

# Husbandry Guidelines for ‘in range’ conservation breeding programmes of *Gyps bengalensis*, *Gyps indicus* and *Gyps tenuirostris*



## Management Guidelines

Vibhu Prakash,  
Chris Bowden, Richard Cuthbert, Nick Lindsay, Nikita Prakash, Andrew Routh, Jemima Parry-Jones

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1.0	30 April 2012	Prepared by: Vibhu Prakash, Nikita Prakash, Chris Bowden, Richard Cuthbert Nick Lindsay, Jemima Parry-Jones and Andrew Routh

For information on any updated versions of this manual contact Dr Vibhu Prakash at the Bombay Natural History Society (Email: [vibhu.mathur@gmail.com](mailto:vibhu.mathur@gmail.com)) or Jemima Parry-Jones at the International Centre for Birds of Prey (Email: [ipj@icbp.org](mailto:ipj@icbp.org))

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## INTRODUCTION

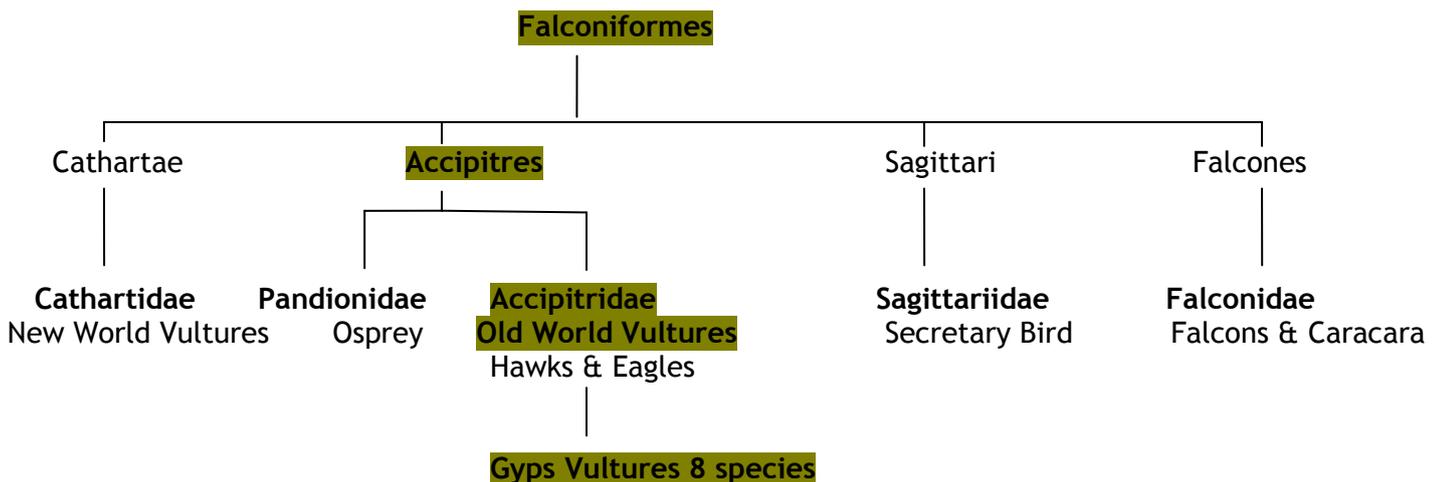
There are 23 species of Old World vultures, most of which have been kept in captivity at some point over the last hundred years. There are eight species of *Gyps* vultures, several of which have been popular in zoos, mainly because of their size. They have been bred in captivity and species such as the Eurasian griffon vulture (*Gyps fulvus*) have benefited from zoo breeding programmes, with concerted efforts resulting in successful release programmes in France and Spain.

These management guidelines have been developed for vultures from the genus *Gyps*, in particular the three critically-endangered species of *Gyps* vultures found in South Asia. Although many aspects will be relevant to other species of vulture, the bulk of this manual refers specifically to this genus. However, in many cases to the experience gained with the breeding programmes of *Gyps bengalensis*, *Gyps indicus* and *Gyps tenuirostris* run in India by BNHS can be transferred to other species and other countries.

## BIOLOGY AND FIELD DATA

The Order of diurnal birds of prey (Falconiformes) has generated considerable admiration, excitement, argument and interest. One only need look at the available literature, both popular and academic, to see how mankind's imagination has been stirred by the raptors. In all probability man has a longer historical involvement with this Order than any other with, the possible exception of the order Galliformes, i.e. the domestic chicken.

In the Order Falconiformes, there are four Suborders and five Families; two of these Families contain one species only. The tree below shows the accepted groupings.



### Suborder - Accipitres Family Accipitridae (hawks, Old World vultures and eagles)

- Birds of prey ranging from tiny to huge, diverse in shape, size, evolution and hunting methods.
- Worldwide distribution.
- Diverse habitats from dense forests to open plains, mountains to highly populated river valleys.
- 64 Genera.
- Some 237 Species. (With reference books giving numbers ranging from 212 - 240 species).
- 535 sub species.

## Old World Vultures Nine Genera, Sixteen species

### Genus *Gyps* - eight species

#### Morphology / Description

The *Gyps* vultures are all large to extremely large birds (3.8-10.0 kg), with large broad wings for efficient soaring flight in up-draughts and thermals. They have a long neck, mostly covered with tiny feathers. There is a ruff of feathers at the base of the neck and two bare patches of skin just below the collar bone. These are often referred to as 'eye patches' and can become quite prominent during behavioural displays.

They all have large powerful beaks and the legs are strong. The feet, although not particularly good for grasping, are much flatter and less powerful than eagles. However, they can easily hold down meat for tearing.

All these species tend to be pale to fairly dark brown. Juveniles tend to be darker than the adults, although in the Oriental white-backed vulture the adults have darker body feathers but a paler neck.

#### Distribution / habitat

In the wild the Old World vultures require open spaces and sources of lift to achieve soaring flight. They are therefore found most commonly in either mountains or plains and savannahs in hotter climates.

The *Gyps* vultures are distributed throughout Africa, Europe and Asia, with none above latitude 50 degrees north.



Of the eight species of *Gyps* vultures worldwide four species are found only in Asia (Oriental white-backed vulture *G. bengalensis*, long-billed vulture *G. indicus*, Himalayan griffon *G. himalayensis*, slender-billed vulture *G. tenuirostris*). Three are found exclusively in Africa (African white-backed vulture *G. africanus*, Cape griffon *G. coprotheres*, Rüppell's griffon *G. rueppellii*). One breeds in Eurasia but migrates into Africa and south Asia

(Eurasian griffon *G. fulvus*). The geographical ranges of several *Gyps* species overlap to some extent with those of others in the same genus (Pain *et al.* 2003). *Gyps* vultures were typically widespread and abundant, accounting for the majority of individual vulture sightings in both Africa (c. 90%) and Asia (c. 99%) (Houston 1983). Up until recently their huge abundance in India could be explained by the enormous availability of food in the form of domestic cattle and buffalo carcasses that are, for religious reasons, usually not consumed as meat. In some ecosystems *Gyps* vultures feed predominantly on the carcasses of wild rather than domestic ungulates. For example, in the Serengeti, Tanzania, high population densities of *Gyps* are present and consume more than a quarter of the available ungulate carcasses (Houston 1983).

Where *Gyps* species have been monitored they have been shown to range widely during foraging (Houston 1974, 1983). Immature birds disperse even more widely after fledging and are often more

nomadic than adults. The establishment of 'nursery' areas, where juveniles congregate prior to breeding, is a not uncommon feature (Mundy *et al.* 1992). Foraging flights for the south Asian vultures may be lower than in other species, possibly due to the high availability of carcasses removing the need to travel long distances in search of food. Advances in radio and satellite tracking are providing new information all the time.

## General Behaviour

### Activity/locomotion/migration

Due to their large size vultures need to conserve energy and avoid demanding activities. They scavenge for food and so they are reliant on finding carcasses in the most efficient manner. Generally they do not attempt to fly until the day warms up. They sun themselves early in the morning when the weather allows but are reluctant to move until thermals, that will assist them in gaining soaring height easily are forming. Once soaring they can stay airborne for hours given the right weather conditions. Some of the more northern living Eurasian griffons, *Gyps fulvus* undertake long migrations to their wintering grounds and can cover hundreds of miles in a day. In some populations *G. fulvus* juveniles appear to undergo large-scale annual migrations before settling into a resident breeding population (Susic 2000).

