generally hardy birds, but individuals can sustain life-threatening trauma such as puncture wounds, or compound fractures of legs or wings. The complications resulting from these injuries can be made worse if individuals are housed with incompatible exhibit-mates (Siegel et al. 2007). Where open wounds are present, kori bustards often do not preen fly eggs or maggots from their wounds, and it is recommended that wounded animals be captured and placed into a fly-free room, or that the wound be covered in fly-repellent gel.

In response to stressors in the environment, kori bustards will run into or pace against the perimeter fencing or walls of their enclosures in attempts to flee from the stressor (or potential stressor). If the containment barriers are not smooth, then there is a greater likelihood that individuals will sustain abrasions to their faces, wings, or pinion sites (Siegel et al. 2007). Excessive pacing may also lead to compaction of the soil, which can be a contributing factor to lameness and pododermatitis in these birds.

Ingestion of certain non-food items by kori bustards can lead to perforation or impaction of the gastrointestinal tract, and can be a significant source of morbidity and mortality for bustards (Bailey et al. 2001). Clinical sings of possible gastrointestinal trauma associated with the ingestion of foreign objects can include decreased appetite, poor pectoral muscle condition, weight loss, palpable abscesses in the abdominal wall, and hematological indicators associated with an inflammatory response (Bailey et al. 2001). Foreign bodies that penetrate the ventriculus of birds once ingested can lead to decreased muscular contractions and poor digestion of food (Lumeij 1994). The use of rigid endoscopy to remove foreign bodies from the ventriculus is generally not possible with kori bustards, given the length of the esophagus, and so ventriculostomy or proventriculostomy are the best techniques to use (Bailey et al.

2001). A ventral laparotomy has also been used successfully to remove wire ingested by a kori bustard (Bailey et al. 2001).

Viral diseases: The following viral diseases have been associated with bustard species (Bailey, in press), and so represent potential health concerns for kori bustards. The significance of these viruses for the care and management of bustards in zoos remains unknown, and additional research is needed on the prevalence and serious of these viruses to kori bustards in the United States.

- Adenovirus
- Avian influenza
- Avipox
- Herpesvirus
- Infectious bursal disease
- Lymphoid leucosis
- Marek's disease
- Newcastle disease
- Pigeon herpes
- PMV-2
- Reovirus

Bacterial diseases: Wild and managed bustards are colonized by several species of bacteria as part of their normal aerobic intestinal flora (e.g., *Proteus spp*., *Enterobacter spp*., *Escherichia coli*, *Klebsiella spp*., *Aerococcus spp*., *Pseudomonas sp*., *Serratia sp*., and *Enterococcus spp*.) (D'Aloia et al. 1996a; Silvanose et al. 1998a). The following bacteria have also been isolated from the conjunctiva of healthy kori bustards: *Micrococcus spp*., *Staphylococcus xylosus*, and *Bacillus spp*.; and from the nasal cavities of healthy animals: *Micrococcus spp*., *Bacillus spp*., *Staphylococcus sciuri*, and *Aerococcus spp*. (Silvanose et al. 2001). Birds from which these samples were taken showed no clinical signs of disease. Aerobic bacteria (including *Klebsiella sp*. and *E. coli*) have also been found in cloacal swabs taken from clinically healthy kori bustards (D'Aloia et al. 1996a). Both Gram-positive cocci and Gram-negative bacilli can be found in fecal samples collected from clinically healthy kori bustard chicks housed in typical zoo conditions, and may represent the normal aerobic microflora associated with these birds (Naldo et al. 1998b). Bacteria have also been isolated from the wing skin of clinically healthy kori bustards, and the species identified from this area include: *Staphylococcus sp*., *Bacillus sp*., *Citrobacter sp*., and *Pseudomonas sp*. (D'Aloia et al. 1996a).

Some clinically active bacterial infections that have been reported in kori bustards include: colisepticaemia, mycobacteriosis, clostridiosis, salmonellosis, yersiniosis, pseudomoniasis, erysipelothrix, and chlamydophilosis (Siegel et al. 2007). *Pseudomonas sp*. infections can present in kori bustards with clinical signs such as mucopurulent nasal and choanal discharge, mucoid ocular discharge, coughing, choanal inflammation, sinus swelling, and anorexia (Bailey et al. 2000). Hematology results from birds presenting with clinical signs of pseudomoniasis are presented by Bailey et al. (2000), along with potential treatment regimens. Control measures include the proper cleaning and sanitization of food and water containers, where the bacteria can proliferate in warm conditions (Bailey et al. 2000). If treatment is warranted for any bacterial diseases, antibiotic selection should be based upon culture and bacterial sensitivity results.

Fungal diseases: Aspergillosis (*Aspergillus fumigatus*) can occur in bustard chicks reared in zoos (Siegel et al. 2007), and has been found in wild and managed great bustards (Garcia-Montijano et al. 2002). Yeast infections (*Candida albicans*) of the oropharyngeal cavity and oesophagus have been reported in birds on antibiotic treatment. While this type of infection typically occurs in juvenile birds with immature immune systems, it can also occur in adult birds (Siegel et al. 2007). A survey of clinically healthy kori bustards found no latent fungal infections (D'Aloia et al. 1996a).

Protozoal diseases: Trichomoniasis is reported as a significant protozoal disease for captive bustards in the Middle East (Naldo et al. 2000a), and has led to fatalities for animals in the United States as well. Clinical signs of trichomoniasis include: lesions in the oro-pharynx and esophagus, foul-smelling odor from the mouth, anorexia, lethargy, dyspnoea, emaciation, oral and lacrimal discharges, and inflammation of the oro-pharynx, tongue, or beak margin (Naldo et al. 2000a). Transmission of the protozoa is through ingestion of contaminated food and water sources (Naldo et al. 2000a). Treatment options for

trichomoniasis include metronidazole and supportive therapy, as well as the use of dimetridazole and ronidazole as preventative medication (Naldo et al. 2000a). Other protozoa that can cause diseases of the digestive tract include: *Eimeria* spp., *Giardia* spp., *Histomonas* spp., and *Entamoeba anatis* (Silvanose et al 1998a).

In general, clinical signs associated with protozoal oro-pharyngeal diseases in kori bustards can include weight loss, weakness, white-yellow lesions, mucus discharge, and exfoliation of epithelial cells (Silvanose et al. 1998b). The nature of clinical signs showed by infected birds is dependent on the level of parasitism, duration of infection, and any secondary bacterial or fungal diseases (Silvanose et al. 1998b).

Parasites: Helminth and cestode infestations can cause morbidity in some kori bustards (Jones et al. 1996). Since birds taken from the wild show significant internal parasite loads, it is recommended that all newly arriving birds be treated with anti-parasitic medication during quarantine periods (Jones et al. 1996; Bailey et al. 2000; Schuster and Kinne 2003). A single dose of praziquantel (10mg/kg p.o.) has been shown to eliminate gastrointestinal cestodes in kori bustards (Jones et al. 1996), although the authors also recommend a second dose after 14 days. To eliminate unnecessary handling of the animals, birds can be treated with anthelmintic tablets placed in preferred food items (e.g., mice) that are offered to the birds (Jones et al. 1996), especially if birds are treated as part of a routine, preventative program.

Metabolic disorders: Hemosiderosis has been reported in some kori bustards in zoos, but the cause of this is not yet known. Two hypotheses that should be explored are a possible dietary etiology or a genetic predisposition (S. Murray, personal communication, 2007). Kori bustards are also susceptible to fatty liver disease (Nicholls et al. 1997). Capture and transport of bustards has been shown to be associated with an increased prevalence of this disease; the clinical biochemical findings linked to fatty liver syndrome are further described by Nicholls et al. (1997). The use of serum bile acid (SBA) concentration in the blood as a diagnostic tool for liver function in kori bustards has been proposed by Howlett et al. (1999), and the authors present reference value ranges for SBA concentrations.

Musculoskeletal disorders: Musculoskeletal disorders can significantly affect the health and development of kori bustards (Naldo et al. 2000b). Common disorders include: angel wing, rotational and angular wing deformities, spraddle legs, rolled toes, and bone fractures (Naldo et al. 1998c), especially in birds experiencing metabolic bone disease (Naldo et al. 2000b). Musculoskeletal disorders are most common in the first 26 weeks of life, when bone growth rates are at their greatest (Naldo et al. 1998c). Assessment of chick growth rate, body weight changes, and food intake, as well as performing routine physical examinations, is important to detect musculoskeletal disorders early on; early detection increases the likelihood of successful treatment (Naldo et al. 2000b). Growth rates, periods, and bone sizes are detailed for kori bustards by Naldo et al. (2000b), and can be used as reference values for developing chicks.

Hereditary issues: No known hereditary diseases or disorders have been reported in kori bustards, although it is possible that hemosiderosis may have a genetic link.

Hospitalization: Wild caught kori bustards that have to be hospitalized benefit from surroundings that are free from noise and disturbance. While hand-reared birds are not as stress prone, they should not be housed in areas where sudden noise or frequent disturbances are a possibility. Sudden and unexpected noises have lead to injury and death to birds in unfamiliar surroundings. During hospitalization, hand-reared birds may benefit from increased visits by keepers, the installation of a mirror within their hospital enclosure, an increase in favored food items, and quiet surroundings. The response of the animal to a mirror should be monitored to ensure that it is not seen as an additional stressor. Wild-caught birds may benefit from a reduction in keeper presence, and environments as free from noise and disruption as possible.

Hospitalization facilities for kori bustards do not need to be elaborate or expensive. In larger enclosures and naturalistic aviaries, small holding pens (19.7' x 19.7'; 6m x 6m) made of shade cloth are suitable for isolating kori bustards (T. Bailey, personal communication, 2007). These can be effective for birds that have minor injuries and need occasional monitoring. These temporary pens can be less stressful for ‘nervous’ birds, as they are further away from the routine human activity that is common in veterinary facilities.

When birds are housed within specific hospital enclosures, the provision of padded rooms should be considered. Hospital stays should be as short as possible, and the birds returned to their normal

enclosures as soon as possible. While housed in hospital facilities, favored food items should be offered to encourage eating. The presence of a familiar keeper may also help some birds adjust to their temporary quarters.

AZA-accredited institutions must have a clear process for identifying and addressing kori bustard welfare concerns within the institution (AZA Accreditation Standard 1.5.8) and should have an established Institutional Animal Welfare Committee. This process should identify the protocols needed for animal care staff members to communicate animal welfare questions or concerns to their supervisors, their Institutional Animal Welfare Committee or if necessary, the AZA Animal Welfare Committee. Protocols should be in place to document the training of staff about animal welfare issues, identification of any animal welfare issues, coordination and implementation of appropriate responses to these issues, evaluation (and adjustment of these responses if necessary) of the outcome of these responses, and the dissemination of the knowledge gained from these issues.

AZA Accreditation Standard

(S1.5.8) The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution.

Given the wide variety of zoos that house kori bustards, the AZA Gruiformes TAG and Kori Bustard SSP cannot provide specific recommendations for the best approaches to take to communicate animal welfare issues effectively within every institution. All animal caretakers that work with kori bustards should be aware of institutional protocols in place for them to identify, communicate, and hopefully address potential animal welfare issues that are associated with the care and management of these animals.

Kori bustards can be very good at hiding an illness. For this reason, animal caretakers should be especially vigilant, and immediately communicate their concerns to a curator and/or veterinarian, as required by institutional protocols (Hallager and Boylan 2004). Animal caretakers should report any signs of illness, especially a reduced appetite, as soon as possible. Kori bustards usually have a very good appetite, and any deviation from this behavior is unusual and should be reported at once. Any lameness issues observed should also be reported and monitored, as kori bustards can develop serious foot and leg problems; if these musculoskeletal health issues are detected early, more serious physical health complications can possibly be avoided (Hallager and Boylan 2004). Familiarity with individual birds is essential when caring for this species effectively.

Euthanasia and necropsy: As care givers for the animals residing in our zoos, it is vital that we provide the best care possible for them until the time their health deteriorates to a point where euthanasia is the most humane treatment, or the animal dies on its own. Necropsies should be conducted on deceased animals to determine their cause of death and the subsequent disposal of the body must be done in accordance with any local, state, or federal laws (AZA Accreditation Standard 2.5.1). Necropsies should include a detailed external and internal gross morphological examination and representative tissue samples form the body organs should be submitted for histopathological examination. Facilities without access to avian pathology labs should please contact the Kori Bustard SSP Pathology Advisor for assistance with the histopathological analysis.

Common causes of kori bustard death are currently being investigated (Hanselmann, in prep.). The AZA Gruiformes TAG and Kori Bustard SSP do not currently have any specific recommended protocols for kori bustard euthanasia within zoos. Veterinarians at each institution are encouraged to contact the AZA Kori Bustard SSP Veterinary Advisor for more specific information or advice on the most effective, safe, and humane approaches to utilize. Each institution housing kori bustards should have a euthanasia protocol in place, developed by the veterinary team, in case euthanasia becomes necessary in a particular situation. The AZA Animal Welfare Committee also encourages each institution to develop a process to determine when elective euthanasia might be appropriate from a quality of life perspective, taking into account behavioral, health, social, nutritional, and animal caretaker perspectives. Examples of approaches used by institutions are available from the AZA Animal Welfare Committee.

See Appendix G for the AZA Kori Bustard SSP standardized necropsy protocol. Information on the gastro-intestinal tract of various bustard species is described in detail by Bailey et al. (1997a), and can be used for comparison with institutional data collected from bustard necropsies. Kori bustards display normal avian anatomy, which should be reflected in histopathological results. The Kori Bustard SSP Pathology Advisor is specifically interested in cardiac, muscle, and gastrointestinal tissues, and blood vessels. Please contact the Pathology Advisory regarding the processing or interpretation of samples.

Chapter 7. Reproduction

7.1 Reproductive Physiology and Behavior

It is important to have a comprehensive understanding of the reproductive physiology and behaviors of the kori bustards in our care. This knowledge facilitates all aspects of reproduction, artificial insemination, egg laying, hatching/rearing, and even contraception efforts that AZA-accredited zoos strive to achieve.

In the wild, kori bustards are polygynous, and males engage in lek-like behavior during the breeding season (Hallager and Boylan 2004). Male kori bustards become sexually mature between 4-6 years, and females between 3-4 years, although sexual maturity may occur earlier in zoos (Hallager and Boylan 2004). The oldest male to successfully breed in a zoo was 27 years of age, while a 28 year old female successfully laid a viable, fertile egg (Hallager and Boylan 2004). The timing of the breeding season in animals held in zoos varies throughout the United States, with breeding commencing as early as February in southern zones, and ending as late as October in northern zones. Once started, male reproductive displays reach their maximum several weeks after their initial onset. Monthly weighing of males at Smithsonian's National Zoo (see Figure 1 below) has demonstrated seasonal weight gains of as much as 4kg immediately before and during this period.

In the wild, males tend to associate with females only during the breeding season (Osborne and Osborne 1998). However, in zoos, single males can be housed with groups of females throughout the year (see Chapter 4, section 4.1). One month prior to the breeding season, males that are housed together should be separated from each other. If monthly weights are being monitored, keepers should separate males when there is an observed weight increase in any of the males, and especially if it is shown by the alpha male. Reproductively active males and females can become more aggressive to both conspecifics and keepers during the breeding season. Separated males should be housed in enclosures that continue to meet the behavioral needs of the animals, as outlined in Chapter 2, section 2.1.

Courtship, copulation, and egg laying: During the breeding season, displaying males produce a low-pitched 6-noted booming noise as part of their mating display (Hallager and Boylan 2004). Males will display in the presence and absence of females, but displays typically intensify when males are able to see females (Hallager and Boylan 2004). The various stages of copulation are initiated by a receptive female in response to the male's display. These stages include (Hallager 2003):

- Pre-copulation: The sequence of copulation begins with the female laying down near the displaying male. Once seated, the male approaches from behind either in full display (neck inflated and wings drooping) or in partial display (neck inflated and tail feathers raised). The male stands over the female and pecks at the back and sides of her head in a slow, deliberate manner, and with his tail and crest feathers raised slightly. The male stands for 5-10 minutes, alternately pecking at the female's head and stepping from side-to-side behind her, before he sits down on his hocks and continues pecking at the back of her head for another 5 minutes as the female remains seated.
- Copulation: After 10-15 minutes of head pecking, the seated male moves closer towards the sitting female using his hocks to progress forward. When close enough, the male spreads his wings and mounts the female from behind. Actual copulation lasts no more than a few seconds.
- Post-copulation: Immediately following copulation, both birds rise and part quickly, violently shaking their feathers. Females often make a "barking" sound as they move away from the male. Following copulation, both birds resume other activities, with the male often resuming courtship display behaviors.

Since copulation involves a lengthy period of head pecking by the male on the female (Hallager 2003), females should be closely monitored during the breeding season for signs of head injuries. While injuries will likely be minimal (feather plucking, bruising, and abrasions), keepers should watch for more serious injuries to the head.

Females typically begin laying 4-6 weeks after males have begun to display. Females can lay eggs as early as February in southern zones, and as early as May in northern zones. The average clutch size is 1.4 eggs. Some females lay only one egg per clutch, while others lay two eggs. Females will lay replacement clutches if previous clutches are pulled. Aggressive behavior during the breeding season (between males, or directed from males to females) does not apply solely to adult males; adult females

exhibit aggressive behaviors as well. Unlike males, fatal aggression between females has not been reported. Hens will aggressively defend their nesting site from other females, males, and animal caretakers. Females that are compatible with other females or males during the non-breeding season can become aggressive to other birds during breeding, and in some cases will not tolerate other females (e.g., subordinate birds) being in close proximity (Hallager and Boylan 2004). In some cases, nesting females may need to be provided with a separate area to set up a nest, with the other females blocked from entering this area.

The following table (Table 17) provides details on incubation, pipping, and hatching durations of bustard eggs.

Table 17: Incubation data for kori, buff-crested, and white-bellied bustards, taken from Bailey and Anderson (2000).

Bustard Species	Incubation Start to Internal Pip (days)	Time to External Pip (hours)	Time to Hatch from External Pip (hours)
Kori	21 (20-22) n=10	13 (3-24) n=10	26 (6-39) n=20
Buff-crested	19 (17-24) n=15	13 (4-24) n=14	18 (6-44) n=34
White-bellied	19 (19-19) n=3	19 (14-24) n=2	26 (8-38) n=5

AZA Institutions breeding kori bustards should submit an annual egg report to the AZA Kori Bustard SSP Coordinator detailing egg size and general egg production (see Appendix H) parameters. Information on the egg size, dimension, and composition of kori bustard eggs (specifically infertile eggs) is provided by Anderson and Deeming (2002), and these data can be used for reference.

Reproductive monitoring: Monitoring weight increase in males is an effective, non-invasive approach to determine when levels of reproductive hormones are beginning to increase. Sexually active males show an increase in body mass during the breeding season, and it appears that the alpha-male shows a significantly greater increase in body weight than the beta-male (where other males are present). Monitoring changes in the weight of males is especially important for institutions that house male kori bustards in physical contact during the non-breeding season; when weights in the alpha-male begin to rise, the males should be separated to prevent aggression. Preliminary analysis of testosterone levels in a male kori bustard at Smithsonian's National Zoo (Figure 1) shows testosterone levels rising at the same time male weight gain begins (Hallager and Lichtenberg 2007).