Once they have fed *Gyps* vultures, like most large carnivores, conserve energy by remaining inactive whilst digesting their relatively large meal. If threatened then they may sacrifice the meal through regurgitation in order to be able to fly efficiently.



### Social Behaviour

*Gyps* vultures form monogamous pairs in which both sexes share the incubation and care of the young. Most species of *Gyps* vulture nest in colonies, usually on cliffs, or loose colonies in trees, a behaviour seen more in the smaller members of the genus, e.g. *G. bengalensis*. They are, therefore, reasonably social though protective of their nests during the breeding season. There is usually one nest to a tree, but occasionally more than one pair will nest in a tree (e.g. *G. bengalensis*). It appears that the slender-billed vulture, *G tenuirostris*, is a solitary tree nester, making it much harder to find in the wild. This bird has only recently been assigned full species status, rather than being a sub-species of the long-billed vulture, *G. Indicus* (Rasmussen and Parry 2000). Its habit of solitary nesting may be more due to low numbers of the species rather than being a chosen habit.

### Vocalisations

*Gyps* vultures are generally silent. When excited, (such as at a carcass), they will emit a series of cackles, hisses and croaks. During mating a pronounced 'wheezing' or dry 'rasping' noise is made by both birds.

## Diet and feeding behaviour

The *Gyps* vultures are specialised carrion feeders. They feed on the carcasses of medium to large mammals which are located from the air. Foraging vultures will either find the carcass themselves or respond to the feeding activity of other scavengers. They will eat the meat, offal and intestines but generally not the stomach contents. In healthy, fat, vultures sufficient food can be taken into the crop at one meal to last several days. *Gyps* vultures generally feed together. They will tear at the softer parts of carcasses to gain entrance and will feed deep into larger carcasses. There is much posturing and squabbling over carcasses and birds will chase and bite one another. However, injuries to birds are generally rare during such activity.

## Reproduction

Though recognised as late-maturing the age of sexual maturity does vary. Most wild *Gyps* vultures start to breed at five to seven years old though they have been known to breed earlier. Breeding in captivity will be influenced by a number of factors, some of which lead to earlier breeding.

Raptors usually have a complex set of behaviours for finding suitable mates and breeding and *Gyps* vultures are no exception. Although in many raptor species the females are larger than the males, in scavenging species the size difference may not be perceptible. Though the breeding displays of the *Gyps* vultures are poorly described it appears that 'tandem flying' (where the birds fly together in 'stacks', mirroring each other's flight path), and 'jetting in' (which is fast and close to simultaneous arrival at the nest) are commonly recorded courtship displays. Sitting and roosting together and some mutual preening have also been recorded by a number of researchers.

Nests can be used year after year. Both birds participate in nest construction with often one bringing sticks and the other doing the building (Mundy *et al.* 1992). Both the tree and cliff nesters build stick or twig-based nests.

One egg is laid and, as far as is recorded in most *Gyps* vultures, the incubation period is between 45-55 days. Both birds in the pair assist in the incubation and rearing of the chick, which is fed with regurgitated food.

Fledging in the wild takes place about three months after hatching (Roberts 1991). This compares with observations made in captivity with 118 days to fledging observed for two captive-bred young at Pinjore in India (Prakash 2008 pers. comm.)

## Survival

### Longevity

*Gyps* vultures can live 20-30 years in the wild and upwards of 40 years in captivity. Mortality is highest in juvenile birds, the rate reducing as the birds become sub-adults. Adult birds in the wild therefore would have an average maximum annual mortality rate of less than 5%.

### Causes of Mortality

A number of causes of mortality, direct and indirect, have been recorded in vultures. These include secondary and direct poisoning, electrocution by power lines, drowning in farm water reservoirs, habitat loss, variable food supply and deliberate persecution (e.g. shooting). Probably the highest cause of mortality for younger birds is starvation due to ineffective foraging behaviour. Older birds can suffer the same fate if they experience a sub-lethal injury that impairs their foraging ability. In normal

circumstances these are incremental, often natural, mortalities not likely to affect the population as a whole. In India a surprisingly high number of vultures (and many other bird species as well) are injured and killed at kite-flying festivals, where the glass-covered strings designed to cut the string of the opposing kite severely injures or kills soaring birds in the vicinity. Though a welfare issue, again this level of mortality is not normally expected to be a cause of population decline. However, when a species becomes critically endangered in the wild, lesser factors leading to mortality become much more significant to the population as a whole.

### Conservation status

In this section the focus is on the three species of vultures endemic to South and Southeast Asia. The Oriental white-backed vulture (*Gyps bengalensis*), the long-billed vulture (*G. Indicus*) and the slender-billed vulture (*G. tenuirostris*) are in grave danger of imminent extinction across most or all of the current geographical range. Earlier population surveys revealed declines of resident *Gyps* spp. vultures in excess of 97% over a 12 year period in India and 92% in a 3 year period in Pakistan (Prakash 1999, Gilbert *et al.* 2002; Virani 2002). A rapid decline has also been recorded in Nepal. Populations of *G. bengalensis* and *G. tenuirostris* in Southeast Asia (Cambodia, Laos PDR, Myanmar and Vietnam) are low but these declines are thought to have been historical and slower in onset, rather than part of the recent and rapid seen in the Indian sub-continent. The world population size is not known for any of these species.

Because of the evidence of widespread and rapid population decline all three vulture species were listed in 2000 by the International Union for the Conservation of Nature (IUCN) as “Critically Endangered”; which is the highest category of endangerment. This assessment is indicative of a high risk of global extinction in the wild in the near future. Although a great deal of work, finances and effort has been expended to date, current captive populations have not achieved the level required for a viable genetic population for any of the species. Of greatest concern are the low numbers of the slender-billed vulture, making this the species most vulnerable to extinction in the near future unless more action is not taken soon.

### South-east Asia

Until the middle of the 20<sup>th</sup> Century, *Gyps bengalensis* and *G. indicus* were abundant, with *G. tenuirostris* at much lower numbers. The long-billed vulture has probably been restricted primarily to India for a long time. However the slender-billed and white-backed vultures were more widely distributed, and in some places abundant, in South-east Asia during the first half of the 20th century. Both species are extinct across almost the entire area, with relict populations remaining in Myanmar and Cambodia. Recent survey work in Cambodia (Tan and Clements pers. comm.) and Myanmar indicate that there are remaining populations of white-backed and slender-billed vultures in these countries, but there is little information about total population abundance or locations and sizes of breeding colonies. It is thought that vulture numbers in Cambodia temporarily increased during the Khmer Rouge in the 1970s due to the abundance of human and livestock carcasses. The few remaining birds in South-east Asia appear to have low breeding success (e.g. Timmins and Ou Ratanak 2001).

### Indian subcontinent

Rapid vulture population declines were first documented in a breeding colony of *Gyps bengalensis* in Keoladeo National Park, eastern Rajasthan, India (Prakash 1999). Numbers of breeding pairs in the park declined steadily through the late 1990s so that by the year 2000 there were no breeding pairs left (Prakash *et al.* 2003). Data on population changes over a wider area were obtained by repeating a road-transect survey of raptor populations carried out in 1991 - 1993 across a large area of northern India. Repeat coverage of the road-transects in 2000 indicated that the vulture declines extended across all of

northern and central India and had occurred for *G. indicus* and *G. tenuirostris* combined, (these two species had not been distinguished from each other at that time), and for *G. bengalensis* (Prakash *et al.* 2003). Road-transects surveys have been repeated across India in 2002, 2003 and 2007. These surveys indicate an overall decline of 99.9% for *G. bengalensis* between 1991 - 93 and 2007, and for the combined counts of *G. indicus* and *G. tenuirostris* a decline of 96.8% (Prakash *et al.* 2007). Rates of annual decline for the period 2000 to 2007 indicate average annual rates of decline 43.9% for *G. bengalensis* and 16% a year for *G. indicus* and *G. tenuirostris*. Analysing counts of *G. indicus* and *G. tenuirostris* after the separation of these species (Rasmussen and Parry 2000) demonstrates that both species are declining, with *G. tenuirostris* (the rarer of the two species) decreasing by 86.6% from 2002 to 2007 (Prakash *et al.* 2007). In 2007 the crude estimated populations of the three resident species in India were *G. indicus* 45,000 individual birds, *G. bengalensis* 11,000 birds and *G. tenuirostris* 1000 birds (Prakash *et al.* 2007).

Intensive monitoring of *G. bengalensis* breeding colonies in Punjab province, Pakistan documented declining numbers of breeding pairs between 2000 and 2003 coupled with high adult mortality rates (Gilbert *et al.* 2002; Virani 2002). Numbers of pairs recorded in the province declined by 92% in three years (M. Gilbert unpublished data), equivalent to an average rate of decline of 57% per year.

Surveys of vultures in lowland Nepal indicate similar considerable population declines, though they have not been as rapid as those in India and Pakistan. Road-transect surveys in lowland areas recorded a population decline of 86% for *G. bengalensis* from 2002 to 2011 (Chaudhary *et al.* 2011). If population decreases commended in Nepal in the same year as in India, then this species has declined by 91% since the mid 1990s. Number of *G. tenuirostris* were very low (none were recorded at all in 2011) but again indicated a decline over the period of survey. The declines appeared to be more pronounced in eastern Nepal, where numbers are currently low, than western Nepal where populations of *G. bengalensis* remain often in areas where vulture conservation activities are being pursued (Chaudhary *et al.* 2011).

From the limited evidence available, populations of *Gyps fulvus* in Central Asia do not appear to have declined in a similar manner, though they have been slowly declining across Central Asia, probably as a result of changing farming practices reducing the availability of livestock carcasses (Katzner 2004). There is very limited monitoring of *G. fulvus* numbers within the Indian subcontinent. Population trends for *Gyps himalayensis* are also poorly known, although repeated counts in Upper Mustang, Nepal, suggest that resident populations of this species are in decline (Acharya *et al.* 2009).

Evidence available for other scavenging bird species is more limited, although the road-transect surveys in India indicate that up until 2003 populations of red-headed vultures (*Sarcogyps calvus*) and Egyptian vultures (*Neophron percnopterus*) had decreased by 91% and 80%, respectively, in comparison to counts from 1991 - 1993 (Cuthbert *et al.* 2006). The IUCN has classified *S. calvus* as "Critically Endangered" and *N. percnopterus* as "Endangered".

### **The role of vultures in ecosystems**

Vultures played a key ecological role in the Indian sub-continental region. In many areas religious and cultural beliefs forbid the consumption of meat but, because milk is a dietary staple, there are a large number of livestock carcasses available to scavengers. With the decline in numbers of resident vulture species, there is now a superabundance of food (Prakash *et al.* 2003). Concurrently, and probably in response to the increased food availability, there appears to be an increase in resident feral dog populations. This increase in feral dog populations could have serious consequences for human and wildlife health, as dogs are carriers of several diseases that affect human beings, wildlife and livestock, including rabies, distemper, and canine parvovirus (Pain *et al.* 2003). India has the highest incidence of human rabies in the world, with the majority of these stemming from dog bites (Prakash *et al.* 2004). In addition, the accumulation of dead livestock carcasses may have implications for groundwater safety and with respect to livestock-borne disease such as tuberculosis and anthrax. Vultures also play a key

role in Parsi beliefs as their dead are not buried, but are left to be eaten by birds in sky burials. The most famous site is the Towers of Silence in Mumbai where thousands of vultures used to congregate around the towers. Since the decline of the vultures they are only attended by smaller and less effective avian scavengers (Parry-Jones 2001).



## MANAGEMENT IN CAPTIVITY

### Introduction

Prior to this project little has been done previously in terms of serious captive management for these three critically-endangered species. Though this section is under-pinned by the successful work of the BNHS breeding programme in India *Gyps* vultures (although differing slightly in their nesting habits) do show much of the same behaviour across their ranges, and we sometimes use examples from other *Gyps* species where necessary.

Dedicated breeding centres have been established to house vultures in the most favourable conditions. Thus these guidelines are written specifically for the endangered south Asian vultures managed in *ex situ* in-country breeding projects. As the birds are kept in captivity within their natural range, climate and weather conditions should not be the issue it can be when keeping birds outside their home ranges.

*PLEASE note that this is a living document and will be added to and changed where experiences point to changes in direction or different management techniques. It has been produced in a file form so pages can be changed, removed or added with time and experience. Contact details for obtaining the latest version of the guidelines are provided at the start of the document.*

What this document describes can be adapted for the few birds held in zoos, mainly in the design of the enclosure where, in a public exhibition situation, natural plants and furnishing to produce a more natural-looking environment are useful tools for public education. It should be remembered that most 'natural-looking environments' within zoos are more likely to be for the benefit of the viewing public than for the welfare of the animal kept within it.

We strongly advise that any zoos wishing to keep these birds for public display and education only have one pair on view to the public (none being the most endangered slender-billed vulture). These zoo pairs must still be given the opportunity to breed meaning that enclosures should contain a known male and female and suitable nest sites to encourage that pair to breed. Should pairs lay eggs there should be cooperative sharing of eggs and incubation facilities between the specialised breeding centres, i.e. both the three BNHS Centres and the zoo Centres. This will benefit all concerned, and most importantly, the vultures and the project.

The breeding centres are currently better equipped and have more expertise on incubation and rearing. However, if a pair in a zoo is incubating well and producing eggs it may be possible to use these as rearing foster parents, even if they do not produce fertile eggs. This involves the zoo and shows the public the young bird growing up, at the same time strengthening the liaisons between the public side of the zoos and the breeding facilities. Young birds should be returned to the breeding facilities at six months old, (see new birds, and quarantine section below), giving the chance for the zoo pair to breed again. Putting young with pairs producing infertile eggs can stimulate them to produce fertile eggs in the future.

With the experience gained at Pinjore and the other breeding centres, we consider that all specialist breeding centres should be off public view, with very limited access to all, (and then only by appointment and agreement with the director of the site who will be best situated to know when are good times to visit and when are most definitely not). Strict guidelines should be set out to help directors from being coerced by those who might want to utilise the breeding centres for their own ends. This should be a National project and it is critically important that there is full back-up from the State Chief Wildlife Wardens to support the staff at the breeding Centres.

We suggest that all centres that are going to allow any limited public access have CCTV, a public welcome/education room for people and, if possible, one public enclosure with one or two birds that have been proved not suitable for the breeding projects. These buildings can serve to host important guests, fund raisers and students etc, but must not be allowed to detract from the purpose of the centres, which is to save the species. Visits should be limited to perhaps one day every two weeks at the most, for invited people only. Numbers of people visiting at any one time need to be strictly limited at the discretion of the site director (e.g. a maximum of 10 people). Under no circumstances should persons other than those designated to tend the vultures be allowed near or in the holding and breeding enclosures.

### **Starting a Conservation Vulture Breeding Programme within India**

**Administration, steering, awareness/public relations, schedule 1 permissions, committees, visitors, communication.**

**Please note that much of this information is relevant to India and written with the experience of doing it. Other countries will have the equivalent government bodies and laws that they will have to comply with.**

All vultures are included on Schedule 1 of the Wildlife Protection Act 1972; this is the highest category of protection.

When setting up a Conservation Breeding Centre (CBC) firstly a proposal has to be sent to (in the case of India) state government for support and consent, if foreign funding is included then the Foreign Currency Regulations Act must be adhered to, (organisations must be 3 years old at least and non profit making organisations).

The proposal should be sent to the government regional office for clarification of the land use of the CBC (in Haryana confirmed that it was a 'forestry purpose' (Forest Conservation Act 1980, controls the use of land for non-forestry purposes) no residences should be allowed except for night watchman and bird staffing purposes. Such activity is may not allowed within a national park or wildlife conservation area and so setting up a CBC on land of these designations would not be permitted. It is easier if the site is close to the Forest Officer/wildlife officer involved. (Access roads, electricity, water etc. are requirements - see section on Location).