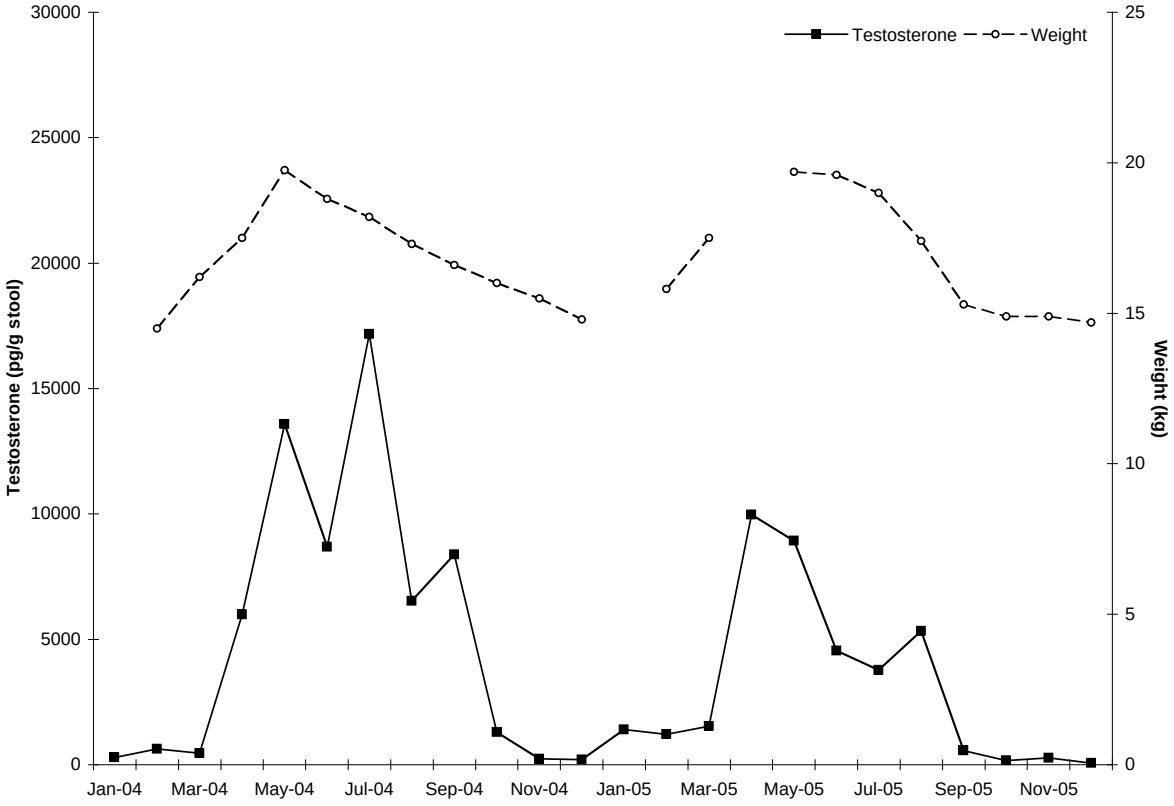

Figure 1: Testosterone and weight changes in a male kori bustard at the Smithsonian's National Zoo (Hallager and Lichtenberg 2007).

7.2 Artificial Insemination

The practical use of artificial insemination (AI) with animals was developed during the early 1900s to replicate desirable livestock characteristics to more progeny. Over the last decade or so, AZA-accredited zoos have begun using AI processes more often with many of the animals residing in their care. AZA studbooks are designed to help manage animal populations by providing detailed genetic and demographic analyses to promote genetic diversity with breeding pair decisions within and between our institutions. While these decisions are based upon sound biological reasoning, the efforts needed to ensure that transports and introductions are done properly to facilitate breeding between the animals are often quite complex, exhaustive, and expensive, and conception is not guaranteed.

AI has become an increasingly popular technology that is being used to meet the needs identified in the AZA studbooks without having to re-locate animals. Males are trained to voluntarily produce semen samples and females are being trained for voluntary insemination and pregnancy monitoring procedures such as blood and urine hormone measurements and ultrasound evaluations. Techniques used to preserve and freeze semen has been achieved with a variety, but not all, taxa and should be investigated further.

Artificial insemination has not been performed with kori bustards in AZA-accredited institutions, although it remains a feasible approach to take in future reproductive efforts. Due to the complexity and inherent risk of transporting a large bird like a kori bustard between institutions for breeding attempts, AI stands as a beneficial means to improve the mean kinship of kori bustards in zoos. It is likely that AI techniques will be most applicable to hand-reared birds, as the nervous nature and inapproachability of wild-caught birds will make sperm collection and insemination procedures very challenging. Hand-reared males are excellent candidates for semen collection, as they show a willingness to copulate with objects that resemble a seated female, and are not disturbed by the presence of nearby caretakers attempting to collect the semen. The process of inseminating females does require handling, which can increase the risk of injuries to both animals and their human caretakers. The time of insemination should coincide with

the female's most fertile period, and this is best determined by running hormonal assays. The expense and the need for facilities and equipment to perform this type of hormonal analysis is a limiting factor for the use of AI techniques in zoos with kori bustards.

Houbara bustard semen collection techniques have been successful in the United Arab Emirates (Jalme and van Heezik 1996), and might provide a useful foundation for future research if the technique is applied to kori bustards. Jalme et al. (1994) also provide some specific information on the results of Houbara bustard (*Chlamydotis undulata macqueenii* and *Chlamydotis undulata undulata*) artificial insemination approaches at the National Wildlife Research Center (Taif), including:

- Mean volume of ejaculate was recorded as 0.08ml
- Mean sperm concentration was 350 x 10^6 spermatozoa ml^{-1}
- Mean number of spermatozoa per ejaculate was approximately 20 x 10^6
- Mean quantity of spermatozoa produced per week by fully sexually mature Houbara bustards was 165 x 10^6
- The intra-individual variation in the number of spermatozoa per ejaculate was attributed to seasonal variation
- There was a statistically significant positive correlation between egg fertility and the quantity of sperm inseminated
- The median sperm storage duration for females was 10 days, with a maximum storage duration of 22 days
- The duration of sperm storage was related to the number of spermatozoa inseminated
- The greatest proportion of fertile eggs was obtained when >10^6 spermatozoa were inseminated between 3-6 days before laying
- Embryo mortality was found to increase when inseminations were performed more than 10 days before laying

Further research is needed to determine if these research findings are applicable to kori bustards, and to develop appropriate protocols for the use of artificial insemination with this species. General information on semen collection, artificial insemination, and cryopreservation of semen in non-domestic birds species is provided by Gee et al. (2004).

7.3 Egg-laying/Incubation/Hatching

Female kori bustards typically begin laying in May in northern zones of the United States, and as early as February in southern zones. Egg laying generally occurs 3-6 weeks after males begin booming as part of their courtship displays. Kori bustard females often pace excessively 2-3 days prior to egg laying, and typically do so around the area where egg laying will occur (Hallager and Boylan 2004). Keepers should monitor this behavior and observe the location of the pacing so that the area can be inspected daily for eggs. However, not all females pace prior to egg-laying, and more research is needed to identify other behaviors that may reliably indicate imminent egg-laying. Males should generally be moved to another enclosure when females are incubating eggs, and other females may have to be separated as well, depending on the behavioral interactions shown by the birds (see sections 7.1 and 7.4 for additional information).

Kori bustard eggs generally hatch on the 23rd day of incubation. The average clutch size for kori bustards is 1.4 eggs (Hallager and Boylan 2004). Most females lay only one egg per clutch. The shortest inter-clutch interval for kori bustards in North American zoos has been documented as 16 days (Hallager and Boylan 2004). On average, kori bustard eggs are 0.3lb (149g), 2.3" (57.6mm) wide, and 3.2" (82.2mm) long (see Hallager and Boylan 2004 for additional information). Not all females incubate their eggs after laying. Unattended eggs should be placed in an incubator as soon as they are found to minimize breakage and reduce bacterial infection. Keepers should continue to inspect the area where the first egg was found, as some females lay a second egg two days after the first. Egg binding has not been reported in kori bustards.

If eggs have been artificially incubated while the female sits on dummy eggs (see section 7.5 for additional information on artificial incubation), the eggs should be returned to the brooding female at internal pip if the chick is to be parent-reared (Hallager and Boylan 2004). The expected pip-to-hatch time is 8-24 hours. No assistance should be provided to hatching chicks until at least 24 hours following external pipping (Hallager and Boylan 2004), or if the chick appears to be weak. If the chick has not hatched after 24 hours, radiography, endoscopy, and ovotomy can be performed to determine the status

of the embryo. Assisted hatching techniques can be successful, but survival of chicks is lower if they are used (see Bailey and Anderson 2000 for details). Following assisted hatches, chicks may require supportive care in the form of subcutaneous fluids, vitamin injections, and antibiotics.

Once chicks have hatched, they should be left with their dam for 24 hours to allow normal imprinting and bonding; a quick medical assessment should be performed after 24 hours have passed, so that chicks can be examined, weighed, the umbilicus cleaned, and a determination made as to whether appropriate yolk-sac reabsorption is occurring (Hallager and Boylan 2004). Morphometric measures can also be taken at this time (see Chapter 6, section 6.1). The chick should be returned to its mother as quickly as possible.

When chicks are being fed or brooded, they produce a light chirp or purring sound (Hallager and Boylan 2004). In response to a negative stressor in the environment, chicks produce a cry that sounds like a long, sad whistle that can escalate into loud whaling cry (Hallager and Boylan 2004). Chicks as young as 2 weeks of age will also bark when alarmed.

7.4 Hatching Facilities

Unless the enclosure is very large, females should have a separate area from the male for nesting, as breeding males will chase females from their nesting sites. In the wild, kori bustard nests are typically shallow scrapes in the soil that are sometimes lined with sticks, grass stems, and mammal pellets (e.g., Mwangi 1988). The nests are often partially hidden and usually located near a grass clump or a rock. Osborne and Osborne (1999) and Mwangi (1988) provide evidence that the location of kori bustard nests may make use of plants and trees that offer shade throughout the day, and that partially obscure the sight of the nest. During incubation, females have been observed to throw sticks, grasses, and leaves onto their back, and this behavior may also be related to camouflage (S. Hallager, personal communication 2007).

In zoos, kori bustard females will also make a small scrape in the ground where the eggs will eventually be laid. The females spend increasing amounts of time in the area, and become protective of it. Once the eggs have been laid, incubating females rarely leave the nest during the 23-day incubation period. When females do leave the nest (e.g., at feeding times or to perform comfort activities such as sunning or dustbathing), they are generally aggressive towards keepers and other birds, and will return very quickly to the nest site. If another bird approaches the incubating female, she will aggressively drive them away. During nesting/incubation, multiple females can remain together as long as no aggression is observed. If aggression is seen between birds, then the non-nesting bird should be removed to a separate enclosure. A dominant female may prevent subordinate females from incubating their eggs.

During the breeding season, care should be taken to minimize all environmental stressors and invasive animal management procedures. All non-essential work within and around the enclosure should stop, and entry into the enclosure should be restricted only to those personnel that need to be there for essential animal management, care, or enclosure maintenance reasons. During feeding times, food bowls can be placed as close to the incubating female as possible, without actually disturbing the hen (Hallager and Boylan 2004). Female aggressiveness towards keepers varies between individual animals. Some individuals will become aggressive when caretakers are 5-10' (1.5-3m) away; others will let animal caretakers remove the eggs from beneath them. Animal caretakers should wear protective eyewear when attempting to remove an egg from under an incubating female, and should take great care as females can defend their nests aggressively. Some females may defend their nest more aggressively than others, and two keepers may be needed to remove the egg. If eggs do need to be removed (e.g., for candling, artificial incubation, etc.), the best approach is to reach under the female from behind.

When chicks hatch, all other birds (even previously compatible ones) should be removed from the enclosure or separated. Adult females other than the dam will attack chicks. Where multiple females are rearing chicks in the same enclosure, erecting small pens around each nest area may help to ensure the safety of the chicks. Alternatively, one set of chicks can be left to be parent-reared, while the others can be removed for hand-rearing. As chicks are mobile from the first day post-hatch, chick-proof mesh (1"/2.5cm) should be installed around the base of the pen before the chicks hatch to prevent them from escaping. Ideally, installation of chick-proof containment barriers should be performed before the start of the breeding season to prevent disturbance to the incubating female. Pens containing chicks should be covered to prevent wild predators from gaining access to the chicks (Hallager and Boylan 2004).

Care should be taken to ensure that enclosures containing chicks do not have areas where chicks can fall (e.g., ledges, terracing, areas of soil erosion). A short drop of 6" (15.2cm) has been identified as a

possible causal factor relating to a chick developing splayed legs, ultimately leading to the chick being euthanized. The short drop from the chick's night shelter to the ground was replaced with a ramp to prevent injuries to other chicks.

Females rearing their first chicks will often ignore the majority of diet items provided in favor of feeding the chicks only with live insects for between 7-10 days in some cases. Even experienced females can follow this chick-feeding strategy. It is very important that sufficient live insects are provided to the female during this time, and especially after the chicks have hatched. When females have two chicks, there may be some situations where one chick may out-compete the other for access to food. The weights of chicks and their food intake should be carefully monitored, especially during the first week, and supplemental feedings can be considered if one chick is not receiving sufficient nutrition.

Chicks can be housed with the dam until the start of the next breeding season. For females that have been separated from other birds during nesting and chick rearing, reintroductions back to the flock can occur when the chicks are around 6 months of age. Reintroductions should follow the protocols described in Chapter 4, section 4.3.

7.5 Assisted Rearing

Although dams may successfully lay eggs, there are times when they are not able to properly care for their offspring, both with *in-situ* and *ex-situ* populations. Fortunately, animal care staff in AZA-accredited institutions are able to assist with the rearing of these *ex-situ* offspring if necessary. Assisted rearing of kori bustards can involve artificial incubation, a combination of artificial and natural incubation, and hand-rearing techniques. Details of these techniques are provided below (Hallager and Boylan 2004).

Assisted incubation: The following protocol provides information on assisted incubation technique for chicks that will be mother-reared, utilizing a combination of both natural and artificial incubation techniques that have been successful at institutions with flocks of breeding kori bustards.

1) On the first day after being laid, eggs should be taken from the incubating female for weighing, measuring, and candling. During this procedure, the egg taken from the female should be replaced with a dummy egg warmed to 99.5°F (37.5°C). Once the egg assessment has been completed, the egg should be returned to the female, and the dummy egg removed.

2) On day 7, the egg (or first egg laid if there are two) should be removed for the remainder of the incubation period, and replaced with a warmed dummy egg. The removed egg should be re-weighed and candled, and placed in an artificial incubator (e.g., Grumbach) at 99.5°F (37.5°C) and 55% relative humidity. If a second egg has been laid, it should be left with the female for natural incubation, after the initial weighing, measuring, and candling has been performed.

3) The target weight loss for kori bustard eggs is 12%, and the humidity in the incubator should be adjusted to result in this weight loss. Eggs should be turned every two hours. Humidity should be increased to 70-80% once candling shows that the air cell within the egg begins to drop down. However, many kori bustard eggs are too dark to candle effectively, and in these cases, humidity should be increased at external pip.

4) At internal pip, the egg should be placed back under the female for hatching. Assistance with hatching is not recommended for at least 24 hours after external pipping. Once hatched, the chick should be left to imprint on the dam for the first 24 hours, where this is possible. After this time, the chick can be removed briefly so that it can be examined, weighed, its umbilicus cleaned, and yolk-sac re-absorption confirmed, before being returned. A 1% iodine solution can be applied to the umbilici of chicks when they are first handled.

Artificial incubation: The following table (Table 18) provides a summary of the artificial incubation protocols for kori bustard eggs used at the Smithsonian's National Zoo and the San Diego Zoo's Wild Animal Park. While the incubators used at these facilities have been successful, other models may be appropriate as well.

Table 18: Artificial incubation protocols for kori bustard eggs

	Smithsonian's National Zoo Protocol	San Diego Zoo's Wild Animal Park Protocol
Incubation		
Incubator	Grumbach incubator	Petersime model 1 or Humidaire model 21 incubator
Temperature	99.5°F (37.5°C)	99.5°F (37.5°C)
Humidity/wet bulb	50-55%	80-86°F (26.7-30°C)
Egg turning	Every 4 hours	Every 1-2 hours, with additional 180° turn twice daily
Egg cleaning	No	Wiped with dry sponge
Egg weight loss	-	15%
Moved to hatchery	External pip	Day 21-22

When bustard eggs are artificially incubated, an average weight loss of 14.9% should be expected for kori bustards (Anderson 1998a). Anderson (1998b,c) provides details on the artificial incubation of buff-crested bustards and white-bellied bustards that may be relevant to kori bustards.

If artificial incubation is performed, delayed incubation of kori bustard eggs is generally not recommended. Delayed incubation of Houbara bustard (*Chlamydotis undulata*) eggs, where the eggs were stored for a period of time before being transferred to incubators, resulted in a 19% lower hatchability rate, with higher mortality recorded between 3-5 days of development (Jalme and Van Heezik 1996). Kori bustard eggs should be placed in an incubator as soon as they are discovered.

If artificially incubated bustard chicks do not hatch within established pipping intervals, or seem to be weak, then it is possible to perform radiography, endoscopy, and ovotomy, to determine the status of the embryo. Assisted hatching techniques can be successful, but survival of chicks is lower if they are used (see Bailey and Anderson 2000 for details). Table 19 provides a summary of the hatching protocols for kori bustard eggs used at the Smithsonian's National Zoo and the San Diego Zoo's Wild Animal Park. While these protocols have been successful for these facilities, other models may be appropriate as well.

Table 19: Artificial hatching protocols for kori bustard eggs

	Smithsonian's National Zoo Protocol	San Diego Zoo's Wild Animal Park Protocol
Hatching		
Hatcher	Grumbach incubator	Leahy hatcher
Temperature	99.3°F (37.4°C)	98.4°F (36.9°C)
Humidity/wet bulb	70-75%	88-90°F (31.1-32.2°C)
Egg turning	None	None

Hand-rearing: Hand-rearing should be considered, and is strongly recommended, for any situation where kori bustard enclosures are not predator-proof. Kori bustard chicks are vulnerable to predation by bird and mammal species that commonly occur in and around zoos in the United States. Hand-rearing should also be considered when dams do not show normal chick rearing behaviors (e.g., feeding and brooding the chicks).

Accumulating evidence indicates that hand-rearing of kori bustards does not negatively impact the future breeding success of the chicks, and may result in animals with a better temperament for management within zoos (e.g., more tractable and more accepting of caretaker/visitor presence) (Hallager and Boylan 2004). Numerous hand-reared kori bustards have become viable breeding birds.