The capture of birds requires the permission (in the case of our examples) of the Government of India (as all vultures are Schedule 1 species). The permission of the Government of India and Chief Wildlife Warden (CWW) is required to move birds (transit permit). Transfer of any genetic material outside of India is strictly prohibited under the Biodiversity Act (except a research provision with foreign collaboration). If any birds die then the mortality must be reported to Central Zoo Authority by the CWW within 24 hours of the death. Conservation Breeding Centres (CBC) are now under the auspices of the CZA. As birds may be being rehabilitated means that application to CZA to get centres registered as Rescue Centres is advisable. In the case of a dead bird the carcass may be kept for future research (but it is categorised as a trophy under WPA) and therefore the permission of the CWW is required to keep the trophy (considered the property of State Government, under the custody of the CBC).

In Haryana the BNHS carry out the day to day workings and management of the CBC, calling upon the support of the CWW to facilitate working when required. This is clearly laid out in an MOU between the parties. This helps to solve the problems caused by discontinuity of the State Government because of job postings.

A governing body / advisory board should be established for each centre (at state level committee, chaired by Forest Secretary and CWW), also an overall national technical committee for overseeing/advising upon activities of all centres. Suggestions that centres are run as projects, sometimes with outsourced expertise, means that international help can be gained, which can be crucial especially at the start of projects.

Existing CBCs should be used for professional training of staff from other areas that are planning to establish new CBCs. A training institute is desirable to build capacity and technical standards. This could be one of the experienced CBCs. Certain times of the year are better than others for training, for example in India and Nepal April - June is a particularly good time of the year for trainees. It may be worth forming an advisory group to look specifically at ex-situ management training.

Right to Information Act - information must be given within 30 days to written requests, charging a fee for administration is acceptable. However any government Centre is duty bound to provide all available information to any **reasonable requests**. Provision exists to withhold unpublished scientific

data under the act, (intellectual property rights). However it is sensible to explain this to any applicant for information. Provision of an Annual Report provides for much of this data.

Any legal Acts within the countries of the Vulture breeding projects are relevant to the handling, housing, trapping, moving and management of birds

Media - Head of the dept. (CWW) is delegated the authority to make statements on behalf of CBCs. There may be problems of people wanting to enter cages for photography etc. CBCs should make crystal clear rules about restriction of entry, i.e. none in the aviaries. The breeding season is particularly sensitive; Closed Circuit Television (CCTV) may alleviate some of these. Individual CBCs may make their own rules (never allowing access INSIDE the cages by non-project staff for example). Consider provision of photos to the media. A written protocol for dealing with the media is useful. You must be clear up-front that these are closed facilities, not open to the public. Separate exhibits can be supplied so that the public etc. can see the species and be made aware of the threats and conservation actions. These may be at the CBCs but also at sites with much greater access and visitation, i.e. Zoos. Use non-breeding birds for such awareness activities. Injured birds could be used if injuries are not too serious or impacting upon the look of the birds, or causing undue stress to the bird. An annual report/newsletter should be produced and available on the website. Competency must be assessed regularly and the setting up of centres must happen with the collaboration of the state.

Roads through wildlife sanctuaries require permission of CWW to access, therefore it is better to have a formalised right of access through a memorandum of understanding.

The ultimate aim of conservation breeding has to be release into the wild and this must never be lost sight of. However once successful breeding takes place there will undoubtedly be outside pressure for releases before the right time. This factor must be recognised and the situation for the continued breeding in captivity to provide the release birds, and the situation of the habitat and needs of the vultures on release must be optimum. We believe that it is advisable to have bred to F<sub>2</sub> generation prior to the first releases to ensure long-term success of the programme.

## **Location**

Sites within the former range of the species are preferable for the setting up of Conservation Breeding Centres. However it is also undesirable to have all the representatives of one species within a single CBC. Support of the State government is very important. The site should be in an area with a stable socio-political situation. It should be fairly easily accessible, have good road access, be fairly close to a town and preferably to an airport. However, if sites are very close to large urban centres then this may involve extra problems of security and bio-security. Flat ground with comparatively few trees is preferable and an area that does not flood is crucial. Some zoo aviaries are deliberately built upon slopes/cliff-faces. This provides practical problems for management but is a good educational tool as long as the environment is relevant for the species. Consideration must be taken of potential natural disasters when siting and constructing aviaries (e.g. having earthquake-resistant buildings, lightning conductors etc). Sites must be large enough, a minimum of 2 ha, to include all the elements required.

The centre should be enclosed by a perimeter fence. If predators and elephants are found locally then the fencing will need to be elephant/predator-proof. The fences need to be able to exclude people and their livestock (dogs and grazing animals). There may be local problems with macaques although these are very difficult to exclude with perimeter fencing. Sites should not be located close

to (less than 5km from) commercial poultry production units or industrial sites. Locations should not be adjacent to areas supporting large numbers of water-birds /wetlands with migrating birds (ideally not within 5km). *An advisory group may be needed to look more closely at the disease risk factors which may vary over time, an example being outbreaks of Avian Influenza.* CBCs linked to zoos must be constructed as off-display facilities or as satellite centres, not necessarily within the zoo perimeter.

Further essentials are adequate power and water. Housing close by for CBC staff is useful, with facilities on site for night watchmen. The location of these facilities within the site is important and a local awareness of local conditions and materials is essential in designing and constructing buildings. Thus buildings for offices and, potentially, conferences could be provided by the local State authorities but care would be needed with regard to where they are on-site and access/security.

## Enclosures/Accommodation

### General information

Only a very few white-backed vultures and, as far as is known, no long-billed vultures or slender-billed vultures had been bred in captivity prior to this project. Most *Gyps* vultures are colonial to a lesser or greater extent in their nesting habits. As a result, they can be kept in groups and still breed, as long as the enclosures are large enough, and the nest sites are suitable (see below). As with species that are unknown quantities a measure of adaptability in managing these species in captivity is essential. Individual enclosures might work better for some individuals. These realities become clear as time goes on and more experience is gained. Certainly breeding sites should have enough land to put up sufficient numbers of breeding enclosures and, once breeding success is assured, holding enclosures when they are required.

The ultimate success of the project could depend on as many vultures as possible to be taken in from the wild to form the founder populations. It is essential that the breeding centres should first build at least one very large colony aviary for each of the species they intend to hold. These are designed to house the birds comfortably and facilitate good management practices whilst, at the same time, allowing birds to select breeding partners and breed when they attain breeding condition. It is anticipated that the project will last for at least 20 years. Even if individual enclosures are built and found to work better, the large enclosures will be needed to house young birds for up to five years as they grow and reach sexual maturity. Large group aviaries where birds can meet and form pair bonds will always be a part of a successful large breeding programme for *Gyps* vultures. At the time of writing it is the opinion of the team that the colony aviaries are working extremely well. All three species have now been bred in captivity using the colony aviaries. We have, in 2012, tried with individual breeding aviaries for pairs of birds. These too are working and the birds that were previously non-productive are laying eggs. However, bird for bird, individual aviaries take up more room and materials than the colony aviaries.

Although nesting sites and perches must be available in the enclosures, unless the aviaries are on view to the public, naturalistic environments are not crucial to the birds' welfare, well-being, or their success in captive breeding. Birds should, however, be given the opportunity to express a range of behaviours. As a result feeding regimes, nest material, varied perching and other enrichment items always need to be incorporated in enclosure design. Giving the birds the lines of sight horizontally out of their enclosures enhances their mental wellbeing. Similarly they are more settled when given the elevation to get above humans in the vicinity.

Vultures can be susceptible to disturbance during the breeding season and can injure themselves in enclosures if disturbance is not kept to a reasonable, manageable, level. Some birds can become

aggressive when nest sites are approached. Until pair bonds are formed, which may take several seasons, some individuals will not share perches or shelters. A range of perches, more than is required for the number of birds being housed, should be available. This allows birds to select their own perches and assists with the establishment of a colony 'pecking order'. Similarly, provision needs to be made for subordinate and/or lower ranked birds to have adequate shelter. Fundamentally, all types of enclosure, not only those built for aesthetic and educational reasons but also those built specifically for breeding projects, should be designed to give more than adequate room, perching and shelter for each individual bird, and for young on nest sites.