Hand-rearing protocol: With only rare exceptions, hatching occurs on the 23rd day of incubation. Hatch weights for chicks range from 0.17-0.26lb (77-116g), with an average of 0.2lb (98g) in chicks from the Smithsonian's National Zoo (n=33). After hatching, the chick's umbilicus should be cleaned with Betadine

(100%) solution, and the chick should be weighed. If the chick is clinically dehydrated or has had difficulty hatching, 2cc of half-strength Lactated Ringer's and 2.5% dextrose solution should be provided subcutaneously (Hallager and Boylan 2005). After the initial assessment, the chick should be allowed to rest for several hours in the hatcher, before being moved to a brooder. Brooders that are 27.5" x 13" x 14" deep (69.9cm x 33cm x 35.5cm) and that are kept at 97°F (36.1ºC) have been successfully used to hand-rear chicks. The floor of the brooder should be carpeted, and a feather duster hung in one corner to simulate the mother. A small mirror affixed in the brooder can also act as a visual stimulus for the chick. When brooder conditions are appropriate and chicks are provided with sufficient food and tactile stimulation, they will often produce a light chirp or purring sound, especially when feeding (Hallager and Boylan 2004). Chicks in conditions that are not meeting their needs can produce a long, sad whistle that can escalate into a loud wailing. The nutritional requirements of hand-reared chicks are covered in Chapter 5, sections 5.1 and 5.2. The following table (Table 20) provides expected growth rates for hand-reared bustards:

Table 20: Growth rates of bustards reared in zoos.

Species	Growth Rates	Source
Kori	7.5-10% for the first month. Adult bodyweight achieved in females at 300-450 days. Adult bodyweight not achieved in males by 330 days	Anderson 1998a
Buff-crested	5-7.5% for the first month[1]	Anderson 1998b
White-bellied	7.5-10% for the first month. Adult bodyweight reached by 6 months	Anderson 1998c

[1] Anderson (1998c) reports that musculoskeletal problems were seen in buff-crested bustards with growth rates in excess of 10% during one season; recommended growth rates are less than 10% (Anderson 1998c).

At 4-5 days after hatching, hand-reared chicks can be placed with other chicks, provided that the older chick is less than two weeks old. Chicks less than 1 week old should not be placed with other chicks that are >2 weeks of age, as the older chick has the capacity to severely (and possibly fatally) wound the younger chick. When chicks are 3 weeks old, they can be housed together with slightly older chicks, but should be carefully monitored. When introducing young chicks together, the older chick will be aggressive towards the younger chick, but the period of aggression is generally limited to the first several hours after the initial introduction. Chicks should be observed carefully during the brief introduction period. Raising hand-reared chicks with a sibling or similarly aged conspecific reduces the likelihood of imprinting.

Chicks housed alone benefit from a mirror or a heterospecific companion (e.g., quail or guinea fowl chick) in their enclosure; the mirror acts as a calming agent, and serves to reduce the degree of imprinting that occurs. Typically, chicks reared alone have the highest degree of imprinting on their caretakers (e.g., approaching animal caretakers, readily accepting food from them). Placing the chicks in visual contact with adult kori bustards may also reduce human imprinting to some degree. However, this may negatively influence the behavior of the breeding flock, and should only be attempted at the end of the breeding season. Imprinted males have been known to be aggressive towards human caretakers as adults (S. Hallager, personal communication, 2006).

Cross-fostering and shared-rearing techniques have not been used with kori bustards in zoos in the United States, but further investigation into these approaches might be useful to determine if they are applicable to this species. For cross-fostering to be successful, the timing needs to be appropriate for the animals involved. Shared rearing is less likely to be appropriate for kori bustards, as chicks imprint on their dam, and females may attack a chick that is not imprinted. This technique has been used in Australian bustards (*Ardeotis australis*), where some highly capable females were regularly used to foster chicks from less competent mothers (P. Goriup, personal communication, 2007).

As hand-reared kori bustard chicks grow, they should be exercised following each feeding session and as often as possible throughout the day. This will minimize musculoskeletal health problems such as slipped tendons. Access to larger, more complex enclosures should be provided as the chicks continue to develop. Containment for hand-reared chicks should follow recommendations made in Chapter 2, section 2.2. To minimize injuries, chicks should not be housed in enclosures with barriers and obstacles that the birds can impact or trip over (Hallager and Boylan 2004). Whenever hand-reared chicks are introduced to a new enclosure, a familiar keeper should acquaint them to the new space immediately after releasing them by walking around with the birds and showing them the resources available within the enclosure (e.g., plants, fences, walls, dishes, etc.).

Complete day-to-day hand-rearing protocols for kori bustard chicks are summarized in Appendix I. Bailey et al. (1997b) also provide recommended approaches to maximize the health of hand-reared bustard chicks.

7.6 Population Control

Many animals cared for in AZA-accredited institutions breed so successfully that contraception techniques are implemented to ensure that the population remains at a healthy size. In the case that the recommendation is made not to breed a female kori bustard, any fertile eggs that are laid should be removed as soon as they are laid and replaced with dummy eggs. The female should be allowed to sit on her nest until she abandons it at the end of the breeding season. Eggs that are removed should always be replaced with dummy eggs in order to stop the female from laying an excessive number of eggs, as females will re-clutch in some cases.

Avian egg embryo euthanasia: The disposal of fertile eggs should be done with proper consideration for animal welfare implications The AZA Kori Bustard SSP and the American Association of Zoo Veterinarians (AAZV) recommend that institutions adopt the guidelines that states: “by 50% gestation the neural tube of avian embryos has developed sufficiently for pain perception, and therefore any bird embryos that old or older should be euthanized using methods appropriate for hatched birds (i.e., chemical).” The incubation period for kori bustards is 23 days, and so the cessation of incubation for kori bustard eggs should occur no later than the 11th day after laying, and preferably sooner. Fertile eggs older than 11 days will need to be euthanized using methods appropriate for hatched birds. The AZA Kori Bustard SSP Veterinary Advisor can provide additional information and advice on effective, safe, and humane approaches to utilize. Veterinarians at each institution should develop their own euthanasia protocols that also include egg embryo euthanasia.

Chapter 8. Behavior Management

8.1 Animal Training

Classical and operant conditioning techniques have been used to train animals for over a century. Classical conditioning is a form of associative learning demonstrated by Ivan Pavlov. Classical conditioning involves the presentation of a neutral stimulus that will be conditioned (CS) along with an unconditioned stimulus that evokes an innate, often reflexive, response (US). If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the animal will begin to produce a conditioned behavioral response to the CS.

Operant conditioning uses the consequences of a behavior to modify the occurrence and form of that behavior. Reinforcement and punishment are the core tools of operant conditioning. Positive reinforcement occurs when a behavior is followed by a favorable stimulus to increase the frequency of that behavior. Negative reinforcement occurs when a behavior is followed by the removal of an aversive stimulus to also increase the frequency of that behavior. Positive punishment occurs when a behavior is followed by an aversive stimulus to decrease the frequency of that behavior. Negative punishment occurs when a behavior is followed by the removal of a favorable stimulus also to decrease the frequency of that behavior.

AZA-accredited institutions are expected to utilize reinforcing conditioning techniques to facilitate husbandry procedures and behavioral research investigations.

Historically, daily husbandry practices involving kori bustards (e.g., crating, shifting, weighing, restraint etc.) have lead to health and injury problems in zoos. Behavioral management of kori bustards utilizing basic operant conditioning techniques can help prevent these types of injuries. Kori bustards at several institutions have been trained to step on weighing scales so that their weight can be monitored on a routine basis to monitor weights (see protocol below). Target training has also been performed to facilitate the training of animals to move to and station on a platform scale to allow their weights to be taken. The training of additional husbandry behaviors using operant conditioning is very feasible with these animals, and kori bustards would benefit from being trained to enter sheds/holding areas on cue (especially useful for northern facilities that have to move birds indoors routinely in colder months). Crate training would also be useful for the occasional situations when birds have to be relocated or transferred for medical treatment, and would reduce the likelihood that birds would be injured during manual capture and restraint procedures that are otherwise used (see Chapter 6, section 6.5).

Scale training: To avoid excessive handling of kori bustards while monitoring general health and documenting seasonal weight changes in males, a 4' x 4' (1.2m x 1.2m) scale can be used to weigh birds on a monthly (or as needed) basis. Recording weight changes can assist in the social and reproductive management of these birds (see Chapter 7, section 7.1). The scale platform should be positioned in an area where the birds feel comfortable (e.g., in front of a feeder), near a dry area where the scale indicator can be located, and in a location where keepers can remain out of sight while still being able to identify the bird and read the indicator. Indoor/outdoor carpet can be placed over the scale in order to hide the bright silver color of the scale, and provide the birds with good footing when they step onto the platform. The process of scale training can begin by placing mealworms or some other favored food item on the scale to encourage the birds to step onto it (see Hallager and Boylan 2004 for additional information). Target training may also be beneficial to help move the birds to the platform within their enclosures. Once the birds feel comfortable stepping onto the scale to reach food items, routine weighing can begin. The birds should be reinforced for standing still on the platform where possible. Scale training can make monthly weighing a relatively quick process, without the need to handle or restrain the birds.

8.2 Environmental Enrichment

Environmental enrichment, also called behavioral enrichment, refers to the practice of providing a variety of stimuli to the animal's environment, or changing the environment itself to increase physical activity, stimulate cognition, and promote natural behaviors. Stimuli, including natural and artificial objects, scents, and sounds are presented in a safe way for the animals to interact with. Some suggestions include providing food in a variety of ways (i.e., frozen in ice or in a manner that requires an animal to solve simple puzzles to obtain it), using the presence or scent/sounds of other animals of the same or different species, and incorporating an animal training (husbandry or behavioral research) regime in the daily schedule.

It is recommended that an enrichment program be based on current information in biology, and should include the following elements: goal-setting, planning and approval process, implementation, documentation/record-keeping, evaluation, and subsequent program refinement. Environmental enrichment programs should ensure that all environmental enrichment devices (EEDs) are safe and are presented on a variable schedule to prevent habituation AZA-accredited institutions must have a formal written enrichment program that promotes kori bustard-appropriate behavioral opportunities (AZA Accreditation Standard 1.6.1).

AZA Accreditation Standard

(S1.6.1) The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.

Enrichment programs should be integrated with veterinary care, nutrition, and animal training programs to maximize the effectiveness and quality of the kori bustard care provided. AZA-accredited institutions must have specific staff members assigned to oversee, implement, train, and coordinate interdepartmental enrichment programs (AZA Accreditation Standard 1.6.2).

AZA Accreditation Standard

(S1.6.2) The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

For kori bustards, some variation in their environment is important to satisfy their natural curiosity and intelligence. With approval from institution veterinarians and nutritionists, food items may be offered as a form of enrichment (see Chapter 5, section 5.2 for additional information on food-based enrichment initiatives). Non-food enrichment initiatives can also be developed as part of a formalize enrichment program (e.g., see www.animalenrichment.org), and should provide opportunities for the birds to express their full range of behaviors (see Appendix B for a kori bustard ethogram). For example, young birds show great interest in knotted short lengths of rope that can be tied to a fence or bush with a large knot at the end; this enrichment initiative can promote a range of hunting, foraging, and object manipulation behaviors that the birds would typically perform while seeking food or interacting with conspecifics in the wild. Youngsters will spend several minutes biting at and pulling on the rope. If the rope is elevated above a bird's head, they may also jump up to reach it. For this enrichment initiative, short lengths of rope are recommended, as longer lengths could potentially wrap around a bird's neck and the rope should be removed when keepers leave the area.

Keepers should observe the animals' interactions with enrichment initiatives to ensure that there are no health or safety concerns. Research is needed to determine the efficacy of enrichment. Kori bustards have been de-sensitized to stepping on a scale or entering crates to obtain food. However, they have not been trained for any husbandry behaviors.

8.3 Staff and Animal Interactions

Animal training and environmental enrichment protocols and techniques should be based on interactions that promote safety for all involved. Kori bustards are not aggressive by nature. The main potential for injury to an animal caretaker from a kori bustard will be during capture and restraint of the birds, and especially when males push out with their feet while they are being held. Kori bustards are very strong-legged birds, and it can be difficult to tuck them into a position to carry them safely. It is recommended to have two keepers present during capture and restraint to ensure proper safety of the bird as well as the keepers involved (see Chapter 6, section 6.5 for additional information). Although kori bustards rarely strike out with their bills, bouts of struggling during restraint procedures could result in a bird inadvertently pecking the face of its handlers. Goggles can be worn to minimize the risk of eye injuries during these procedures. Leather gloves are not recommended during restraint procedures, as they inhibit the handler's ability to hold the bird properly.

Unlike cranes, kori bustards are not usually aggressive, and unprotected free contact management of these animals is the most common form of interaction between the keeper and the bird. Males can be aggressive to keepers during the breeding season, and keepers may opt to carry a broom or other soft/rigid object that can be used to push the bird away. In some cases, the use of the broom may increase aggression, as some birds focus their aggressive responses solely on the broom.

Attention to the design of enclosures and facilities housing kori bustards, and to the behavior of staff members working with these birds, is important to minimize trauma-related problems during human-animal interactions, such as capture/restraint and animal training. In the daily management of kori

bustards, the likelihood of trauma to the birds can be reduced in the following ways (T. Bailey, personal communication, 2007):

- Using plastic coated foam padding to surround the sides of enclosures or pens, especially in areas where birds are regularly caught, such as in hospital or quarantine pens. Padding minimizes abrasion injuries to wingtips.
- Using shade-cloth or tension netting on the roof and sides of aviaries to cushion the impact that may result from birds flying within an enclosure (birds can still attempt flight whether they are flight restricted or not).
- Modifying behavior of the birds by habituating nervous individuals to common stimuli that may occur within the zoo environment (e.g., noises, presence of veterinarians, visitors, etc.), or housing such birds in naturalistic pens with plenty of cover to allow them to avoid potential negative stressors.
- Ensuring that birds that have not been pinioned are regularly feather trimmed to prevent the birds from getting airborne (see Chapter 6, section 6.4 for additional information).
- Minimizing stress by reducing the number of non-essential people who enter kori bustard enclosures or the off-exhibit areas directly around these enclosures.

8.4 Staff Skills and Training

Staff members should be trained in all areas of animal behavior management. Funding should be provided for AZA continuing education courses, related meetings, conference participation, and other professional opportunities. A reference library appropriate to the size and complexity of the institution should be available to all staff and volunteers to provide them with accurate information on the behavioral needs of the animals with which they work.

Animal care staff should have a complete understanding of the natural history, behavior, and biology of kori bustards. For the effective management of the animals, animal caretakers should be familiar with their range of vocalizations (e.g., barks, growls, and booms) and their postures/displays and should be able to capture and restrain bird quickly and safely when needed. New keepers should be trained by keepers experienced in large bird handling, whenever possible. The AZA Gruiformes TAG and Kori Bustard SSP do not have any specific recommendations for certifications and qualifications needed by animal care staff working with kori bustards, but encourage all institutions to provide opportunities for animal caretakers to gain additional experience in all fields of animal management and care.

Chapter 9. Program Animals

9.1 Program Animal Policy

AZA recognizes many public education and, ultimately, conservation benefits from program animal presentations. AZA's Conservation Education Committee's Program Animal Position Statement (Appendix J) summarizes the value of program animal presentations. For the purpose of this policy, a program animal is described as an animal presented either within or outside of its normal exhibit or holding area that is intended to have regular proximity to or physical contact with trainers, handlers, the public, or will be part of an ongoing conservation education/outreach program.

Program animal presentations bring a host of responsibilities, including the welfare of the animals involved, the safety of the animal handler and public, and accountability for the take-home, educational messages received by the audience. Therefore, AZA requires all accredited institutions that give program animal presentations to develop an institutional program animal policy that clearly identifies and justifies those species and individuals approved as program animals and details their long-term management plan and educational program objectives.

AZA's accreditation standards require that the conditions and treatment of animals in education programs must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, sound and environmental enrichment, access to veterinary care, nutrition, and other related standards (AZA Accreditation Standard 1.5.4). In addition, providing program animals with options to choose among a variety of conditions within their environment is essential to ensuring effective care, welfare, and management. Some of these requirements can be met outside of the primary exhibit enclosure while the animal is involved in a program or is being transported. For example, housing may be reduced in size compared to a primary enclosure as long as the animal's physical and psychological needs are being met during the program; upon return to the facility the animal should be returned to its species-appropriate housing as described above.

AZA Accreditation Standard

(S1.5.4) A written policy on the use of live animals in programs should be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.

Kori bustards are not commonly used in formal conservation/education programs, and the AZA Kori Bustard SSP has no specific recommendations for the use of kori bustards as program animals beyond the general recommendations included within this manual. Any future recommendations will be added to this manual as they are developed by the AZA Gruiformes TAG and Kori Bustard SSP. Institutions that utilize kori bustards in formal or informal programs should provide updates to the AZA Kori Bustard SSP in regards to the approaches used with this species.

9.2 Institutional Program Animal Plans

AZA's policy on the presentation of animals is as follows: AZA is dedicated to excellence in animal care and welfare, conservation, education, research, and the presentation of animals in ways that inspire respect for wildlife and nature. AZA's position is that animals should always be presented in adherence to the following core principles:

- Animal and human health, safety, and welfare are never compromised.
- Education and a meaningful conservation message are integral components of the presentation.
- The individual animals involved are consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs.

AZA-accredited institutions which have designated program animals are required to develop their own Institutional Program Animal Policy that articulates and evaluates the program benefits (see Appendix K for recommendations). Program animals should be consistently maintained in a manner that meets their social, physical, behavioral, and nutritional needs. Education and conservation messaging must be an integral component of any program animal demonstration (AZA Accreditation Standard 1.5.3).

AZA Accreditation Standard

(S1.5.3) If animal demonstrations are a part of the institution's programs, an education and conservation message must be an integral component.

Given the management challenges associated with kori bustard capture and restraint, this species is not involved in conservation/education programs outside of their enclosures, but may be involved in animal training demonstrations that zoo visitors can observe, whether out on exhibit or during 'behind the scenes' tours. The provision of enrichment to kori bustards in the view of the public could also be considered an educational program based on the definition of 'program animals' provided in section 9.1.

Only animal caretakers that have received training within the institution relevant to working with kori bustards should be involved in any animal training demonstrations, and specific protocols should be developed and implemented to ensure that animal care staff members remain safe and focused on the animals during any demonstrations. The presence of zoo visitors should not distract animal caretakers during interactions with the animals. Animal care staff members should be competent in recognizing stress or discomfort behaviors exhibited by any animals used in programs/demonstrations (e.g., increased aggression, barking, running, crouching), and be able to communicate these issues effectively using institution-specific animal care protocols so that welfare or safety concerns can be specifically addressed. Animal care staff members involved in kori bustard 'programs' should be trained in conservation and education messaging techniques and public interaction procedures.

Program animals that are taken off zoo grounds for any purpose have the potential to be exposed to infectious agents that could spread to the rest of the institution's healthy population. AZA-accredited institutions must have adequate protocols in place to avoid this (AZA Accreditation Standard 1.5.5).

Careful consideration must be given to the design and size of all program animal enclosures, including exhibit, off-exhibit holding, hospital, quarantine, and isolation areas, such that the physical, social, behavioral, and psychological needs of the species are met and species-appropriate behaviors are facilitated (AZA Accreditation Standards 10.3.3 and 1.5.4).

Animal transportation must be conducted in a manner that is lawful, safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public (AZA Accreditation Standard 1.5.11).

AZA-accredited institutions which have an Institutional Program Animal Plan are required to evaluate the efficacy of the plan routinely (see Appendix K for recommendations). Education and conservation messaging content retention, animal health and well-being, guest responses, policy effectiveness, and accountability and ramifications of policy violations should be assessed and revised as needed.

Chapter 10. Research

10.1 Known Methodologies

> **AZA Accreditation Standard**
>
> **(S5.3)** Institutions should maximize the generation of scientific knowledge gained from the animal collection. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

AZA believes that contemporary animal management, husbandry, veterinary care and conservation practices should be based in science, and that a commitment to scientific research, both basic and applied, is a trademark of the modern zoological park and aquarium. AZA-accredited institutions have the invaluable opportunity, and are expected, to conduct or facilitate research both in *in-situ* and *ex-situ* settings to advance scientific knowledge of the animals in our care and enhance the conservation of wild populations. For kori bustards, this knowledge can be achieved in part by participating in the AZA Gruiformes TAG or Kori Bustard SSP sponsored research, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials (AZA Accreditation Standard 5.3).

Research investigations, whether observational, behavioral, physiological, or genetically based, should have a clear scientific purpose with the reasonable expectation that they will increase our understanding of kori bustards and may provide results which benefit the health or welfare of animals in wild populations. Many AZA-accredited institutions incorporate superior positive reinforcement training programs into their routine schedules to facilitate sensory, cognitive, and physiological research investigations and these types of programs are strongly encouraged by the AZA.

The Smithsonian's National Zoo and Dallas Zoo have conducted significant research on kori bustards. Learn more at http://nationalzoo.si.edu and www.dallaszoo.com/default.htm. The International Union for the Conservation of Nature (IUCN) Bustard Specialist Group is another recommended resource (www.iucn.org).

The research priorities listed below were identified by the AZA Kori Bustard SSP in their 2009-2011 Action Plan (see Appendix L) and are currently in progress.

- Identify factors necessary to get additional birds breeding. Complete hormonal research studies and publish results.
- Document growth and development of chicks (through weight gains, photographs, and plumage changes).
- Continue to document adult (primarily male) seasonal weight changes. Expand weighing study to include monthly weights of chicks from birth through three years.
- Refine adult and chick rearing diets to that more appropriate of an omnivorous bird.
- Support field work and research where needed (e.g., Botswana, Namibia, East Africa).

Keeper research: Keepers are in a great position to contribute to kori bustard management and husbandry advances and research, as they work with the species on a daily basis. Some areas where keeper input and participation can be very valuable include:

- Instituting scale training so that birds can be routinely weighed in order to assess seasonal and lifetime changes in body mass.
- Documenting physical development of chicks, including data collection on weight, specific diet ingredient intake (weighed amounts), morphometrics, and plumage changes.
- Recording weight, culmen length, skull length, tibiotarsus length, tail length, and wing chord when adult birds are handled.
- Weighing and measuring all eggs (fresh weight and length/width).
- Collecting data on activity budgets of adults and chicks.
- Determining food preferences of females when feeding chicks.
- Recording space utilization by monitoring types of areas preferred by kori bustards, and by comparing on-exhibit birds with off-exhibit birds.
- Documenting personalities of wild versus zoo-reared, and hand- versus parent-reared individuals.
- Documenting molt patterns.

AZA-accredited institutions are required to have a clearly written kori bustard research policy that identifies the types of research being conducted, methods used, staff involved, evaluations of the projects, the animals included, and guidelines for the reporting or publication of any findings (AZA Accreditation Standard 5.2). Institutions must designate a qualified individual designated to oversee and direct its kori bustard research program (AZA Accreditation Standard 5.1). If institutions are not able to conduct in-house research investigations, they are strongly encouraged to provide financial, personnel, logistical, and other support for priority research and conservation initiatives identified by TAGs or SSPs, including the Kori Bustard SSP.

AZA Accreditation Standard

(S5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

AZA Accreditation Standard

(S5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

10.2 Future Research Needs

This Animal Care Manual is a dynamic document that will need to be updated as new information is acquired. Knowledge gaps have been identified throughout the Manual and are included in this section to promote future research investigations. Knowledge gained from areas will maximize AZA-accredited institutions' capacity for excellence in animal care and welfare as well as enhance conservation initiatives for the species.

Kori bustard behavior: Additional behavioral research that focuses on the behavior of wild kori bustards, and that can be used to make general comparisons with the behavior of kori bustards in zoos (e.g., based on daily activity budgets) in different social and physical conditions, will always be beneficial for improving appropriate animal management recommendations.

Enrichment: Most zoos employ some form of enrichment with their kori bustards. Research is needed to determine the efficacy of the enrichment as well as the required frequency.

Body condition: Huchzermeyer (1998) provides a scale (1-10) for scoring body condition in ostrich and Bailey (2008) provides descriptive text for assessing weight, hydration, cere, nares, beak, oropharynx, eyes, ears, pectoral muscle condition, neck, saccus oralis, body, coelomic space, vent, thoracic and pelvid limbs, feathers and skin. A grading system for overall body condition that takes into account the entire body of the bird should be developed for kori bustards to assist in proper husbandry.

Sunning: A study done by Fernandes and Hallager (2007) demonstrated that the act of sunbathing plays an integral role in the health and feather condition of captive kori bustards and suggests that ectoparasite control is the most plausible cause for sunning in captive kori bustards. However, additional observations are needed of birds in the wild to further elucidate the significance, frequency and occurrence of sunning in kori bustards.

Sound sensitivity: Little is known about the hearing sensitivity of kori bustards, and additional research on hearing would provide some guidance for creating more objective recommendations for managing sound stimuli for this species.

Enclosure containment: Covered enclosures are strongly recommended if kori bustard hens are allowed to raise chicks naturally, and it is also possible that completely covered enclosures may help to minimize the risk of avian flu transmission. Further research is needed to determine the role that covered aviaries can play in minimizing the transmission of diseases from wild birds.

Single-sexed groups: There is a need to keep adult males (>3 years old) separate during the breeding season, because dominant males may kill or severely wound subordinate males. It is recommended that adult males be housed separately at all times. Where multiple males are maintained together, more research is recommended to determine the appropriate conditions (if any) for being able to house these males together all year round.

Energy requirements: Additional research that focuses on exact daily food intake and energy expenditure for this species, and that covers all life stages (e.g., chick, juvenile, reproductive adult, senescent adult), will be important to perform so that more specific nutritional requirements and recommendations can be developed for kori bustards.

Target serum/nutrient values: More information is needed from blood samples collected from clinically 'normal' kori bustards. It is recommended that blood samples be taken opportunistically (e.g., during routine physicals), and analyzed for nutritionally related information that can be used to develop appropriate target serum and nutrient values.

Viral diseases: The following viral diseases have been associated with bustard species, but the significance of these viruses for the care and management of bustards in zoos remains unknown. More research is needed on the prevalence and treatment of these diseases within the zoo population.

- Adenovirus
- Avian influenza
- Avipox
- Herpesvirus
- Infectious bursal disease
- Lymphoid leucosis
- Marek's disease
- Newcastle disease
- Pigeon herpes
- PMV-2
- Reovirus

Metabolic diseases: Hemosiderosis has been reported in some kori bustards managed in zoos, but the causal factors associated with this disorder are not yet known. More research is needed to test hypotheses that link this disorder with a possible dietary etiology, or a genetic predisposition.

Chick rearing: Angel wing in chicks can begin to occur between 7-11 days post-hatch. Although parent-reared chicks seem to have higher growth rates than hand-reared chicks during the first week of life, parent-reared chicks tend not to develop angel wing. More research is needed to determine why parent-reared chicks do not develop angel wing but hand-reared chicks do. Institutions should carefully monitor the growth rate of hand- and parent-reared chicks, and should maintain detailed records on the nutrient composition of the diets provided to hand-reared chicks. More research is also needed on the ways in which both diet and exercise affect growth and development of kori bustard chicks.

Preliminary research has shown that the mortality of female chicks within the first year has been found to be higher than mortality rates for males, and further research is needed to determine if this is a phenomenon seen in wild populations of kori bustards, or if it represents sub-optimal husbandry and management within zoo environments.

Feathers and flight restriction: Pinioning kori bustards as chicks may make them more prone to injury and trauma within their enclosures, but more research is needed to determine the incidence of injuries in flight restrained and free-flighted individuals throughout the population of kori bustards managed in zoos.

Additional information is needed to determine the natural molt pattern of kori bustards, and whether this pattern is affected by diet, local environmental conditions, the social environment, etc. Naturally molted feathers should be picked up and recorded as they are discovered so that the normal molt pattern of kori bustards can be described at different institutions.

Artificial insemination: Artificial insemination has not been performed with kori bustards in AZA - accredited institutions, although it remains a feasible approach to take in future reproductive efforts. Houbara bustard semen collection techniques have been successful in the United Arab Emirates, and might provide a useful foundation for future research if the technique is applied to kori bustards, but more research is needed on kori bustards to develop suitable semen collection, storage, and insemination practices that are specific to kori bustards.

Behavioral indicators of laying: Kori bustard females often pace excessively 2-3 days prior to egg laying, and typically do so around the area where egg laying will occur. However, not all females pace prior to egg-laying, and more research is needed to identify other behaviors that may reliably indicate imminent egg-laying.

Assisted rearing: Cross-fostering and shared-rearing techniques have not been used with kori bustards in zoos in the United States, but further investigation into these approaches might be useful to

determine if they are applicable to this species. Research should focus on the timing of cross-fostering attempts in kori bustards and related species, when this approach has been attempted, and the influence that imprinting has on the success of shared-rearing techniques.

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Appendix A: Accreditation Standards by Chapter

The following specific standards of care relevant to kori bustards are taken from the AZA Accreditation Standards and Related Policies (AZA 2010) and are referenced fully within the chapters of this animal care manual:

Chapter 1

(S1.5.7) The animal collection must be protected from weather detrimental to their health.

(S10.2.1) Critical life-support systems for the animal collection, including but not limited to plumbing, heating, cooling, aeration, and filtration, must be equipped with a warning mechanism, and emergency backup systems must be available. All mechanical equipment should be under a preventative maintenance program as evidenced through a record-keeping system. Special equipment should be maintained under a maintenance agreement, or a training record should show that staff members are trained for specified maintenance of special equipment.

Chapter 2

(S1.5.2) Animals should be displayed, whenever possible, in exhibits replicating their wild habitat and in numbers sufficient to meet their social and behavioral needs. Display of single specimens should be avoided unless biologically correct for the species involved.

S10.3.3) All animal enclosures (exhibits, holding areas, hospital, and quarantine/isolation) must be of a size and complexity sufficient to provide for the animal's physical, social, and psychological well-being; and exhibit enclosures must include provisions for the behavioral enrichment of the animals.

(S11.3.3) Special attention must be given to free-ranging animals so that no undue threat is posed to the animal collection, free-ranging animals, or the visiting public. Animals maintained where they will be in contact with the visiting public must be carefully selected, monitored, and treated humanely at all times.

(S11.3.1) All animal exhibits and holding areas must be secured to prevent unintentional animal egress.

(S11.3.6) Guardrails/barriers must be constructed in all areas where the visiting public could have contact with other than handleable animals.

(S11.2.3) All emergency procedures must be written and provided to staff and, where appropriate, to volunteers. Appropriate emergency procedures must be readily available for reference in the event of an actual emergency. These procedures should deal with four basic types of emergencies: fire, weather/environment; injury to staff or a visitor; animal escape.

(S11.6.2) Security personnel, whether staff of the institution, or a provided and/or contracted service, must be trained to handle all emergencies in full accordance with the policies and procedures of the institution. In some cases, it is recognized that Security personnel may be in charge of the respective emergency (i.e., shooting teams).

(S11.2.4) The institution must have a communication system that can be quickly accessed in case of an emergency.

Chapter 3

(S1.5.11) Animal transportation must be conducted in a manner that is safe, well-planned and coordinated, and minimizes risk to the animal(s), employees, and general public. All applicable local, state, and federal laws must be adhered to.

Chapter 5

(S2.6.2) A formal nutrition program is recommended to meet the behavioral and nutritional needs of all species and specimens within the collection.

(S2.6.3) Animal diets must be of a quality and quantity suitable for each animal's nutritional and psychological needs. Diet formulations and records of analysis of appropriate feed items should be maintained and may be examined by the Visiting Committee. Animal food, especially seafood products, should be purchased from reliable sources that are sustainable and/or well managed.

(S2.6.1) Animal food preparations must meet all local, state/provincial, and federal regulations.

(S2.6.4) The institution should assign at least one person to oversee appropriate browse material for the collection.

Chapter 6

(S2.1.1) A full-time staff veterinarian is recommended. However, the Commission realizes that in some cases such is not practical. In those cases, a consulting/part-time veterinarian must be under contract to make at least twice monthly inspections of the animal collection and respond as soon as possible to any emergencies. The Commission also recognizes that certain collections, because of their size and/or nature, may require different considerations in veterinary care.

(S2.1.2) So that indications of disease, injury, or stress may be dealt with promptly, veterinary coverage must be available to the animal collection 24 hours a day, 7 days a week.

(S2.2.1) Written, formal procedures must be available to the animal care staff for the use of animal drugs for veterinary purposes and appropriate security of the drugs must be provided.

(S1.4.6) A staff member must be designated as being responsible for the institution's animal record-keeping system. That person must be charged with establishing and maintaining the institution's animal records, as well as with keeping all animal care staff members apprised of relevant laws and regulations regarding the institution's animal collection.

(S1.4.7) Animal records must be kept current, and data must be logged daily.

(S1.4.5) At least one set of the institution’s historical animal records must be stored and protected. Those records should include permits, titles, declaration forms, and other pertinent information.

(S1.4.4) Animal records, whether in electronic or paper form, including health records, must be duplicated and stored in a separate location.

(S1.4.3) Animals must be identifiable, whenever practical, and have corresponding ID numbers. For animals maintained in colonies or other animals not considered readily identifiable, the institution must provide a statement explaining how record keeping is maintained.

S1.4.1) An animal inventory must be compiled at least once a year and include data regarding acquisitions and dispositions in the animal collection.

(S1.4.2) All species owned by the institution must be listed on the inventory, including those animals on loan to and from the institution. In both cases, notations should be made on the inventory.

(S2.7.1) The institution must have holding facilities or procedures for the quarantine of newly arrived animals and isolation facilities or procedures for the treatment of sick/injured animals.

(S2.7.3) Quarantine, hospital, and isolation areas should be in compliance with standards or guidelines adopted by the AZA.

(S2.7.2) Written, formal procedures for quarantine must be available and familiar to all staff working with quarantined animals.

(S11.1.2) Training and procedures must be in place regarding zoonotic diseases.

(S11.1.3) A tuberculin testing and surveillance program must be established for appropriate staff in order to ensure the health of both the employees and the animal collection.

(S2.5.1) Deceased animals should be necropsied to determine the cause of death. Disposal after necropsy must be done in accordance with local/federal laws.

(S2.4.1) The veterinary care program must emphasize disease prevention.

(S1.5.5) For animals used in offsite programs and for educational purposes, the institution must have adequate protocols in place to protect the rest of the collection from exposure to infectious agents.

(S2.3.1) Capture equipment must be in good working order and available to authorized, trained personnel at all times.

(S2.4.2) Keepers should be trained to recognize abnormal behavior and clinical symptoms of illness and have knowledge of the diets, husbandry (including enrichment items and strategies), and restraint procedures required for the animals under their care. However, keepers should not evaluate illnesses nor prescribe treatment.

(S2.3.2) Hospital facilities should have x-ray equipment or have access to x-ray services.

(S1.5.8) The institution must develop a clear process for identifying, communicating, and addressing animal welfare concerns within the institution.

Chapter 8

(S1.6.1) The institution must have a formal written enrichment program that promotes species-appropriate behavioral opportunities.

(S1.6.2) The institution must have a specific staff member(s) or committee assigned for enrichment program oversight, implementation, training, and interdepartmental coordination of enrichment efforts.

Chapter 9

(S1.5.4) A written policy on the use of live animals in programs should be on file. Animals in education programs must be maintained and cared for by trained staff, and housing conditions must meet standards set for the remainder of the animal collection, including species-appropriate shelter, exercise, social and environmental enrichment, access to veterinary care, nutrition, etc. Since some of these requirements can be met outside of the primary enclosure, for example, enclosures may be reduced in size provided that the animal's physical and psychological needs are being met.

(S1.5.3) If animal demonstrations are a part of the institution's programs, an education and conservation message must be an integral component.

Chapter 10

(S5.3) Institutions should maximize the generation of scientific knowledge gained from the animal collection. This might be achieved by participating in AZA TAG/SSP sponsored research when applicable, conducting original research projects, affiliating with local universities, and/or employing staff with scientific credentials.

(S5.2) Institutions must have a written policy that outlines the type of research that it conducts, methods, staff involvement, evaluations, animals to be involved, and guidelines for publication of findings.

(S5.1) Research activities must be under the direction of a person qualified to make informed decisions regarding research.

Appendix B: Kori Bustard Ethogram

Behavior	Description
Resting behaviors	
Alert	Bird sits on the ground or stands with its eyes open.
Resting	Bird sits or stands with its eyes closed.
Hock sitting	Bird sits with its tarsi on the ground and tibias vertical, leaving the belly raised off the ground.
Wet weather standing	During periods of light to heavy rain, bird tucks its head tightly against the back of its neck, giving it a hunched appearance. During poor weather, bird may stand under a bush for protection from the elements.
Comfort/maintenance behaviors	
Scratching	Bird scratches body (i.e., neck and head areas) using a toe.
Stretching	Bird stretches its leg, wing, or body, and typically involves stretching the wing and leg on the same side of the body. During a body stretch, neck is extended forward, body is lowered slightly, and wings are raised.
Wing flapping	Bird extends its wings and flaps them several times, often in conjunction with stretching or jumping.
Body fluffing	Bird briefly erects feathers on the neck, wings, and back.
Ruffling	Bird shakes its body, with movement passing as a wave from head to tail, which is usually slightly fanned.
Preening	Birds use their bill to straighten the feathers on their breast, neck, tail, legs, or wings. Preening is performed while sitting or standing, and the birds' eyes are often closed.
Toe picking	Bird uses bill to pull at a toe or nail, while standing on one leg.
Dust bathing	Bird lies flat and rubs its belly, head, neck, and wings on the ground, in a sandy or dusty depression. Feathers are ruffled during bathing.
Sun bathing	Bird sits in the direct sun (often near a bush or short grass clump) with one or both of its wings spread horizontal to the ground. Sun bathing often leads to heavy panting, and is always followed by preening.
Bill gaping	Bird briefly opens mouth wide.
Bill open	Bird partially opens bill for several seconds.
Panting	Bill is slightly open and the gular skin is moved back and forth. Panting is a cooling mechanism.
Tail erection	Birds raise their tails vertically and fan their tail feathers out. Tail erection occurs commonly after rain has ended, and may help in drying.