### Barriers

Stand away barriers should be included for all enclosures, even if there is no public access. These barriers assist captive birds in developing a feeling of security within the enclosure. In non-public centres stand away barriers need only be simple structures (e.g. a single rope), mainly to discourage occasional or unfamiliar personnel from approaching too close. In public collections stand away barriers should be at least 1.5 metres from the side of the enclosure and secure enough to prevent small children and others from reaching the enclosure completely.



### Walls/roof/doors

At least one side, and preferably two sides, of any enclosure should be secluded or of a solid material, in particularly the walls with nest ledges. This allows for bird staff to approach for management purposes without birds seeing them. Even enclosures that are built for educational viewing rather than captive breeding should give the naturally-nervous vultures, particularly adult birds from the wild, a large area where they cannot see any approaches. This will enable them to feel secure.

Wire and metal mesh generally are not kind to vultures. If they fly into it they can sustain injuries. However, in a zoo situation one wall will probably need to be of a mesh for viewing purposes. Chicken wire is a highly unsuitable medium for birds in general and does them great physical damage if they fly into it. Chain link as roofing material has been known to kill birds that have managed to catch a flight feather in one of the twisted links. However, experience at the Indian centres has shown that chain link works well for walls. Welded mesh can be used - and appears to be the most suitable, and should be a minimum of 10 gauge wire with a mesh diameter of 50mm. Painting the outside of the wire with matt black paint leads to far better visibility for the public and bird staff, whatever the size of the mesh.

For the breeding centres a concrete or block-work base with vertical wooden slats or heavy bamboo poles (e.g. 5-10cm diameter) with 5 cm gaps in between is a suitable option, giving the birds more privacy and security whilst also allowing a flow of air through and some visibility. These have mesh on the outside so that if the bamboo fails or rots, the mesh (and aviary integrity) will be retained. It is important though that the vultures can see through these bars and gain some sight of keepers to get them used to people moving around the project. The low retaining wall or block-work base all around the enclosure will discourage snakes or ground living mammals from entering the enclosures. The wall also will keep any wooden components off the ground and thus less available to termites and potential wood rot.

Vultures, like most raptors, feel more secure if they are able to gain some height. However, high enclosures must also be long enough for birds to manoeuvre without touching the sides. Enclosures

which are high but short are not suitable. The length must be suitable for the height. If enclosures are to be for example 20 feet (6.0m) high they would need to be at least 40 feet (12.0m) long.

Enclosures should be partially roofed with solid weatherproof material so that all vultures have adequate shade and shelter - shade is crucial in hot countries. Nest areas are better shaded and usually completely covered. Roofing material used should prevent excessive build-up of heat in the summer or condensation in winter - steel and tin are only suitable if used to protect or overlay sheets of plywood or some other material with low thermal conductivity. Large areas of transparent roofing material are not suitable, as excessive heat is directed into the enclosure on sunny days. Concrete fibre roofs have good insulating properties and cut down condensation to a minimum. Enclosures should be designed to encourage good ventilation.

Those parts of the roof that are not solid are best covered with a strong mesh/net material. A product such as Netlon®, or similar, is extruded polymer netting and is very kind to birds. Netting made from UV resistant polypropylene or similar material is also very effective and safe for birds. Net-strand diameter should be at least 3mm, with a mesh size of at least 45-50mm. The lightweight (but strong) nature of these types of netting means it does not require as strong a support as heavier materials. This reduces the need for vertical roof supports within the enclosure. These are not a good design feature as the birds will hit them in flight.

### **Access**

Access must ALWAYS be through a safety, double door system of some sort. Access and the ability to monitor birds and clean enclosures with the minimum of disturbance are all best achieved from a darkened service passage. Doorways should be large enough to allow easy access for wheelbarrows and people alike -1.0m x 1.75m makes for safe and comfortable entrance for bird staff. A double door system is mandatory to avoid escapes and for security. A service passage should also give access for cleaning and monitoring of breeding behaviours, nest sites and so on. Access doors will usually be located at the rear of the aviary and, as such, be part of a solid wall.

### **Furnishings and Maintenance**

Apart from building enclosures that are comfortable, manageable, safe and lending themselves to reasonable hygiene, they need to be furnished with perches, nest areas and very importantly - baths.

### **Perches**

Vultures do not have feet that grip particularly well, so a good proportion of the perches should be large, with non-slip perch surfaces and plenty of space for landing without hitting wing feathers. Because vultures tend to squabble over sitting and roosting locations, sufficient high perches are required to allow all birds space to perch, i.e. more perches than birds. There should be enough space around the perches for birds to be able to land without hitting their wings on the enclosure sides, nest sites, or other perches.

Having said that the perches need to be large in diameter, it is however surprising how narrow a branch on which vultures can perch. It is therefore important for enclosures to have a range of perches of differing diameters. These should range from relatively narrow (5-6cm) to very wide (15-20cm). This provides valuable gripping exercise for the birds and irregular shapes also mean less chance of pressure sores or bumble-foot. Covering perches with a non-slip soft material, such as coconut rope wound round the perches, makes for a more comfortable perch. It is more than likely that vultures will destroy the covering. However, if cheap (and non-toxic) materials are used it can be replaced regularly and the birds appear to enjoy destroying these types of materials. This in turn adds to the enrichment of the enclosure for the birds in captivity.

Over time wooden perches 'season' and the timber can get very hard and slippery. It is important to keep an eye on perches and change them regularly. This changing of the perches also gives mental stimulus to birds. The positioning of perches will lead to either reasonably clean enclosures that are easy to maintain or, if badly placed, will make for droppings all over walls which are difficult to clean and unsightly. Extreme care must be taken to ensure that perch positions do not result in water baths being contaminated with faeces. Placing perches too close to corners is poor practice. Apart from the build up of droppings on walls, flight feathers can be damaged as birds fly into the narrowing space to land on the perch. Perches sited away from walls make for better visibility, cleaner enclosures and birds in better feather condition. Perches fixed to walls and coming out at right angles a good distance (e.g. 2m) into the enclosure, giving wing room are useful and should keep walls clean. Good perches should be placed close to nest areas so that young birds have a place to hop to once they become active.

We have found in Pinjore that building the colony aviaries around living trees makes for a more natural appearance and the vultures enjoy the trees and the shade they provide on the ground.

### **Nest areas**

Although two of the three species of *Gyps* vultures in South Asia are tree nesters it is difficult to be able to replicate this in captivity and still be able to monitor and manage the breeding cycle. It is recommended that nest 'ledges' are placed on accessible walls so that eggs and young can be manipulated during the breeding season. In captivity the size of the nest area is quite important and this should be taken into account when building a ledge. A reasonable minimum size is 2m x 1m, but larger ledges are both possible and recommended. There needs to be room for both parent birds and the nearly full-grown young. In addition, reasonably-sized nest ledges gives room for adults to display without getting too close to one another in the early, sensitive, stages of courtship and mating with room for pairs to choose a nest area at different points on the ledge. It gives sufficient space for developing young to grow, practise wing flapping and play. It also gives room for bird staff to get to the ledges out of season and clean them properly.

All nest areas should be easily monitored with the minimum of disturbance and easily accessible to facilitate the removal or replacement of eggs and young. Spy-holes, panes of one-way glass or small painted glass windows are a must where captive breeding is a serious intent. Access hatches or doors should be incorporated in any nest area. If this is not possible then CCTV cameras placed in strategic points are invaluable, but they must be well-maintained each year and their limited lifespan allowed for in planning and budgets.

As eggs are fragile it is advisable to have a soft substrate material on nest ledges. This means that a low lip around the edge of the ledge is required to keep the substrate on the ledge. The substrate needs to be at least 150mm - 220mm deep. Experience has found that sand or pea gravel is the best material available. Wood chips are dangerous, both in terms of harbouring infection and for young swallowing large pieces. Peat is too dusty and can cause gut impaction in young birds. Gravel is acceptable in some species but once the nest areas get dirty during incubation the stones stick together forming a hard base. This can lead to broken eggs so care must be taken. The gravel need to be small and rounded and not sharp. Sand is generally not too dusty. It absorbs droppings and small amounts can be swallowed without too detrimental an effect. However it is heavy and nest ledges need to be strongly constructed to support the weight. It is important to have some substrate even though nests may be built on top. A soft underlay of sand will stop eggs being broken if the nests are poorly constructed by the birds and the eggs slip through the nesting materials.