Behavior	Description
Locomotion	
Walking	Bird moves about on the ground at a leisurely pace (e.g., 1kmph). Walking is the primary mode of locomotion for kori bustards.
Running	Bird moves faster (at running human speed), with head held high and extended, or low andhorizontal to the ground. Wings may be extended or held close to body. Running is used for avoiding predators.
Flying	Birds take off into the wind following a short run and wing flapping. Flying is also used for predator avoidance.
Jumping	Bird will jump into the air (up to 7 feet) without a running start. Jumping may be a means of evading terrestrial predators.
Feeding behavior	
Drinking	Birds drink while standing or hock sitting by submerging the beak in water, using tongue or throat motions to suck in water, and then raising the head to around a 45° angle to gulp down the water.
Foraging	Birds search for food while walking and looking down at the ground. Birds can also jump for food that is out of their reach.
Feeding	Birds peck at food within their reach or snap at jumping or flying prey with their bill. Larger vertebrates are shaken or struck against the ground before being swallowed whole; small items are just swallowed.
Grit eating	Birds peck at and ingest grit or small pebbles to aid in digestion.
Bill wiping	Bird rubs the sides of its bill along the ground, a tree trunk, or other object, to remove any debris attached to the bill.
Defecation	Fecal matter is excreted mainly while walking, or during short pauses, and typically when the bird wakes in the morning. Smaller amounts are excreted throughout the day. Defecation is also part of a fear response.
Social behavior	
Aggressive displacement	One bird chases another bird, by lowering its head, raising its head crest, ruffling its plumage slightly, and aiming its body towards it. Pursuit will often continue until the other bird it is out of sight.
Non-aggressive displacement	One bird walks toward another bird, causing the second bird to vacate its position and move elsewhere. Females do not displace adult males.
Fighting (males)	Birds grasp each other' beaks and shove each other, with feathers fluffed out and tails raised. May establish dominance during breeding.
Aggressive head pecking	A dominant bird pecks at the head of a subordinate bird for a short period of time, usually with no injuries.
Tail lifting	Sitting or standing bird lifts tail up to a 90º angle, fans out tail feathers, and then lowers the tail. Behavior may be repeated multiple times, and may be accompanied by erection of the head crest feathers. Occurs when birds approach. Males do not tail-lift to approaching females.

Behavior	Description
Threat posture	A standing bird lifts its tail and fans its tail feathers; its wings are outstretched, its plumage ruffled, and its head extended forward. The wings and tail may be vibrated.
Inter-specific threat response	
Skyward looking	Alert bird extends its head and cocks it upward, and may also tilt the head sideways so only one eye is facing upwards.
Crest up	Bird erects head crest feathers in response to a potential threat.
Neck fluffing	Bird erects neck feathers and head crest to increase its apparent size.
Tail spreading	Bird raises tail vertically and fans tail feathers as a defense posture against aerial predators.
Predator defense display	Bird crouches with its tail raised and fanned, wings loosely tucked to the body, and with its head and neck extended upwards in response to a potential or perceived predator flying overhead.
Sexual behavior	
Chasing females (males)	Males chase females with raised head crest and tail. Pursuit will often cease if females run away out of view.
Tail up position (males)	Males stands or walks with tail raised and fanned, wings held close to the body, and head crest erect, to attract the attention of females.
Partial balloon display (males)	Males stand with neck partially inflated, tail raised up, and head crest erect.
Balloon display (males)	Male extends neck and fully inflates the esophageal pouch (up to 4 times normal size) with the bill pointed upward. The tail and wing feathers point downward and the head crest is erect. Bird emits a low-pitched booming sound as bill is snapped open and shut. The balloon display is the most intense form of courtship.
Copulation initiation (females)	Female initiates copulation by sitting down near a displaying male to allow him to approach her from behind.
Head pecking (males)	Male approaches sitting female, and pecks (for 5-10 minutes) at the back of her head, stepping from one side of the female to the other.
Squatting and pecking (males)	Male squats on his hocks while continuing to peck at the female's head. This element of copulation generally lasts 5 minutes.
Mounting (males)	Male spreads wings, climbs onto the back of the seated female and transfers sperm (taking only a few seconds).
Post-copulation feather shaking	Males and females stand up after copulations and vigorously shake their feathers before resuming normal activities.
Maternal behavior	
Pacing (females)	The female walks back and forth in a particular area, faster than when just walking, for a few minutes or for several hours prior to egg-laying.
Incubating (females)	Females sit on eggs after first or subsequent eggs are laid. Incubating

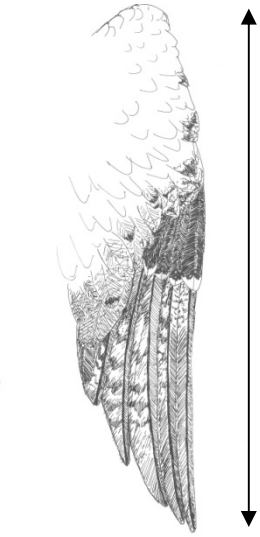
Behavior	Description
	females rarely leave the nest, but will do so for behaviors such as feeding, dustbathing, and sunbathing.
Egg turning (females)	Females stand over the nest and rotate their eggs with their bills several times throughout the day and night.
Nest building (females)	Sitting female throws leaf litter and small sticks onto her back while incubating.
Parental care behavior (females)	Females in zoos are highly protective of the chicks and will act aggressively towards other females and keepers. Female will pick up food and present it to the chicks, bending her head and neck down while holding the food in her bill, and salivating copiously. The female produces a quiet vocalization when feeding the chicks.
Vocalizations	
Barking	Nervous or startled birds produce a soft, gruff “bark”, also called a “gronk” call. Barking birds typically stand, remain focused on the cause of concern, and may move away from this object.
Growling	A soft “rrrrrr” sound, similar to a cat’s growl. Females may growl when defending eggs or chicks, or when handled by keepers.
Booming (males)	A low-pitched booming vocalization produced by males in the breeding season when the bill is snapped open and shut. Males emit 6 calls in rapid succession, and may repeat the 6-call cycles for several minutes.
Chick chirp	A light chirp or purring sound produced by chicks being fed or brooded.
Chick cry	Stressed, chicks produce a long, sad whistle that can escalate into a loud wailing.
Grunting (females)	A low- to high-pitched sound produced by females to call their chicks, especially when food is available.
Roaring	A very loud vocalization similar to a lion’s roar, often occurring when birds are initially captured.

Taken from Lichtenberg and Hallager, 2007

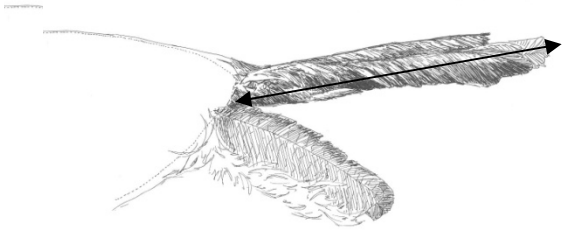
Appendix C: Measuring Adult Birds

It is important to take body measurements on every kori bustard at some point during the animal's life. These measurements are of important use in taxonomy, species characterization, and eco-morphology (the study of the relationship between body form and ecology). In addition to the measurements taken below (drawings provided courtesy of Debi Talbott, Smithsonian's National Zoo), collectors should also record the sex, age, collection date, sexual condition, weight, and their (the collector's) name. Please send these measurements to the Kori Bustard SSP Coordinator.

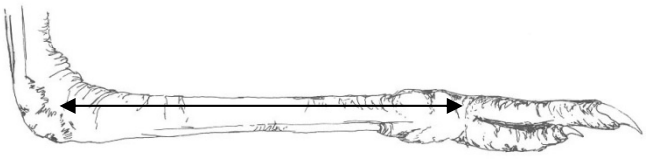
Wing length: Measure from the "wrist" to the tip of the longest primary.



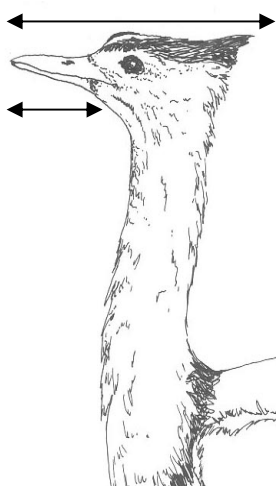
Tail length: Insert a ruler centrally between the longest tail feathers and the under-tail coverts until the ruler stops.



Tarsus: Measure on the front of the leg from the joint of the tibiotarsus with the tarsometatarsus to the lower end at the foot (last scute).

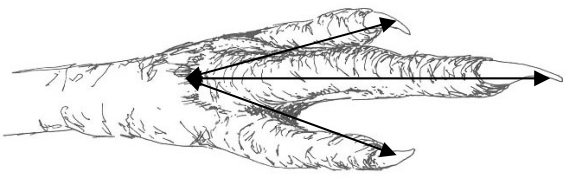


Skull: Maximum length from the rear of the skull to the tip of the bill. Also measure skull width (across the postorbital bones).



Culmen: Tip of bill to base of skull.

Toe, inner, middle and outer: Measure from the tip of the nail to the joint of the toe with the tarsometatarsus.



Appendix D: Acquisition/Disposition Policy

I. Introduction: The Association of Zoos and Aquariums (AZA) was established, among other reasons, to foster continued improvement in the zoological park and aquarium profession. One of its most important roles is to provide a forum for debate and consensus building among its members, the intent of which is to attain high ethical standards, especially those related to animal care and professional conduct. The stringent requirements for AZA accreditation and high standards of professional conduct are unmatched by similar organizations and also far surpass the United States Department of Agriculture's Animal and Plant Health Inspection Service's requirements for licensed animal exhibitors. AZA member facilities must abide by a Code of Professional Ethics - a set of standards that guide all aspects of animal management and welfare. As a matter of priority, AZA institutions should acquire animals from other AZA institutions and dispose of animals to other AZA institutions.

AZA-accredited zoological parks and aquariums cannot fulfill their important missions of conservation, education and science without living animals. Responsible management of living animal populations necessitates that some individuals be acquired and that others be removed from the collection at certain times. Acquisition of animals can occur through propagation, trade, donation, loan, purchase, capture, or rescue. Animals used as animal feed are not accessioned into the collection.

Disposition occurs when an animal leaves the collection for any reason. Reasons for disposition vary widely, but include cooperative population management (genetic or demographic management), reintroduction, behavioral incompatibility, sexual maturation, animal health concerns, loan or transfer, or death.

The AZA Acquisition/Disposition Policy (A/D) was created to help (1) guide and support member institutions in their animal acquisition and disposition decisions, and (2) ensure that all additions and removals are compatible with the Association's stated commitment to "save and protect the wonders of the living natural world." More specifically, the AZA A/D Policy is intended to:

- Ensure that the welfare of individual animals and conservation of populations, species and ecosystems are carefully considered during acquisition and disposition activities;
- Maintain a proper standard of conduct for AZA members during acquisition and disposition activities;
- Ensure that animals from AZA member institutions are not transferred to individuals or organizations that lack the appropriate expertise or facilities to care for them.
- Support the goal of AZA’s cooperatively managed populations and associated programs, including Species Survival Plans (SSPs), Population Management Plans (PMPs), and Taxon Advisory Groups (TAGs).

The AZA Acquisition/Disposition Policy will serve as the default policy for AZA member institutions. Institutions may develop their own A/D Policy in order to address specific local concerns. Any institutional policy must incorporate and not conflict with the AZA acquisition and disposition standards.

Violations of the AZA Acquisition/Disposition Policy will be dealt with in accordance with the AZA Code of Professional Ethics. Violations can result in an institution's or individual's expulsion from membership in the AZA.

II. Group or Colony-based Identification: For some colonial, group-living, or prolific species, such as certain insects, aquatic invertebrates, schooling fish, rodents, and bats, it is often impossible or highly impractical to identify individual specimens. These species are therefore maintained, acquisitioned, and disposed of as a group or colony. Therefore, when this A/D Policy refers to animals or specimens, it is in reference to both individuals and groups/colonies.

III. Germplasm: Acquisition and disposition of germplasm should follow the same guidelines outlined in this document if its intended use is to create live animal(s). Ownership of germplasm and any resulting animals should be clearly defined. Institutions acquiring or dispositioning germplasm or any animal parts or samples should consider not only its current use, but also future possible uses as new technologies become available.

IV(a). General Acquisitions: Animals are to be acquisitioned into an AZA member institution's collection if the following conditions are met:

1. Acquisitions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all acquisitions.
3. Acquisitions must be consistent with the mission of the institution, as reflected in its Institutional Collection Plan, by addressing its exhibition/education, conservation, and/or scientific goals.
4. Animals that are acquired for the collection, permanently or temporarily, must be listed on institutional records. All records should follow the Standards for Data Entry and Maintenance of North American Zoo and Aquarium Animal Records Databases®.
5. Animals may be acquired temporarily for reasons such as, holding for governmental agencies, rescue and/or rehabilitation, or special exhibits. Animals should only be accepted if they will not jeopardize the health, care or maintenance of the animals in the permanent collection or the animal being acquired.
6. The institution must have the necessary resources to support and provide for the professional care and management of a species, so that the physical and social needs of both specimen and species are met.
7. Attempts by members to circumvent AZA conservation programs in the acquisition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to acquire SSP species and adhere to the AZA Full Participation policy.
8. Animals are only to be acquired from sources that are known to operate legally and conduct their business in a manner that reflects and/or supports the spirit and intent of the AZA Code of Professional Ethics as well as this policy. Any convictions of state, federal, or international wildlife laws should be reviewed, as well as any previous dealings with other AZA-accredited institutions.
9. When acquiring specimens managed by a PMP, institutions should consult with the PMP manager.
10. Institutions should consult AZA Wildlife Conservation and Management Committee (WCMC)-approved Regional Collection Plans (RCPs) when making acquisition decisions.

IV(b). Acquisitions from the Wild: The maintenance of wild animal populations for education and wildlife conservation purposes is a unique responsibility of AZA member zoos and aquariums. To accomplish these goals, it may be necessary to acquire wild-caught specimens. Before acquiring animals from the wild, institutions are encouraged to examine sources including other AZA institutions or regional zoological associations.

When acquiring animals from the wild, careful consideration must be taken to evaluate the long-term impacts on the wild population. Any capture of free-ranging animals should be done in accordance with all local, state, federal, and international wildlife laws and regulations and not be detrimental to the long-term viability of the species or the wild or captive population(s). In crisis situations, when the survival of a population is at risk, rescue decisions are to be made on a case-by-case basis.

V(a). Disposition Requirements – living animals: Successful conservation and animal management efforts rely on the cooperation of many entities, both within and outside of AZA. While preference is given to placing animals within AZA member institutions, it is important to foster a cooperative culture among those who share the primary mission of AZA-accredited facilities. The AZA draws a strong distinction between the mission, stated or otherwise, of non-AZA member organizations and the mission of professionally managed zoological parks and aquariums accredited by the AZA.

An accredited AZA member balances public display, recreation, and entertainment with demonstrated efforts in education, conservation, and science. While some non-AZA member organizations may meet minimum daily standards of animal care for wildlife, the AZA recognizes that this, by itself, is insufficient to warrant either AZA membership or participation in AZA's cooperative animal management programs. When an animal is sent to a non-member of AZA, it is imperative that the member be confident that the animal will be cared for properly.

Animals may only be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. The Director or Chief Executive Officer of the institution is charged with the final authority and responsibility for the monitoring and implementation of all dispositions.
3. Any disposition must abide by the Mandatory Standards and General Advisories of the AZA Code of Professional Ethics. Specifically, "a member shall make every effort to assure that all animals in his/her collection and under his/her care are disposed of in a manner which meets the current disposition standards of the Association and do not find their way into the hands of those not qualified to care for them properly."
4. Non-domesticated animals shall not be disposed of at animal auctions. Additionally, animals shall not be disposed of to any organization or individual that may use or sell the animal at an animal auction. In transactions with AZA non-members, the recipient must ensure in writing that neither the animal nor its offspring will be disposed of at a wild animal auction or to an individual or organization that allows the hunting of the animal.
5. Animals shall not be disposed of to organizations or individuals that allow the hunting of these animals or their offspring. This does not apply to individuals or organizations which allow the hunting of only free-ranging game species (indigenous to North America) and established long-introduced species such as, but not limited to, white-tailed deer, quail, rabbit, waterfowl, boar, ring-necked pheasant, chukar, partridge, and trout. AZA distinguishes hunting/fishing for sport from culling for sustainable population management and wildlife conservation purposes.
6. Attempts by members to circumvent AZA conservation programs in the disposition of SSP animals are detrimental to the Association and its conservation programs. Such action may be detrimental to the species involved and is a violation of the Association's Code of Professional Ethics. All AZA members must work through the SSP program in efforts to deacquisition SSP species and adhere to the AZA Full Participation policy.
7. Domesticated animals are to be disposed of in a manner consistent with acceptable farm practices and subject to all relevant laws and regulations.
8. Live specimens may be released within native ranges, subject to all relevant laws and regulations. Releases may be a part of a recovery program and any release must be compatible with the AZA Guidelines for Reintroduction of Animals Born or Held in Captivity, dated June 3, 1992.
9. Detailed disposition records of all living or dead specimens must be maintained. Where applicable, proper animal identification techniques should be utilized.
10. It is the obligation of every loaning institution to monitor, at least annually, the conditions of any loaned specimens and the ability of the recipient to provide proper care. If the conditions and care of animals are in violation of the loan agreement, it is the obligation of the loaning institution to recall the animal. Furthermore, an institution's loaning policy must not be in conflict with this A/D Policy.
11. If live specimens are euthanized, it must be done in accordance with the established policy of the institution and the Report of the American Veterinary Medical Association Panel on Euthanasia (Journal of the American Veterinary Medical Association 218 (5): 669-696, 2001).
12. In dispositions to non-AZA members, the non-AZA member's mission (stated or implied) must not be in conflict with the mission of AZA, or with this A/D Policy.
13. In dispositions to non-AZA member facilities that are open to the public, the non-AZA member must balance public display, recreation, and entertainment with demonstrated efforts in conservation, education, and science.
14. In dispositions to non-AZA members, the AZA members must be convinced that the recipient has the expertise, records management practices, financial stability, facilities, and resources required to properly care for and maintain the animals and their offspring. It is recommended that this documentation be kept in the permanent record of the animals at the AZA member institution.
15. If living animals are sent to a non-AZA member research institution, the institution must be registered under the Animal Welfare Act by the U.S. Department of Agriculture Animal and Plant

Health Inspection Service. For international transactions, the receiving facility should be registered by that country's equivalent body with enforcement over animal welfare.