More recently the project in India has used woven jute beds, some 1.0m x 2.0m, for the nest ledges. These are very good and the birds like them. The weave must be very tight so that birds cannot get a toe caught in the spaces and it will need to be changed yearly as the jute will not last.

It is good practice to build stick nests on the ledges for the birds prior to the breeding season as this may encourage nesting behaviour.

It is also important to put nesting materials on the floor of the aviary so the birds can build their own nests.

## **Baths**

Bathing facilities are crucial for vultures; they love to bathe and drink, so fresh clean water must be available at all times. They should be large enough to give enough room to bathe actively but fairly shallow, with a non-slip surface. Baths for the *Gyps* vultures should be about 15 - 20 cm deep and at least five feet wide.

The baths are best sited so they can be cleaned and filled without entering into the enclosure itself. Positioning the bath by an outside wall with an access door makes for easy care. Baths must be situated away from corners and perches where droppings can fall into the water.

If the bath is raised a little from the ground level of the aviary it is less likely to get dirty as quickly. Baths should be emptied and cleaned at least twice a week, more in hot weather. Put a drain hole in the middle that can be opened and sealed from outside the aviary. When the dirty water has drained away a scrub with a brush can be done through the access hole and the bath is ready to be filled again. A commercial, safe, disinfectant F10® can be added to the bath water at a dilution of 1:1000. This will keep baths cleaner.

It has been found in Pinjore that the birds bath more readily the more the baths are cleaned and refilled. In the colony aviaries there are four baths, two on each of the long sides. Water is replaced twice weekly and troughs are cleaned out thoroughly once every 15 days. By alternating troughs they can be allowed to dry out and help reduce algal growth. If it is preferred not to leave baths empty a spray with diluted F10®, then leaving it for 15 minutes to dry before refilling will also disinfect and kill algal growth.

## **Feed Areas**

Feeding birds from a hatch way at ground level from outside the enclosures is the easiest way to manage feeding regimes. Vultures need to feed on the ground and preferably from whole carcasses. If a door is sited at ground level in the service passage or any external wall food can be pushed through onto the feeding area. If a large carcass, such as goat, has a rope tied round one leg and tied to a fixture in the passageway wall this will anchor the carcass, making it easier for the vultures to pull at it. Once the carcass is finished with it can be pulled back through the door with minimum disturbance to the birds in the enclosures. Spy holes will allow bird staff to see when the carcass is finished.

## **Enrichment**

Vultures are intelligent social birds and can be very inquisitive. Keeping relatively large groups together is enrichment. Visual stimulation is important. Widening gaps in aviary screening so that individuals have a better view of the outside world will help. Thick, 3 - 4 inch (75 - 100mm) diameter ropes attached to the sides of the enclosure can give vultures something to play with and tug at.

## Specific Aviary Information based on many years of Experience at Pinjore India

### Nursery Aviaries



These are designed for nestlings being brought into captivity. The nestlings are normally (and preferably) at least 40 days old and are kept in groups of two or more, depending on their age. We also use them for hand-reared captive bred chicks to ensure that the birds do not become imprinted. If birds are being hand-reared from incubation then some view of adult birds should be provided if possible. Long-term captive disabled birds may be useful for this. These are a minimum of 10' x 12' x 8' high, (3.3m x 3.6m x 2.4m) containing a full length nest ledge at 4' (1.3m) and some perches below. Food is placed through hatches so the birds do not see the provider. Water is also available on the ledge, although this may not be necessary until the birds are fledging.

### Quarantine Aviaries

These, as their name implies, are for quarantining any new birds to the facility and so need to be sited away from the main centre, in Pinjore these are more than 5 km away; a distance we believe to be safe. These enclosures can be much more temporary, but must be predator proof. Those used so far have been 20' x 20' x 14' high (6.0m x 6.0m x 4.2m), see pictures. A double door system is essential, as are the baseline requirements for all the daily needs of the vultures. They should be easily disinfected between each period of isolation (currently 45 days). Disinfectant footbaths must be at the door of the aviaries, along with changing areas for staff if required. The facility should be away from public areas. They should be serviced by separate staff from the CBC. Contamination is avoided by changing clothes and footwear and servicing the quarantine aviaries last in the day. These temporary enclosures would also be useful if a colony aviary needs



to be emptied for maintenance or for a particularly invasive clean or when extensively changing furniture inside, thus needing staff to be working in there for longer than one day. They will also be useful to quarantine birds prior to going to the release sites.

### Colony Aviaries

These aviaries have been designed with the ecology and behaviour of the species in mind. Constant

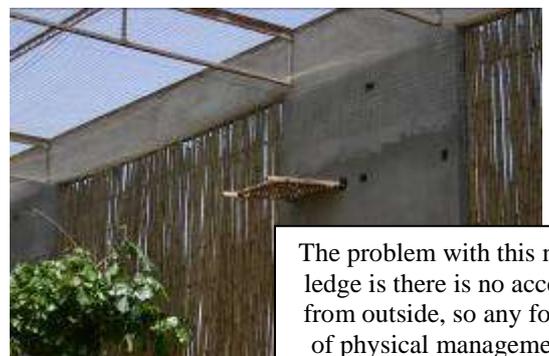


modification as new information is learned is put into practise and they work very well. At Pinjore the aviaries are 100' x 40' x 20' high (30.0m x 12.0m x 6.0m). These internal dimensions appear adequate for keeping 20 pairs of vultures. Aviaries must be long enough to allow vultures to land easily. We have found that the 100' (30.0m) inside measurement is adequate. The birds can achieve flapping flight, gliding and landing in this length. Having enough perches of differing sizes for good foot health is crucial. In addition, enough space on perches and ledges is required for vultures to sit together. There is an access corridor at each end but the birds become accustomed to only one being used. These corridors should not impinge on the aviary length of 100' (30.0m).

Water areas for drinking and bathing work much better if accessible from the outside. We have also found that the more often the baths are refreshed the more the birds utilise them. A feeding area with a hatch that allows feeding without having to enter aviary works well. Multiple feeding doors allow for multiple feeding stations to be used during the breeding season when continuous food availability is required.

Good ventilation is required to allow a through draft. The vultures prefer to utilise sunny areas in the early morning and the evening. Having enough perches in both shade and sun is important. Access should be such that disturbance can be kept to a minimum. Perches above human height allow the birds to get up high and they are less stressed when staff enters the aviary. Lower perches are useful for allowing vultures to move up on to higher perches. Perches should not be right across the aviary and not restricting flying. A double door safety porch system is essential.

Nesting platforms - ledges of both concrete with 3'' (75mm) of sand and of wood with a jute base have been used. Birds have nested on both. There must be more than enough ledges for all pairs so that they have a choice. The platforms must be accessible from the outside via hatches cut through the walls. Aviaries should be predator-proof (see comments under perimeter fence) with, if necessary, strong roofs that are leopard/macaque proof. However any double skin of



The problem with this nest ledge is there is no access from outside, so any form of physical management from outside is very difficult, even though the birds love them!

mesh must not take away from the internal height of the aviary, but should be on the outside. The secondary ceiling is used so the wire roof does not damage the vultures should they fly into it and our recommendation would be a suspended soft Netlon®/nylon net at the top of the aviary wall with the wire at least 18 inches (450mm) above that.

Pest-proofing for rodents may be necessary. Concrete flooring or under-wiring the substrate can be used to prevent this. Any concrete should have adequate drainage and sand must be placed on top to a suitable depth of at least 8 inches (200mm). Stopping access from pigeons is important. Covering the service corridor and roof with builders' debris-netting will stop them coming in and will even stop bees. The floor substrate consists of sand, (replaced annually), so that the aviary is well drained and providing the vultures with a softer surface for landing. Perching must be coarse enough to allow grip and help prevent foot problems. If smooth perching like *Eucalyptus* is used then this can be wrapped in coconut rope or fibre to roughen the perches.

One-way viewing windows are very useful, especially if it is darkened on the staff side of the window (for example from within the service corridor). This allows for vital monitoring. There are roofed areas, providing shelter, at each end of the colony aviary. The best products for roofing are corrugated concrete fibre as these do not produce condensation, have low solar gain and do not overheat the aviaries in sunny weather. Steel is not a good material as it heats up greatly in hot weather.

Low level perching and nesting platforms are required if non-flighted birds are included within breeding colony aviaries.

### Breeding Aviaries

These are smaller versions of the colony aviaries. Having now bred all three species we are tending towards colony rather than individual enclosures. However because of their isolated nesting in the wild, smaller breeding aviaries could be used especially for slender-billed vultures. This is something we are considering but for which we do not have sufficient data to recommend as a preference to the colony aviaries.

These smaller aviaries are designed for keeping one pair of birds only. Longer narrower aviaries may be the best design to give enough space for the birds to move freely. However they afford less opportunity for exercise and so birds may become over-weight. Individual birds may need to be segregated to breed. Their management is a little easier than for the colony aviaries through reduced disturbance, but with a change in management to acclimatize birds to a more invasive husbandry, colony aviary stress should be mitigated.



### Potential Hazards

Over the years there have been, unsurprisingly in a large project, various problems at the centres in India. Flooding has happened three times at one Centre as the river bed has changed during the monsoons. This has been dealt with by the State who have put barriers in the river bed to divert the water. High winds can be a problem, particularly if large trees are nearby. People, predators and wildlife, and in particular elephants, can often cause problems. Substantial fences, including

electrified fencing, have to be an integral part of the centre design. An unlikely and unpredictable event was an attack by wild bees when a swarm in an adjacent tree was disturbed by a wild honey buzzard. Several vultures were badly stung and killed by the disturbed bees. Over time all projects will come up with problems and ways to deal with them. The plan should be to be always open-minded, move quickly, resolve the problems and then publish what they were and how they were dealt with.



#### Other facilities required on each site are:

- A laboratory where haematology and basic screening can be done. (Appropriate training in avian haematology is required). Permission of the CWW is required to move samples between States.
- Sample storage & post-mortem room (10' x 8', 3.30m x 2.40m) containing a freezer and refrigerator, with good water supply and tiled.
- A small hospital room - just 12' x14' (3.6m x 4.20m) would be sufficient. It should be easily cleanable and contain the basics such as a treatment table with a, strong light above and a store for syringes, needles, swabs, antibiotics, fluids and other basic emergency veterinary equipment.
- A critical care room with a couple of large critical care boxes in which to place sick birds that need constant treatment and monitoring. Pinjore has one of these that works very well. Radiography facilities should be available as close by as possible if not on site.
- Incubation room - this could be a central facility to which eggs are moved from a number of centres, if they are not too far apart. However, on our project each centre will require its own facility. This has to be very much a "limited access facility". The room should be windowless and able to be blacked-out. It should be dust free and as clean and sterile as possible. A good, consistent electrical supply is absolutely crucial, along with air-conditioning in hot countries in order to keep the room temperature stable. Access should not ideally be directly from the outside.
- Brooder room - a facility at which to hold very young birds for the first week or two prior to being moved to nursery aviaries adjacent to vultures. This needs to be light and airy.
- Display Aviaries/Education Centre for Centres that might have visitors - not all require this. However these become a little more important at release stages where education is crucial and where there is outside pressure for the general populace to see and understand what is going on.
- Food storage (freezer) /preparation room
- Live-food holding area away from the Centre for holding goats etc.
- Water storage
- Store room

- Holding Aviaries
- (Release pens)
- Security guardroom/watch room
- Generator
- Toilets
- Staff room
- Incinerator/waste disposal
- Vehicles
- Information Technology
- CCTV is an essential for monitoring colony, breeding and nursery aviaries. It has proved its worth in Pinjore time and time again. Cameras should be weather and vulture proofed. The screens can be viewed from within the office or, if required additionally, a display area
- Staff resources & training

### **Maintenance**

For vultures to breed successfully in captivity a certain amount of privacy needs to be factored in. Cleaning enclosures on a daily basis can cause disturbance and is unnecessary. It will stop birds from feeling they have their own territory, which can lead to breeding failure. On the other hand if enclosures are not entered at least twice a week management of breeding becomes much more difficult. In addition, enclosures do need to be kept reasonably clean, particularly in hot climates. If the enclosure is well designed with perching facing well away from walls, vultures are reasonably easy to keep clean. A rake of the substrate of the enclosure once a week should suffice to keep the enclosure reasonably clean and the birds from feeling invaded. This also gives the chance to monitor birds from the inside to watch for problems. If the birds are acclimatised to this process they should not be worried even though egg-laying commences. This is really important as the more the birds are used to human presence the easier managing eggs and young becomes.

Each enclosure should be completely cleaned out once a year. This needs to occur at least six to eight weeks before the start of the breeding season. Preparation is the key to this procedure. If all the birds are to be caught up then all holding boxes need to be clean, have carpet in the base and be placed ready for the birds in a cool shaded area. New perches should be prepared and ready, as should all the tools needed, the cleaning equipment, plus disinfectant, paint and so on. If blood samples are going to be taken then a good experienced team of people need to be ready with all the equipment needed (syringes, needles, swabs, blood tubes, paperwork and so on). For personnel, a team of catchers - probably two people, two people to hold birds and a spare person for problems, then two teams each consisting of a trained technician for taking the blood, one person to help with holding the bird for taking blood, a recording person to mark the blood pots, with a second person recording the check over of the bird will all be needed. The birds should be caught up to allow for a physical check over. It is rare in vultures for beaks and talons to need to be trimmed but they should be checked, birds may be wormed, blood tested on occasion and generally checked over for condition.

All checks and taking of blood should be done as quickly as possible and as early in the day as possible to avoid the heat. To catch up 50 birds, check them and take blood at seven minutes per bird would take nearly six hours. Then the aviary has to be cleaned. A very early start is needed to get the birds back into the aviary before dark. Once they have been checked over they should then be placed in a dark box lined on the floor with old carpet or some non-slip material. The boxes need to be left somewhere secure, quiet and cool, out of the sun, while their enclosure is cleaned, disinfected and generally checked over. This is the time to clean nest ledges, rebuild nests and get ready for the coming breeding season. If time is a problem, get the nest ledges, nests and perches done as the floor area can be more easily done with the birds in the enclosure.

Should the manager feel that this major clean can be done without catching up the birds, that is acceptable, HOWEVER it is vital to physically check a percentage of the birds each year, which will mean a once yearly catch up for some birds each year.

Cleaning should consist of each nest ledge being cleared and cleaned completely, all walls, nest areas and baths should be scrubbed with a good disinfectant. (We recommend F10®). Walls could also be repainted with a water-based paint once they are dry. Sand should be raked clean and then sprayed. Fresh sand can be added, if necessary, and the nest ledges re-sanded and a new nest built on each one. It's a massive job requiring a good team of hard working people.

Once the enclosure is cleaned and ready, the occupants can be returned. They should not spend more than 12 hours in the box. However it is rare that an enclosure will take more than a day to clean if there are enough people. Should enclosures need major refurbishing, birds can be placed in a safe holding enclosure, for example empty quarantine aviaries, until the work is complete.

At existing centres the left over carcasses are removed every 15 days. The aviaries are also spot cleaned at the same time to remove faeces from under perches etc. We are revising this and consider that carcasses should be removed every week during the cleaning process. The geographical location of the CBC may well affect the regularity of cleaning regimes, especially in wetter areas.

Smaller aviaries are cleaned more regularly and rearing areas must be maintained much more hygienically and with very regular cleaning.