16. No animal disposition should occur if it would create a health or safety risk (to the animal or humans) or have a negative impact on the conservation of the species.
17. Inherently dangerous wild animals or invasive species should not be dispositioned to the pet trade or those unqualified to care for them.
18. Under no circumstances should any primates be dispositioned to a private individual or to the pet trade.
19. Fish and aquatic invertebrate species that meet ANY of the following are inappropriate to be disposed of to private individuals or the pet trade:
    a. species that grow too large to be housed in a 72-inch long, 180 gallon aquarium (the largest tank commonly sold in retail stores)
    b. species that require extraordinary life support equipment to maintain an appropriate captive environment (e.g., cold water fish and invertebrates)
    c. species deemed invasive (e.g., snakeheads)
    d. species capable of inflicting a serious bite or venomous sting (e.g., piranha, lion fish, blue-ringed octopus)
    e. species of wildlife conservation concern
20. When dispositioning specimens managed by a PMP, institutions should consult with the PMP manager.
21. Institutions should consult WCMC-approved RCPs when making disposition decisions.

V(b). Disposition Requirements – dead specimens: Dead specimens (including animal parts and samples) are only to be disposed of from an AZA member institution's collection if the following conditions are met:

1. Dispositions of dead specimens must meet the requirements of all applicable local, state, federal and international regulations and laws.
2. Maximum utilization is to be made of the remains, which could include use in educational programs or exhibits.
3. Consideration is given to scientific projects that provide data for species management and/or conservation.
4. Records (including ownership information) are to be kept on all dispositions, including animal body parts, when possible.
5. SSP and TAG necropsy protocols are to be accommodated insofar as possible.

VI. Transaction Forms: AZA member institutions will develop transaction forms to record animal acquisitions and dispositions. These forms will require the potential recipient or provider to adhere to the AZA Code of Professional Ethics, the AZA Acquisition/Disposition Policy, and all relevant AZA and member policies, procedures and guidelines. In addition, transaction forms must insist on compliance with the applicable laws and regulations of local, state, federal and international authorities.

Appendix E: Recommended Quarantine Procedures

Quarantine facility: A separate quarantine facility, with the ability to accommodate mammals, birds, reptiles, amphibians, and fish should exist. If a specific quarantine facility is not present, then newly acquired animals should be isolated from the established collection in such a manner as to prohibit physical contact, to prevent disease transmission, and to avoid aerosol and drainage contamination.

Such separation should be obligatory for primates, small mammals, birds, and reptiles, and attempted wherever possible with larger mammals such as large ungulates and carnivores, marine mammals, and cetaceans. If the receiving institution lacks appropriate facilities for isolation of large primates, pre-shipment quarantine at an AZA or American Association for Laboratory Animal Science (AALAS) accredited institution may be applied to the receiving institutions protocol. In such a case, shipment must take place in isolation from other primates. More stringent local, state, or federal regulations take precedence over these recommendations.

Quarantine length: Quarantine for all species should be under the supervision of a veterinarian and consist of a minimum of 30 days (unless otherwise directed by the staff veterinarian). Mammals: If during the 30-day quarantine period, additional mammals of the same order are introduced into a designated quarantine area, the 30-day period must begin over again. However, the addition of mammals of a different order to those already in quarantine will not have an adverse impact on the originally quarantined mammals. Birds, Reptiles, Amphibians, or Fish: The 30-day quarantine period must be closed for each of the above Classes. Therefore, the addition of any new birds into a bird quarantine area requires that the 30-day quarantine period begin again on the date of the addition of the new birds. The same applies for reptiles, amphibians, or fish.

Quarantine personnel: A keeper should be designated to care only for quarantined animals or a keeper should attend quarantined animals only after fulfilling responsibilities for resident species. Equipment used to feed and clean animals in quarantine should be used only with these animals. If this is not possible, then equipment must be cleaned with an appropriate disinfectant (as designated by the veterinarian supervising quarantine) before use with post-quarantine animals.

Institutions must take precautions to minimize the risk of exposure of animal care personnel to zoonotic diseases that may be present in newly acquired animals. These precautions should include the use of disinfectant foot baths, wearing of appropriate protective clothing and masks in some cases, and minimizing physical exposure in some species; e.g., primates, by the use of chemical rather than physical restraint. A tuberculin testing/surveillance program must be established for zoo/aquarium employees in order to ensure the health of both the employees and the animal collection.

Quarantine protocol: During this period, certain prophylactic measures should be instituted. Individual fecal samples or representative samples from large numbers of individuals housed in a limited area (e.g., birds of the same species in an aviary or frogs in a terrarium) should be collected at least twice and examined for gastrointestinal parasites. Treatment should be prescribed by the attending veterinarian. Ideally, release from quarantine should be dependent on obtaining two negative fecal results spaced a minimum of two weeks apart either initially or after parasiticide treatment. In addition, all animals should be evaluated for ectoparasites and treated accordingly.

Vaccinations should be updated as appropriate for each species. If the animal arrives without a vaccination history, it should be treated as an immunologically naive animal and given an appropriate series of vaccinations. Whenever possible, blood should be collected and sera banked. Either a -94°F (-70ºC) frost-free freezer or a -4°F (-20ºC) freezer that is not frost-free should be available to save sera. Such sera could provide an important resource for retrospective disease evaluation.

The quarantine period also represents an opportunity to, where possible, permanently identify all unmarked animals when anesthetized or restrained (e.g., tattoo, ear notch, ear tag, etc.). Also, whenever animals are restrained or immobilized, a complete physical, including a dental examination, should be performed. Complete medical records should be maintained and available for all animals during the quarantine period. Animals that die during quarantine should have a necropsy performed under the supervision of a veterinarian and representative tissues submitted for histopathologic examination.

Quarantine procedures: The following are recommendations and suggestions for appropriate quarantine procedures for birds that are applicable to kori bustards:

Required:

1. Direct and floatation fecals
2. Evaluate for ectoparasites
3. Appropriate serological tests for psittacosis, and if positive, confirmed by culture vaccinate as appropriate

Strongly Recommended:

1. CBC/sera profile
2. Fecal culture for *Salmonella sp.*
3. Fecal gram stain

Appendix F: Hematological Reference Values

A couple publications provide hematological reference values for mature and growing kori bustards and have been included here (Tables 1-5) for consultation and comparison with values taken during quarantine and when examining the current health status of birds as part of each institution's preventative veterinary health program.

Table 1: Hematological reference values for mature and growing kori bustards (Howlett et al. 1995)

Cell Description	Mean ± SEM* (minimum--maximum)	*N*
Erythrocytes Length x width *µ*m	13.5±0.05 x 7.3±0.06 (13-15) x (6-8)	100
Erythrocytes nucleus Length x width *µ*m	6.4±0.05 x 2±0.01 (5.5-7.5) x (2-2.5)	100
Heterophils Diameter *µ*m	11.5±0.21 (10-15)	50
Eosinophils Diameter *µ*m	11.8±0.17 (9-15)	50
Basophils Diameter *µ*m	9.5±0.27 (7-12)	30
'Small' lymphocytes Diameter *µ*m	7.2±0.12 (6-9)	50
'Large' lymphocytes Diameter *µ*m	10.7±0.16 (9-13)	50
Monocytes Diameter *µ*m	14±0.2 (12-20)	50
'Small' thrombocytes Length x width *µ*m	5.6±0.14 x 5.6±0.14 (5-7) x (5-7)	25
'Large' thrombocytes Length x width *µ*m	8.8±0.19 x 8.1±0.16 (7-10) x (7-10)	25
'Mean' thrombocytes Length x width *µ*m	7.3±0.26 x 6.8±0.21 (5-11) x (5-10)	50
'Mean' thrombocyte nucleus Length x width *µ*m	5.1±0.13 x 4.7±0.10 (4-8) x (4-6)	50

* Mean ± standard error of mean

Table 2. Normal adult kori bustard haematological reference values (Howlett et al. 1995)

	Mean ± SEM* (minimum--maximum)	*N*
RBC $x10^{12}$/l	2.30±0.06 (1.74-2.95)	28
Hb g/dl	14.10±0.16 (11.9-15.9)	28
Hct l/l	0.47±0.05 (0.395-0.525)	28
MCV fl	208.5±5.1 (161.9-275.4)	28
MCH pg	62.4±1.6 (48.0-84.6)	28
MCHC g/dl	30.0±0.4 (29.7-34.9)	28
WBC $x10^{9}$/l	7.29±0.42 (3.05-12.85)	28

Heterophils x10^9/l	3.98±0.32 (0.95-9.25)	28
Lymphocytes x10^9/l	2.21±0.24 (0.41-5.45)	28
Monocytes x10^9/l	0.60±0.07 (0.0-1.57)	28
Eosinophils x 10^9/l	0.35±0.05 (0.0-1.15)	27
Basophils x 10^9/l	0.20±0.03 (0.0-0.80)	28
Thrombocytes x 10^9/l	5.5±0.7 (1.49-18.0)	25
Fibrinogen g/l	2.42±0.10 (1.42-4.5)	27

* Mean ± standard error of mean
Hb, haemoglobin; Hct, haematocrit; MCV, mean cell volume;MCH, mean cell haemoglobin; MCHC, mean cell haemoglobin concentration

Table 3: Kori bustard (*Ardeotis kori*): haematological findings in birds of different ages (1-5 months) (Howlett et al. 1998)

	1 month	***n*1**	**2 months**	***n*2**	**3 months**	***n*3**	**4 months**	***n*4**	**5 months**	***n* 5**
RBC x 10^{12}/l	1.28±0.06* (1.04-1.61)**	9	1.57±0.06 (1.22-2.01)	12	1.76±0.08 (1.31-2.4)	14	2.06±0.08 (1.39-2.63)	15	2.07±0.08 (1.79-2.59)	11
HB g/dl	7.5±0.2 (6.8-8.3)	9	9.7±0.3 (7.4-10.9)	12	10.9±0.3 (9.6-13.1)	14	12.1±0.3 (10.3-14.0)	15	12.1±0.4 (9.1-14.0)	11
Hct l/l	0.23±0.7 (0.195-0.26)	9	0.30±0.9 (0.24-0.34)	12	35.1±0.7 (0.30-0.41)	14	0.374±0.7 (0.32-0.41)	15	0.396±0.9 (0.33-0.44)	11
MCV fl	178.4±7.9 (152.2-219.6)	9	195.2±6.6 (159.2-225.4)	12	204.3±8.1 (168.8-262.8)	14	185.2±7.9 (144.0-241.0)	15	194.2±7.8 (152.5-225.4)	11
MCH pg	59.3±3.4 (42.2-77.6)	9	62.0±1.5 (52.2-69.0)	12	63.5±2.4 (49.2-79.4)	14	59.6±2.3 (45.9-74.1)	15	59.5±3.1 (42.1-73.7)	11
MCH g/dl	33.2±1.0 (27.8-37.2)	9	32.0±0.9 (28.2-40.4)	12	31.2±0.8 (27.5-38.1)	14	32.3±0.5 (29.2-35.3)	15	30.5±0.7 (24.3-33)	11
THROMB x 10^9/l	7.03±1.79 (3.1-15.0)	6	8.1±0.8 (4.07-15.6)	12	6.7±0.4 (4.6-9.2)	14	7.9±0.7 (3.7-15.0)	15	7.35±0.61 (3.7-10.8)	11
WBC x 10^9/l	8.78±0.45 (6.65-10.85)	9	10.2±0.6 (6.1-14.75)	12	10.7±0.7 (7.05-16.2)	14	12.7±0.7 (8-18.8)	15	12.5±0.4 (10.35-15.15)	11
HET x 10^9/l	5.42±0.38 (3.72-6.94)	9	4.28±0.30 (2.62-6.34)	12	5.14±0.65 (2.58-11.8)	14	6.2±0.6 (2.9-10.2)	15	5.1±0.5 (1.5-7.5)	11
LYMPH x 10^9/l	2.63±0.26 1.37-3.70)	9	4.64±0.33 (2.50-6.97)	12	4.19±0.27 (3.08-6.35)	14	5.1±0.4 (2.9-7.8)	15	5.49±0.45 (3.60-9.05)	11
MONO x 10^9/l	0.24±0.06 (0.08-0.63)	9	0.66±0.15 (0.24-1.92)	12	0.80±0.12 (0.00-1.58)	14	0.81±0.08 (0.35-1.50)	15	1.13±0.16 (0.49-2.03)	11
EOS x 10^9/l	0.28±0.08 (0.00-0.65)	9	0.32±0.04 (0.1-0.5)	12	0.38±0.08 (0.07-1.03)	14	0.35±0.05 (0.00-0.78)	15	0.42±0.08 (0.00-1.06)	11
BAS x 10^9/l	0.21±0.06 (0.00-0.47)	9	0.12±0.04 (0.00-0.43)	12	0.04±0.01 (0.00-0.13)	14	0.11±0.04 (0.00-0.48)	15	0.05±0.01 (0.00-0.16)	11
FIB g/l	1.76±0.18 (1.1-2.6)	8	2.0±0.1 (1.2-2.8)	12	2.25±0.2 (1.6-3.8)	12	2.57±0.3 (1.6-4.0)	8	2.58±0.49 (1.6-4.8)	8

RBC, red blood cells; HB, haemoglobin; Hct, haematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration; THROMB, thrombocytes; WBC, white blood cells; HET, heterophils; LYMPH, lymphocytes; MONO, monocytes; EOS, eosinophils; BAS, basophils; FIB, fibrinogen.
* Mean ± standard error of mean
** Minimum--maximum
n = no. of samples

Table 4: Kori bustard (*Ardeotis kori*): haematological findings in birds of different ages (6-15 months) (Howlett et al. 1998)

	6 months	***n*6**	**7 months**	***n*7**	**8 months**	***n*8**	**9 months**	***n*9**	**15 months**	***n*15**
RBC x 10^{12}/l	2.14±0.07* (1.84-2.46)**	10	2.12±0.07 (1.79-2.61)	12	2.0±0.1 (1.72-2.6)	10	2.1±0.04 (1.91-2.23)	8	2.08±0.06 (1.81-2.47)	13
HB g/dl	11.4±0.4 (9.9-13.2)	10	11.7±0.3 (10.5-13.1)	12	12.5±0.4 (10.9-14.3)	10	12.8±0.4 (10.9-14.2)	8	14.2±0.4 (12.1-16.1)	13
Hct l/l	0.38±0.9 (0.34-0.42)	10	0.396±0.9 (0.35-0.45)	12	0.39±1.0 (0.36-0.45)	10	0.39±0.9 (0.36-0.43)	8	0.47±0.9 (0.41-0.51)	13
MCV fl	179.9±5.0 (160.6-210.1)	10	188.2±5.6 (165.1-220.7)	12	200.5±7.4 (138.5-219.3)	10	186.5±3.6 (168.2-200.5)	8	226.5±7.3 (195.5-273.5)	13
MCH pg	53.7±2.1 (40.2-66.5)	10	55.8±2.1 (43.7-66.5)	12	64.4±2.5 (45.4-74.6)	10	60.5±1.3 (57.1-68.6)	8	68.7±2.4 (58.2-84.0)	13
MCH g/dl	29.8±0.7 (25.1-32.4)	10	29.6±0.6 (25.6-32.3)	12	32.2±0.6 (29.5-36.3)	10	32.5±0.7 (29.8-35.5)	8	30.3±0.5 (27.6-33.2)	13
THROMB x 109/l	9.98±1.09 (4.9-1.7)	10	11.61±1.0 (5.5-16.7)	12	10.6±0.9 (6.3-15)	10	7.0±1.0 (4.8-9.5)	4	6.52±0.54 (4.05-10.2)	13
WBC x 10^9/l	13.5±0.7 (9.8-16.1)	10	15.6±0.7 (9.2-18.5)	12	13.5±0.9 (9.25-17.05)	10	14.5±0.5 (12.8-6.9)	8	14.10±0.61 (11.25-17.8)	13
HET x 10^9/l	5.1±0.9 (1.9-11.4)	10	6.34±0.58 (2.76-8.83)	12	5.41±0.58 (2.59-8.35)	10	6.27±0.76 (4.08-10.8)	8	5.84±0.61 (2.70-10.63)	13
LYMPH x 10^9/l	6.7±0.6 (3.0-10.5)	10	7.32±0.59 (4.50-11.84)	12	6.38±0.52 (3.80-9.29)	10	6.49±0.59 (2.85-8.45)	8	6.49±0.43 (4.37-9.43)	13
MONO x 10^9/l	0.93±0.14 (0.14-1.64)	10	1.12±0.13 (0.45-1.78)	12	1.18±0.13 (0.63-1.70)	10	0.75±0.17 (0.13-1.41)	8	1.13±0.07 (0.80-1.53)	13
EOS x 10^9/l	0.36±0.07 (0.14-1.64)	10	0.48±0.08 (0.0-0.89)	12	0.21±0.06 (0.0-0.63)	10	0.53±0.09 (0.13-0.92)	8	0.35±0.05 (0.13-0.68)	13
BAS x 10^9/l	0.23±0.07 (0.0-0.57)	10	0.08±0.01 (0.0-0.14)	12	0.03±0.01 (0.0-0.08)	10	0.08±0.01 (0.02-0.14)	8	0.29±0.06 (0.0-0.69)	12
FIB g/l	2.83±0.22 (1.7-4.0)	10	3.0±0.2 (2.0-4.7)	11	2.7±0.3 (1.1-5.4)	10	2.65±0.27 (2.0-3.3)	4	3.0±0.3 (1.3-5.3)	13

RBC, red blood cells; HB, haemoglobin; Hct, haematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration; THROMB, thrombocytes; WBC, white blood cells; HET, heterophils; LYMPH, lymphocytes; MONO, monocytes; EOS, eosinophils; BAS, basophils; FIB, fibrinogen.

*Mean ± SEM

**Minimum--maximum

n = no. of samples

Table 5: Reference blood chemistry values for clinically normal adult kori bustards (*Ardeotis kori*) (D'Aloia et al. 1996b)

Assay	Mean ± SEM* (minimum--maximum)	*n*
Glucose (mmol/l)	13.35 ± 0.47 (9.28-19.97)	24
Uric acid (*µ*mol/l)	469.45 ± 29.75 (208.25-850.85)	26
Creatinine (*µ*mol/l	50.35 ± 3.53 (17.66-97.16)	24
Total bilirubin (*µ*mol/l)	11.90 ± 0.51 (5.1-22.10)	25
Total protein (g/l)	29.60 ± 1.60 (20.0-52.0)	25
Albumin (gl/l)	15.90 ± 0.80 (12.0-31.0)	25
Globulin (gl/l)	13.0 ± 0.80 (8.0-24.0)	22
Albumin/globulin ratio	1.20 ± 0.06 (0.70-2.10)	23
GGT (U/l)	13.25 ± 0.47 (12.0-14.0)	4
ALT (U/l)	16.17 ± 2.24 (4.0-52.0)	23
AST (U/l)	226.50 ± 10.80 (200.0-251.0)	4
LDH (U/l)	3862.50 ± 307.0 (2637.0-4689.0)	6
CK (U/l)	135.60 ± 20.90 (47.0-510.0)	24
Ammonia (*µ*mol/l)	465.90 ± 47.40 (172.0-932.0)	21
Carbon dioxide (mmol/l)	27.47 ± 4.41 (10.0-94.0)	19
Magnesium (mmol/l)	0.35 ± 0.02 (0.12-0.77)	24
Phosphorus (mmol/l)	1.33 ± 0.08 (0.83-2.38)	26
Calcium (mmol/l)	3.12 ± 0.20 (1.52-5.25)	24
Potassium (mmol/l)	2.94 ± 0.19 (1.80-6.10)	25
Sodium (mmol/l)	154.48 ± 1.42 (145.0-174.0)	25
Chloride (mmol/l)	115.34 ± 0.98 (109.0-127.0)	23
Cholesterol (mmol/l)	3.12 ± 0.17 (1.71-5.0)	26
Triglycerides (mmol/l)	1.21 ± 0.09 (0.68-2.53)	25

*Mean ± standard error of mean; GGT, x-glutamyl transferase; ALT, alanine aminotransferase; AST, aspartate aminotransferase; LDH, lactate dehydrogenase; CK, creatine kinase

Appendix G: AZA Kori Bustard SSP Necropsy Form – Revised December 2008

For best results, all dead birds should be necropsied as soon as possible. Carcasses should be refrigerated (never frozen) until the time of necropsy. Please contact the Veterinary Advisor or pathologist if necropsy presents an institutional burden. Post-mortem examinations should be conducted in a routine fashion and all findings should be recorded on the AZA SSP Kori Bustard Necropsy Form presented below (or on a comparable form).

The Tissue Check List should be consulted to ensure that all samples have been collected. For proper tissue preservation, the volume of 10% buffered formalin used must be at least 10 times the volume of the tissue samples. After fixation (at least 24 hours) excess formalin can be poured off to facilitate shipping. Enough formalin should remain to keep tissues moist. One set of fixed tissues should be sent to the institution's Primary Pathologist for evaluation. If possible a duplicate set of tissue samples, along with copies of the Necropsy Form and Primary Pathologist's final report. Splitting of samples and lesions may not be advantageous. Alternatively a duplicate set of histology slides (if available) and the original paraffin blocks (if agreeable to the laboratory), should be sent to the AZA Kori Bustard SSP Veterinary Advisor for storage and reference.

In addition to basic necropsy and histology, there should be a thorough examination of the vascular system including the large arteries and small peripheral ones associated with the intestines and distant sites such as skin. Also, any heart abnormalities should be noted and sampled. Some changes in the ventriculus (gizzard) such as distension, impaction, and muscle lesions have been recorded, and so recording the contents and appearance would be helpful. If pallor is noted in muscle, heart, or ventriculus, additional samples of frozen liver should be retained for possible nutritional evaluation after histopathology is completed.

If any questions arise regarding this protocol, please contact the AZA Kori Bustard SSP Pathology Advisor, Dr. Tim Walsh (202-633-4267) before proceeding with the necropsy.

SSP Pathology Advisor:
Dr. Tim Walsh
Smithsonian's National Zoo
3001 Connecticut Ave NW
Washington DC 20008
Phone 202-633-4267; Cell phone 202-327-3768. Email: walsht@si.edu

SSP Veterinary Advisor:
Dr. Suzan Murray
Smithsonian's National Zoo
3001 Connecticut Ave NW
Washington DC 20008
Phone 202-633-3192; Email: murrays@si.edu

Please send a copy of the final pathology report to the AZA Kori Bustard SSP Coordinator:
Sara Hallager
Smithsonian's National Zoo
3001 Connecticut Ave NW
Washington DC 20008
Phone (202-633-3088); Email: hallagers@si.edu

INSTITUTION/OWNER _____

ADDRESS_____ COUNTRY _____

ID# _____ ISIS# _____ STUDBOOK# _____ SEX _____

AGE ___Y ___M ___D (Actual or estimate?) CAPTIVE-BORN OR WILD-CAUGHT?

WEIGHT (IN GRAMS OR KILOGRAMS) _____

DEATH DATE _____ NECROPSY DATE _____

DEATH-NECROPSY INTERVAL (HRS) _____

DEATH LOCATION _____ NECROPSY LOCATION _____

EUTHANIZED? y / n . If yes, what method?_____

HISTORY (Include clinical signs, circumstances of death, clinical labwork, diet and housing)

GROSS EXAMINATION

If no abnormalities are noted mark as normal or not examined (NE). Please perform complete necropsy and sample collection regardless if cause of death is known or grossly obvious.

GENERAL EXAM (Amount of subcutaneous and celomic fat, muscle condition pectoral/legs, skin, plumage, body orifices)

MUSCULOSKELETAL SYSTEM (Bones, marrow, joints, muscle)

RESPIRATORY SYSTEM (Nasal passages, pharynx, larynx, trachea, bronchi, lungs, air sacs). Please note the extent of the gular pouch in both genders.

CARDIOVASCULAR SYSTEM (heart, pericardial sac, great vessels, valves)

DIGESTIVE SYSTEM (mouth, beak, tongue, esophagus, proventriculus gizzard/ventriculus, intestines, cloaca, liver and gallbladder, pancreas). Please note the thickness of the ventricular wall and contents of the ventriculus.

SPLEEN AND THYMUS

URINARY SYSTEM (kidneys, ureters)

REPRODUCTIVE SYSTEM (gonads, oviduct)

ENDOCRINE SYSTEM (thyroids, parathyroids, adrenals, pituitary)

NERVOUS SYSTEM (nerves, brain, meninges, spinal cord, eyes)

ADDITIONAL COMMENTS OR OBSERVATIONS:

Prosector: _____ Date: _____

SUMMARIZE GROSS FINDINGS OR DIAGNOSES:

LABORATORY STUDIES: Results of cytology, fluid analysis, urinalysis, serum chemistries, bacteriology, mycology, virology, parasitology, radiography, etc.

Tissue Check List
Where possible freeze 0.4-1.2" (1-3cm) blocks of tissue from major organs (e.g., liver, kidney, spleen, intestine) in small plastic bags, preferably to be kept ultrafrozen at -94°F (-70°C); freezing at conventional temperatures is acceptable if there is no access to an ultrafreezer. An additional sample of organs with a lesion should be taken. Additional liver (and possibly other organs) should be frozen if nutritional or toxin analysis is anticipated.

Preserve the following tissues in 10% buffered formalin at a ratio of approximately 1 part tissue to 10 parts solution. Large organs should have multiple samples taken from different areas. Where possible, always try to include junctions of different mucosal types (e.g., proventricular-ventricular junction; ileocecal junction, etc.). Tissues should be no thicker than 0.2-0.4" (0.5-1cm). If possible, take two sets of fixed tissue, one for the Primary pathologist, and the other for the SSP Advisor. Alternatively, duplicate slides and blocks could be prepared for the SSP Advisors by the pathology facility. Tissues required for diagnosis should be sent to the primary pathologist, and a duplicate set of slides requested for the SSP Advisor, who should be contacted for further instructions.

NOTE: There is generally no need to fix and label each tissue separately.

- Skin (with feathers)
- Muscle (leg and pectoral)
- Nerve (Sciatic)
- Tongue
- Esophagus
- Proventriculus
- Kidney
- Duodenum
- Jejunum
- Ileum
- Colon
- Spinal cord*
- Cecum
- Cloaca (with bursa of Fabricius)
- Liver
- Heart (atria, R/L ventricle, septum)
- Blood vessels (aorta, femoral, etc.)
- Thyroid (bilateral)
- Gizzard (full thickness)
- Adrenal
- Testis
- Ovary
- Oviduct
- Bone with metaphyseal marrow
- Trachea
- Lung (bilateral)
- Air Sac
- Gallbladder
- Pancreas
- Spleen
- Parathyroid
- Thymus
- Brain (whole)
- Pituitary
- Eye

* If neurologic deficits are suspect

PRIMARY PATHOLOGIST:
Name: _____
Lab: _____
Address: _____
_____
Phone: _____

Please attach a copy of the final pathology report and send with the duplicate set of fixed tissues to the AZA Kori Bustard SSP Veterinary Advisor.

Appendix H: Kori Bustard Egg Production Annual Update Report

Egg Sizes

Egg Number	Sire Studbook Number	Dam Studbook Number	Date Egg Laid	Length	Width	Lay Weight
Ex.	143	119	25/5/03			
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

If you ARTIFICALLY incubate any eggs, please provide your incubator settings and Incubator type _____

Temperature_____(F) or (C)

Humidity (wet bulb)_____

OR, Relative Humidity_____%

Please make any comments on the back of this sheet. Please copy this sheet as needed.

General Egg Production

				Incubation					Fertility			Results						Rearing				Chick Sex		
Egg Number	Sire Studbook Number	Dam Studbook Number	Date Egg Laid	Parental	Incubator	Fostered	Combination	Not Incubated	Fertile	Infertile	Unknown	Hatched	Died in Shell	Broken	Missing	Unknown	Result Date or Hatch Date	Parental	Hand	Combination	Chick ID #	Male	Female	Unknown
Ex.	143	119	25/5/03		x				x			x					17/6/03		x		213964		x	
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								

If you ARTIFICALLY incubate any eggs, please provide your incubator settings / Incubator type_____

Temperature_____(F) or (C) Humidity (wet bulb)_____ OR Relative Humidity_____%

Please make any comments on the back of this sheet. Please copy this sheet as needed.

Appendix I: Kori Bustard Chick Hand-rearing Protocol

Day	Brooder/Temp.	# of Feedings	Notes
0	- 97°F (36.1°C) - Brooder: 69.85cm x 33cm x 35.5cm deep, floor is carpeted and a feather duster is hung in a corner - Single chicks are given a mirror	11	- Chicks should be fed as soon as they demonstrate a feeding response. This can be as early as 8 hours post hatch. After this period, chicks should be fed every 60-90 minutes for the first 24 hours post hatch. Night feedings may be necessary if a chick has hatched after 1700hrs. - Each feeding on Day 0: 1-2 cricket abdomens (remove heads and legs) 1-2 small pieces watermelon 1 green bean - Later feedings on Day 0: Add pellets (no more than 5 pellets). - Water is not necessary for the first three days following hatch provided watermelon is fed and chick hydration is monitored. After three days, chicks will begin drinking from a bowl with encouragement. - Crickets must be maintained on a high calcium insect diet for 72 hours prior to being fed. - Healthy chicks will attempt to grab offered food. Birds that do not show interest in food may be dehydrated. Puffy legs are a good sign of hydration, if skin on the legs appears tight, hydration is poor and chicks must be given SQ fluids. - Chicks will often have poor aim when attempting to eat, but this improves on day 3. - Keepers should brood chicks at every feeding, and as often as possible during the first 7 days. - Do not offer mealworms until day 21 as some chicks have impacted on this food.
1-2	Same as for 'day 0'	6	- Chicks are fed at two-hour intervals from 0630 to 1730. Refer to Tables 1, 2, and 3 for daily amounts of food to be fed. Chicks will demonstrate a preference of fruits, crickets, vegetables over pellets so pellets should be fed first followed by the remaining diet. - Healthy chicks normally lose 3-5g on Day 1, but their weights stabilize on Day 2 and increase thereafter. - In addition to crickets, two waxworms per day should be offered. The number is limited to two per day due to high fat content. Mealworms are considered enrichment items and are not offered until day 21 to avoid impaction - Chicks can stand and walk on Day 2. - Night feedings are not necessary provided the chick is gaining weight.

Day	Brooder/Temp.	# of Feedings	Notes
3	- 95°F (35°C) - Carpeted nursery area (1.8m x 3.7m) - 3 heat bulbs suspended from the ceiling so that 3 separate sections of floor are kept at 95°F (35ºC). - Several feather dusters are suspended near the heat bulbs. - Single chicks are given a mirror. Mirrors can be used with multiple chicks, but this may cause some chicks to be agitated; the mirror should be removed if this is the case.	6	- Feed every 2 hours (0630-1830). - Chicks must be encouraged to exercise in the pen following each feeding to avoid problems such as slipped tendon. - Watermelon should be discontinued. Keepers should offer additional fruits (see Table 3). - Chicks should be trained to drink from a dish. Encouraging the birds to peck at shallow water dishes by using floating greens can be successful. - Use a shallow water bowl and place a rock in the bowl to prevent chicks from falling in and becoming wet. Do not use marbles as chicks can easily ingest these. - Egg (including pulverized shell) introduced into diet (scrambled, microwaved and cut into small pieces).
4-5	Same as 'day 4'	6	- Feed every 2 hours (0630-1830) - By Day 5, chicks are keen to pick food floating in water, so to encourage self-feeding some food is left in shallow water bowls during the day. - The need for brooding diminishes around day 6 - chicks will object strongly when brooded. - Chicks may now be offered whole crickets (no need to remove head and legs). - A mix of greens is essential for proper vitamin levels.
6-12	Same as 'day 4'	6	- Feed every 2 hours (0630-1830 h). - Hand-reared chicks may develop slipped wings (i.e., an outward turning of the manus) anywhere from Day 7-11. Slipped wing is easily and permanently corrected if the primaries of the affected wing(s) are taped to the body in a natural position for 7-10 days at the first sign of the problem.
13	Same as 'day 4'	5	- Feedings may be reduced to five per day. - Chicks are taken outside for the day if the temperature is above 24°C. Once chicks have been given access to outside yards, they should be carefully monitored for the ingestion of foreign material that could result in impaction. The chicks should be watched to

Day	Brooder/Temp.	# of Feedings	Notes
			ensure that they do not consume too many pebbles, or stones that are too large. - Ensuring that chicks continue to defecate normally is important. - Once outside, chicks should be monitored frequently for internal parasites and treated as necessary.
14-30	Same as 'day 4'	4	- Move the heat lamps up as the chicks grow so that they do not burn the top of their head. Also, beware of chicks jumping- they can jump very high and if heat lamps are too low, they will hit the bulb and break it. - Mealworms may now be introduced into the diet as an enrichment food, but limit the total number fed each day to <10 to reduce the risk of impaction. Mealworms must be maintained on a high calcium insect diet 72h prior to feeding. - Feed chicks 4 times per day.
30-60	When chicks are 30-40 days old, they are moved outside to a covered yard measuring 5m x 15m. The young birds spend the day outside and are housed in a heated shed at night.	3	- If chicks are scale trained, weights may be continued. Otherwise, daily weights can be discontinued at around 30 days to minimize the risks associated with repeated handling. - Maintain daily diet components in same approximate percentages as Day 30. - Three feedings / day is sufficient for chicks 30 days and older. - Chicks will likely demonstrate decreased interest in fruit and vegetables by 60 days. Greens are relished up until 8-12 months. - At 60+ days, add pellet-carnivore diet "meatballs" (see Table 4). Although chicks have been successfully reared without mammalian whole prey and carnivore diet introduced into their diet, at 60 days fuzzies may be introduced for behavioral management (scale training, close up viewing, etc.) but amounts should be limited to 4 per day.

Table 1: Daily quantities of food items offered to 1 kori bustard chick, based on 35% BW intake

Days of Age	Average BW (g)	Total Food Offered (g)	Pellet (g)	Insects ⇨ (g)		Crickets each	Waxworms each	Egg (g)	Greens (g)	Vegetables (g)	Fruits (g)
0	99.7										
1	93.4	32.7	6.5	3.3 g	=	10	2	0.0	1.6	8.2	13.1
2	98.7	34.5	6.9	3.5 g	=	11	2	0.0	1.7	8.6	13.8
3	102.0	35.7	8.9	3.6 g	=	12	2	1.8	3.6	8.9	8.9
4	110.8	38.8	9.7	3.9 g	=	13	2	1.9	3.9	9.7	9.7
5	123.0	43.1	10.8	4.3 g	=	15	2	2.2	4.3	10.8	10.8
6	130.3	45.6	11.4	4.6 g	=	16	2	2.3	4.6	11.4	11.4
7	145.8	51.0	12.8	5.1 g	=	18	2	2.6	5.1	12.8	12.8
8	157.3	55.0	13.8	5.5 g	=	20	2	2.8	5.5	13.8	13.8
9	175.0	61.3	15.3	6.1 g	=	22	2	3.1	6.1	15.3	15.3
10	192.5	67.4	16.8	6.7 g	=	24	2	3.4	6.7	16.8	16.8
11	217.8	76.2	25.2	5.3 g	=	18	2	3.8	11.4	19.1	11.4
12	240.0	84.0	27.7	5.9 g	=	20	2	4.2	12.6	21.0	12.6
13	253.5	88.7	29.3	6.2 g	=	22	2	4.4	13.3	22.2	13.3
14	287.5	100.6	33.2	7.0 g	=	25	2	5.0	15.1	25.2	15.1
15	316.3	110.7	36.5	7.7 g	=	27	2	5.5	16.6	27.7	16.6
16	338.8	118.6	39.1	8.3 g	=	29	2	5.9	17.8	29.6	17.8
17	358.5	125.5	41.4	8.8 g	=	31	2	6.3	18.8	31.4	18.8
18	390.0	136.5	45.0	9.6 g	=	34	2	6.8	20.5	34.1	20.5
19	418.8	146.6	48.4	10.3 g	=	37	2	7.3	22.0	36.6	22.0
20	444.5	155.6	51.3	10.9 g	=	39	2	7.8	23.3	38.9	23.3
21	475.0	166.3	54.9	11.6 g	=	41	2	8.3	24.9	41.6	24.9
22	513.3	179.6	59.3	12.6 g	=	44	2	9.0	35.9	44.9	18.0
23	560.8	196.3	64.8	13.7 g	=	48	2	9.8	39.3	49.1	19.6
24	596.5	208.8	68.9	14.6 g	=	51	2	10.4	41.8	52.2	20.9
25	631.3	220.9	72.9	15.5 g	=	54	2	11.0	44.2	55.2	22.1
26	665.3	232.8	76.8	16.3 g	=	57	2	11.6	46.6	58.2	23.3
27	700.0	245.0	80.9	17.2 g	=	60	2	12.3	49.0	61.3	24.5
28	743.0	260.1	85.8	18.2 g	=	64	2	13.0	52.0	65.0	26.0
29	786.3	275.2	90.8	19.3 g	=	68	2	13.8	55.0	68.8	27.5
30	825.8	289.0	95.4	20.2 g	=	71	2	14.5	57.8	72.3	28.9

Table 2: Relative proportions of dietary components, fresh weight

Dietary Component	Day (d) 0-2	d 3-10	d 11-21	d 22-30
Pellet	20%	25%	33%	33%
Insects (crickets, waxworms)	10%	10%	7%	7%
Egg	0%	5%	5%	5%
Greens	5%	10%	15%	20%
Vegetables	25%	25%	25%	25%
Fruits	40%	25%	15%	10%

Table 3: Kori bustard chick hand-rearing diet, food items and feeding information by dietary component category

Dietary Component	Food Items and Feeding Information
Pellet	Mixture of 50% Ratite + 50% Gamebird Maintenance **or** Crane Maintenance, by weight Product Examples: Mazuri Ratite Diet (5647) Mazuri Exotic Gamebird Maintenance (5643) Zeigler Crane Maintenance
Insects	Crickets + Waxworms, offered daily / Mealworms occasionally after d20 Crickets and mealworms must be maintained on a high calcium insect diet 72h prior to feeding Product Examples: Marion Zoological Insect Supplement Mazuri Hi-Ca Cricket Diet Zeigler Hi-Cal Cricket
Egg	Whole egg, including finely chopped shell, scrambled and cooked (microwave)
Greens	Offer a mixture of 2+ varieties: Chicory (Endive) Dandelion Kale Romaine Spinach Chicks will readily consume increasing quantities of greens through ~d45 and as through the first year
Vegetables	Offer a mixture: Peas, frozen, thawed Green beans, frozen, thawed
Fruits	Offer a mixture of 2+ varieties beginning d3: Watermelon – offer as 100% of fruit allotment days 0-2 (for hydration) Apple Banana Cantaloupe Grapes Honeydew Papaya Fruit initially serves as an important source of hydration, and is then decreased with an increased emphasis on the other diet components.

Table 4: Example proportions for kori bustard pellet-carnivore diet “meatballs”

Amount (g)	Meatball Ingredients and Information
150 g	Mazuri Exotic Gamebird
50 g	Mazuri Ratite Diet
250 g	Water
	Allow water to fully absorb, store mixture under refrigeration overnight
150 g	Commercial carnivore diet
	Thaw under refrigeration overnight
	Product Examples:
	Natural Balance Meat-Eating Bird Diet / Carnivore Diet, various
	Central Nebraska Bird of Prey Diet / Carnivore Diet, various

Appendix J: Program Animal Position Statement

The Conservation Education Committee (CEC) of the Association of Zoos and Aquariums supports the appropriate use of program animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective (emotional) messages about conservation and wildlife. Utilizing these animals allows educators to strongly engage audiences. As discussed below, the use of program animals has been demonstrated to result in lengthened learning periods, increased knowledge acquisition and retention, enhanced environmental attitudes, and the creation of positive perceptions concerning zoo and aquarium animals.

Audience engagement: Zoos and aquariums are ideal venues for developing emotional ties to wildlife and fostering an appreciation for the natural world. However, developing and delivering effective educational messages in the free-choice learning environments of zoos and aquariums is a difficult task. Zoo and aquarium educators are constantly challenged to develop methods for engaging and teaching visitors who often view a trip to the zoo as a social or recreational experience (Morgan and Hodgkinson 1999). The use of program animals can provide the compelling experience necessary to attract and maintain personal connections with visitors of all motivations, thus preparing them for learning and reflection on their own relationships with nature.

Program animals are powerful catalysts for learning for a variety of reasons. They are generally active, easily viewed, and usually presented in close proximity to the public. These factors have proven to contribute to increasing the length of time that people spend watching animals in zoo exhibits (Wolf and Tymitz 1981; Bitgood et al. 1986, 1988). In addition, the provocative nature of a handled animal likely plays an important role in captivating a visitor. In two studies (Povey and Rios 2002; Povey 2002), visitors viewed animals three and four times longer while they were being presented in demonstrations outside of their enclosure with an educator than while they were on exhibit. Clearly, the use of program animals in shows or informal presentations is effective in lengthening the potential time period for learning and overall impact.

Program animals also provide the opportunity to personalize the learning experience, tailoring the teaching session to what interests the visitors. Traditional graphics offer little opportunity for this level of personalization of information delivery and are frequently not read by visitors (Churchman 1985; Johnston 1998). For example, Povey (2002) found that only 25% of visitors to an animal exhibit read the accompanying graphic; whereas, 45% of visitors watching the same animal handled in an educational presentation asked at least one question and some asked as many as seven questions. Having an animal accompany the educator allowed the visitors to make specific inquiries about topics in which they were interested.

Knowledge acquisition: Improving our visitors' knowledge and understanding regarding wildlife and wildlife conservation is a fundamental goal for many zoo educators using program animals. A growing body of evidence supports the validity of using program animals to enhance delivery of these cognitive messages as well.

- MacMillen (1994) found that the use of live animals in a zoomobile outreach program significantly enhanced cognitive learning in a vertebrate classification unit for sixth grade students.
- Sherwood et al. (1989) compared the use of live horseshoe crabs and sea stars to the use of dried specimens in an aquarium education program and demonstrated that students made the greatest cognitive gains when exposed to programs utilizing the live animals.
- Povey and Rios (2002) noted that in response to an open-ended survey question (“Before I saw this animal, I never realized that…”), visitors watching a presentation utilizing a program animal provided 69% cognitive responses (i.e., something they learned) versus 9% made by visitors viewing the same animal in its exhibit (who primarily responded with observations).
- Povey (2002) recorded a marked difference in learning between visitors observing animals on exhibit versus being handled during informal presentations. Visitors to demonstrations utilizing a raven and radiated tortoises were able to answer questions correctly at a rate as much as eleven times higher than visitors to the exhibits.

Enhanced environmental attitudes: Program animals have been clearly demonstrated to increase affective learning and attitudinal change.

- Studies by Yerke and Burns (1991) and Davison et al. (1993) evaluated the effect live animal shows had on visitor attitudes. Both found their shows successfully influenced attitudes about conservation and stewardship.
- Yerke and Burns (1993) also evaluated a live bird outreach program presented to Oregon fifth-graders and recorded a significant increase in students' environmental attitudes after the presentations.
- Sherwood et al. (1989) found that students who handled live invertebrates in an education program demonstrated both short and long-term attitudinal changes as compared to those who only had exposure to dried specimens.
- Povey and Rios (2002) examined the role program animals play in helping visitors develop positive feelings about the care and well-being of zoo animals.
- As observed by Wolf and Tymitz (1981), zoo visitors are deeply concerned with the welfare of zoo animals and desire evidence that they receive personalized care.

Conclusion: Creating positive impressions of aquarium and zoo animals, and wildlife in general, is crucial to the fundamental mission of zoological institutions. Although additional research will help us delve further into this area, the existing research supports the conclusion that program animals are an important tool for conveying both cognitive and affective messages regarding animals and the need to conserve wildlife and wild places.

Appendix K: Developing an Institutional Program Animal Policy

Membership in AZA requires that an institution meet the AZA Accreditation Standards collectively developed by our professional colleagues. Standards guide all aspects of an institution's operations; however, the accreditation commission has asserted that ensuring that member institutions demonstrate the highest standards of animal care is a top priority. Another fundamental AZA criterion for membership is that education be affirmed as core to an institution's mission. All accredited public institutions are expected to develop a written education plan and to regularly evaluate program effectiveness.

The inclusion of animals (native, exotic and domestic) in educational presentations, when done correctly, is a powerful tool. CEC's Program Animal Position Statement (Appendix J) describes the research underpinning the appropriate use of program animals as an important and powerful educational tool that provides a variety of benefits to zoo and aquarium educators seeking to convey cognitive and affective messages about conservation and wildlife. Ongoing research, such as AZA's Multi-Institutional Research Project (MIRP) and research conducted by individual AZA institutions will help zoo educators to determine whether the use of program animals conveys intended and conflicting messages and to modify and improve programs accordingly.

When utilizing program animals our responsibility is to meet both our high standards of animal care and our educational goals. Additionally, as animal management professionals, we must critically address both the species' conservation needs and the welfare of the individual animal. Because "wild creatures differ endlessly," in their forms, needs, behavior, limitations and abilities (Conway 1995), AZA, through its Animal Welfare Committee, has recently given the responsibility to develop taxon-specific animal welfare standards to the Taxon Advisory Groups (TAG) and Species Survival Plan® Program (SSP). Experts within each TAG or SSP, along with their education advisors, are charged with assessing all aspects of the taxons' biological and social needs and developing animal care standards that include specifications concerning their use as program animals.

However, even the most exacting standards cannot address the individual choices faced by each AZA institution. Therefore, each institution is required to develop a program animal policy that articulates and evaluates program benefits. The following recommendations are offered to assist each institution in formulating its own Institutional Program Animal Policy.

The policy development process: Within each institution, key stakeholders should be included in the development of that institution's policy, including, but not limited to representatives from:

- The Education Department
- The Animal Husbandry Department
- The Veterinary and Animal Health Department
- The Conservation and Science Department
- Any animal show staff (if in a separate department)
- Departments that frequently request special program animal situations (e.g., special events, development, marketing, zoo or aquarium society, administration)
- Additionally, staff from all levels of the organization should be involved in this development (e.g., curators, keepers, education managers, interpreters, volunteer coordinators).

To develop a comprehensive Program Animal Policy, we recommend that the following components be included:

I. Philosophy: In general, the position of the AZA is that the use of animals in up close and personal settings, including animal contact, can be extremely positive and powerful, as long as:

- The use and setting is appropriate.
- Animal and human welfare is considered at all times.
- The animal is used in a respectful, safe manner and in a manner that does not misrepresent or degrade the animal.
- A meaningful conservation message is an integral component. Read the AZA Board-approved Conservation Messages.
- Suitable species and individual specimens are used.

Institutional program animal policies should include a philosophical statement addressing the above, and should relate the use of program animals to the institution's overall mission statement.

II. Appropriate settings: The Program Animal Policy should include a listing of all settings both on and off site, where program animal use is permitted. This will clearly vary among institutions. Each institution's policy should include a comprehensive list of settings specific to that institution. Some institutions may have separate policies for each setting; others may address the various settings within the same policy. Examples of settings include:

On-site programming:

Informal and non-registrants:

- On-grounds programming with animals being brought out (demonstrations, lectures, parties, special events, and media)
- Children's zoos and contact yards
- Behind-the-scenes open houses
- Shows
- Touch pools

Formal (registration involved) and controlled settings:

- School group programs
- Summer Camps
- Overnights
- Birthday parties

Offsite and outreach:

- PR events (TV, radio)
- Fundraising events
- Field programs involving the public
- School visits
- Library visits
- Nursing Home visits (therapy)
- Hospital visits
- Senior Centers
- Civic Group events

In some cases, policies will differ from setting to setting (e.g., on-site and off-site use with media). These settings should be addressed separately, and should reflect specific animal health issues, assessment of stress in these situations, limitations, and restrictions.

III. Compliance with regulations: All AZA institutions housing mammals are regulated by the USDA's Animal Welfare Act. Other federal regulations, such as the Marine Mammal Protection Act, may apply. Additionally, many states, and some cities, have regulations that apply to animal contact situations. Similarly, all accredited institutions are bound by the AZA Code of Professional Ethics. It is expected that the Institution Program Animal Policy address compliance with appropriate regulations and AZA Accreditation Standards.

IV. Collection planning: All AZA-accredited institutions should have a collection planning process in place. Program animals are part of an institution's overall collection and must be included in the overall collection planning process. The AZA Guide to Accreditation contains specific requirements for the institution collection plan. For more information about collection planning in general, please see the Collection Management pages in the Members Only section of the AZA website (www.aza.org). The following recommendations apply to program animals:

1. Listing of approved program animals (to be periodically amended as collection changes). Justification of each species should be based upon criteria such as:
    a. Temperament and suitability for program use
    b. Husbandry requirements
    c. Husbandry expertise
    d. Veterinary issues and concerns
    e. Ease and means of acquisition / disposition
    f. Educational value and intended conservation message
    g. Conservation Status
    h. Compliance with TAG and SSP guidelines and policies

2. General guidelines as to how each species (and, where necessary, for each individual) will be presented to the public, and in what settings
3. The collection planning section should reference the institution's acquisition and disposition policies.

V. Conservation education message: As noted in the AZA Accreditation Standards, if animal demonstrations are part of an institution's programs, an educational and conservation message must be an integral component. The Program Animal Policy should address the specific messages related to the use of program animals, as well as the need to be cautious about hidden or conflicting messages (e.g., "petting" an animal while stating verbally that it makes a poor pet). This section may include or reference the AZA Conservation Messages.

Although education value and messages should be part of the general collection planning process, this aspect is so critical to the use of program animals that it deserves additional attention. In addition, it is highly recommended to encourage the use of biofacts in addition to or in place of the live animals. Whenever possible, evaluation of the effectiveness of presenting program animals should be built into education programs.

VI. Human health and safety: The safety of our staff and the public is one of the greatest concerns in working with program animals. Although extremely valuable as educational and affective experiences, contact with animals poses certain risks to the handler and the public. Therefore, the human health and safety section of the policy should address:

- Minimization of the possibility of disease transfer from non-human animals to humans, and vice-versa (e.g., hand washing stations, no touch policies, use of hand sanitizer).
- Safety issues related to handlers' personal attire and behavior (e.g., discourage or prohibit use of long earrings, perfume and cologne, not eating or drinking around animals, smoking etc.).

AZA's Animal Contact Policy provides guidelines in this area; these guidelines were incorporated into accreditation standards in 1998.

VII. Animal health and welfare: Animal health and welfare are the highest priority of AZA-accredited institutions. As a result, the Institutional Program Animal Policy should make a strong statement on the importance of animal welfare. The policy should address:

- General housing, husbandry, and animal health concerns (e.g. that the housing and husbandry for program animals meets or exceeds general standards and that the needs of the individual animal, such as enrichment and visual cover, are accommodated).
- The empowerment of handlers to make decisions related to animal health and welfare; such as withdrawing animals from a situation if safety or health is in danger of being compromised.
- Requirements for supervision of contact areas and touch tanks by trained staff and volunteers.
- Frequent evaluation of human/animal interactions to assess safety, health, welfare, etc.
- Ensure that the level of health care for the program animals is consistent with that of other animals in the collection.

VIII. Taxon specific protocols: The AZA encourages institutions to provide taxonomically specific protocols, either at the genus or species level, or the specimen, or individual, level. Some taxon-specific guidelines may affect the use of program animals. To develop these, institutions refer to the Conservation Programs Database. Taxon-specific protocols should address:

- How to remove the individual animal from and return it to its permanent enclosure.
- How to crate and transport animals.
- Signs of stress, stress factors and discomfort behaviors.
- Situation specific handling protocols (e.g., whether or not animal is allowed to be touched by the public, and how to handle in such situations)
- Guidelines for disinfecting surfaces, transport carriers, enclosures, etc.
- Animal facts and conservation information.
- Limitations and restrictions regarding ambient temperatures and or weather conditions.
- Time limitations (including animal rotation and rest periods, as appropriate, duration of time each animal can participate, and restrictions on travel distances).

- The numbers of trained personnel required to ensure the health and welfare of the animals, handlers and public.
- Taxon-specific guidelines on animal health.

IX. Logistics, and managing the program: The Institutional Policy should address a number of logistical issues related to program animals, including:

- Where and how the program animal collection will be housed, including any quarantine and separation for animals used off-site.
- Procedures for requesting animals, including the approval process and decision making process.
- Accurate documentation and availability of records, including procedures for documenting animal usage, animal behavior, and any other concerns that arise.

X. Staff training: Thorough training for all handling staff (keepers, educators, and volunteers, and docents) is clearly critical. Staff training is such a large issue that many institutions may have separate training protocols and procedures. Specific training protocols can be included in the Institutional Program Animal Policy or reference can be made that a separate training protocol exists. It is recommended that the training section of the policy address:

- Personnel authorized to handle and present animals.
- Handling protocol during quarantine.
- The process for training, qualifying and assessing handlers including who is authorized to train handlers.
- The frequency of required re-training sessions for handlers.
- Personnel authorized to train animals and training protocols.
- The process for addressing substandard performance and noncompliance with established procedures.
- Medical testing and vaccinations required for handlers (e.g., TB testing, tetanus shots, rabies vaccinations, routine fecal cultures, physical exams, etc.).
- Training content (e.g., taxonomically specific protocols, natural history, relevant conservation education messages, presentation techniques, interpretive techniques).
- Protocols to reduce disease transmission (e.g., zoonotic disease transmission, proper hygiene and hand washing requirements, as noted in AZA's Animal Contact Policy).
- Procedures for reporting injuries to the animals, handling personnel or public.
- Visitor management (e.g., ensuring visitors' interact appropriately with animals, do not eat or drink around the animal, etc.).

XI. Review of institutional policies: All policies should be reviewed regularly. Accountability and ramifications of policy violations should be addressed as well (e.g., retraining, revocation of handling privileges, etc.). Institutional policies should address how frequently the Program Animal Policy will be reviewed and revised, and how accountability will be maintained.

XII. TAG and SSP recommendations: Following development of taxon-specific recommendations from each TAG and SSP, the institution policy should include a statement regarding compliance with these recommendations. If the institution chooses not to follow these specific recommendations, a brief statement providing rationale is recommended.

Appendix L: Kori Bustard SSP 3-Year Action Plan (2009, 2010, 2011)

Communication & Fundraising	Champion	Action Needed
Continue fund raising efforts	Sara Hallager, AAZK chapters	
Publish Gompou annually	Katie Bagley	Recruit new SSP keeper rep in 2010
Maintain website and update as necessary	Jamie Ford	
Utilize kori bustard listserve	Everyone	
Population Management	**Champion**	**Action Needed**
Increase target size to 85 birds (based on 2007 Gruiformes Space Survey results); recruit new holding facilities	Sara Hallager	
Recruit zoo(s) to act as temporary holding facilities for bachelor groups	Sara Hallager James Ballance	
Continue efforts to breed founders	All zoos	
Send genetically surplus stock to facilities already identified overseas		On an as needed basis
Captive Studies & Husbandry Goals	**Champion**	**Action Needed**
Complete AZA Animal Care Manual	Sara Hallager	
Publish results of fecal hormone study	Sara Hallager, Jeanette Boylan, Linda Penfold	
Continue to document growth and development of chicks (through weight gains, photographs, and plumage changes)	All zoos raising chicks	
Continue to document adult (primarily male) seasonal weight changes. Expand weighing study to include monthly weights of chicks from birth through three years	National Zoo Dallas Zoo Cheyenne Mt Zoo Birmingham Zoo Zoo Atlanta	Need other institutions to participate in the study
Refine adult diet as well as chick rearing diet to that more appropriate of an omnivorous bird	Mike Maslanka, Karen Lisi, Leslie Ziegler	
Continue sending naturally molted feathers to J. McLain for distribution to fly tiers to minimize harvesting of feathers from wild birds	All participating zoos	More zoos needed to join
Continue Ethotrak data collection; decide on end point of data collection	National Zoo Dallas Zoo Birmingham Zoo Toledo Zoo Miami Metrozoo Phoenix Zoo Cheyenne Mt Zoo White Oak Zoo Atlanta Living Desert	More zoos needed to join

Compile and publish results of Mortality and Morbidity survey	Rhea Hanselmann (UCDavis)	
Recruit new members to Steering Committee	Sara Hallager	Set term limits
Formulate plans for husbandry workshop	Sara Hallager James Ballance	
Field Studies	**Champion**	**Action Needed**
Support field work and research where needed (e.g. Botswana, Namibia, East Africa)	Any zoo interested	
Education	**Champion**	**Action Needed**
Promote and support in-situ and field education and training regarding the kori bustard and its habitat.	Any zoo interested	