## Feeding

Vultures are carnivorous obligate scavengers. Generally they are not fussy feeders; happy on a diet of dead meat. However a single food source is not good for any creature, nor is it advisable to feed such if possible. A wider variety of food leads to a better balanced diet, more interest for the birds and causes less reliance on one food type, thus avoiding problems should a food type become unavailable. The MOST CRUCIAL ASPECT OF FOOD for vultures in South Asia is to make sure that it is SAFE AND CLEAR OF ANY CHEMICAL CONTAMINATION. As we know that NSAIDs have caused the dramatic decline of the wild vultures, and may be affecting other species as well. It is therefore ABSOLUTELY VITAL to know the exact history of the carcass animals that are being utilised for the vultures. This cannot be stressed enough. If one animal that has been treated with diclofenac, or other potentially lethal drugs is fed to the vultures, the whole aviary full of birds could be killed. Also be aware that carcasses must not be fed if they are likely to contain lead shot. This scenario is highly unlikely in India, but could happen in other countries.

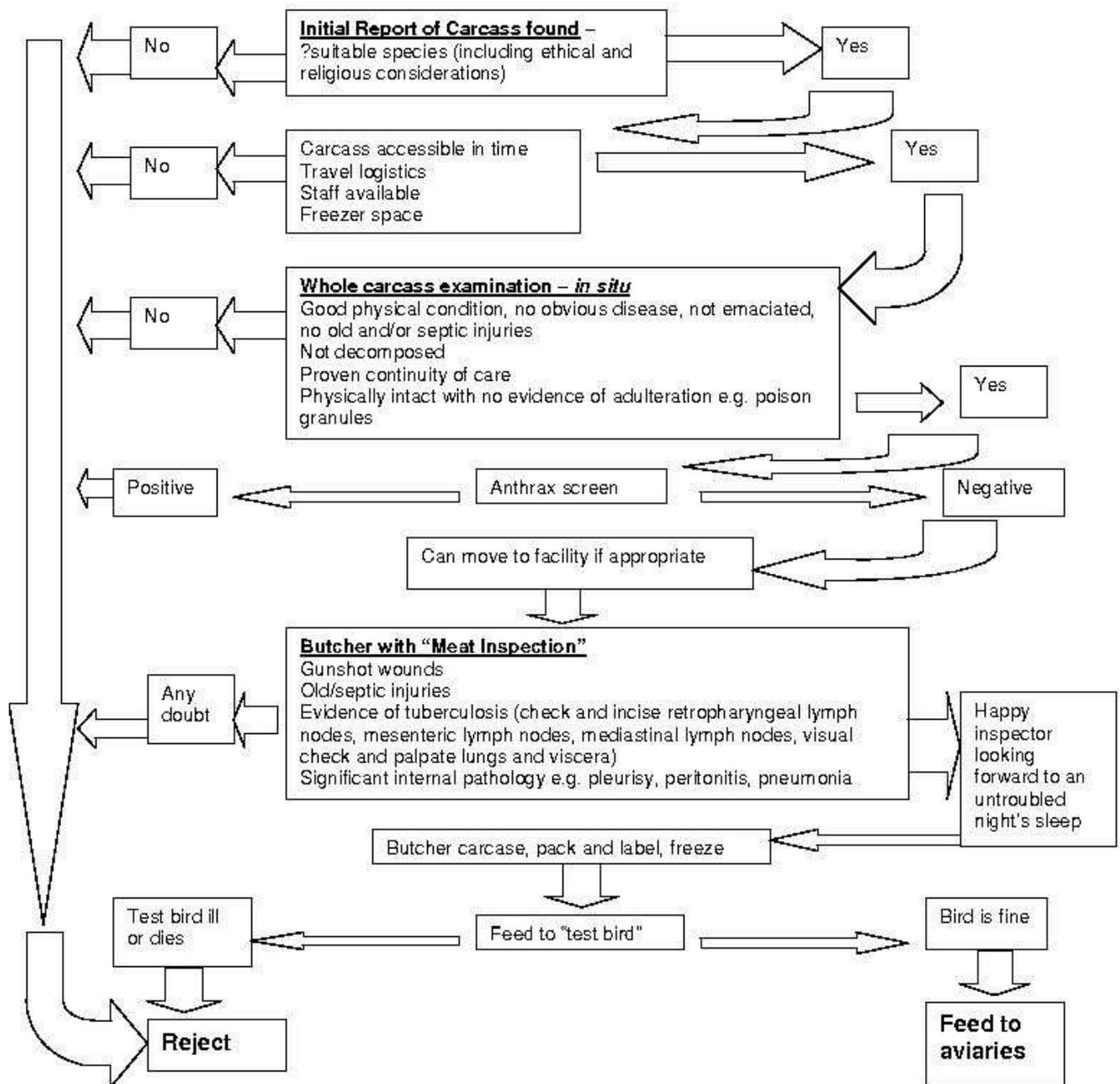
Potential solutions for safe food have initially focused on goats due to:

- a) the fact that they are less frequently treated with diclofenac than cattle, and
- b) if treated, the diclofenac passes through the animal more swiftly.

Unfortunately, goat meat tends to be one of the most expensive options. Other options that could be considered are rats which could be bred specifically for the project, either on site or at a designated site close by, rabbits could also be considered, this has to take into consideration local religious concerns so people would not be offended by food being reared for the birds, if rabbits are acceptable for human consumption at a later date after the project, this would make for a useful addition in the future. Under no circumstances should chicken or other avians be fed as they can too easily transmit disease to the vultures. We have looked into wild ungulates and other large wild animals that have been killed by vehicles or trains. These are, at this time, generally buried or destroyed by the Forest authorities in India, but would make an excellent natural food source, and it

is a good use of the animals that have been killed, with the added bonus of there being no chance of any drugs or NSAIDs being within the body. A system involving health checks of any dead wild animals must be put into place, taking human health hazards as a very serious concern. A walk in freezer is a very useful addition to any project such as this as food can be stored and saved when available and used at need.

### Flow chart for utilisation of wild-meat



## Feeding at the existing Centres

Vultures require approximately 5% of their body weight per day, normally ingested irregularly. Goats are used at Pinjore (although goats are an expensive source of meat). They are kept for 15 days to ensure that they are diclofenac-free before slaughtering. Vultures do not normally consume the skin and so the carcasses are skinned prior to feeding. The intestines are removed but the organs are fed intact. Non skinned-carcasses would give the opportunity for the birds to produce natural castings. Large bone fragments can be dangerous, so the bones are broken up into smaller fragments which are eaten. It may be important to consider feeding carcasses with the skin on in order to limit ingestion of sand/gravel from the aviary floor and in order for vultures to be familiar with feeding on whole carcasses. Other food items could be considered for both cost and variety. (Only mammals should be used as bird meat would pose an unacceptable disease risk). Remote weighing of birds could be very effective for monitoring the weights of birds (a number of simple devices are available for recording the weights of birds on perches or platforms) but have yet to be tried.

Food is weighed before feeding and again weighed when removed to calculate the consumption. Total amount of food is doubled during the breeding season, after allowing for the wastage. Also when young are present then food must always be present and so starve days should not be included. Calcium supplementation should be given all year through the provision of substantial quantities of chipped bone.

**It is very difficult and indeed very unwise to give an exact required measurement of food, because this is too rigid a regime.** The weather, the individual bird requirements, temperature and many other factors mean that birds require differing amounts individually and at different times of the year. The general rule of thumb is to feed *ad lib*. If all food is consumed very quickly increase the amount. If food is left then decrease it, but not permanently, then increase gently until birds are leaving food again and bring the amount just below that level. Always watch the behaviour of the birds at feeding time. That should tell you if not enough, enough or too much is being given. To mimic wild conditions and to ensure positive feeding behaviour, a regular fasting day (e.g. one or two days per week) is recommended for all of the year. This also allows for the transit of food through the crop, which can take more than 24 hours. The exception is when birds are rearing young. When birds have young and during the egg-laying period we recommend feeding every day.

Some birds are natural bullies and will drive less aggressive birds from food. Thus enough food is required to allow the less aggressive birds to get to food after stronger birds have had sufficient.

In the run up to the breeding season food needs to be increased to get the females in fat enough condition to produce and lay eggs and withstand the weight loss they usually suffer during incubation.

### Supplementary additives

There are a number of multi-vitamin supplements available on the market today. Some are made specifically for birds, with others even more specialised for birds of prey. All should be used according to the manufacturer's instructions. Only one supplement should be used at a time in line with the advice of a good and experienced veterinary surgeon. Calcium supplements such as Nutrobal® (Vetark, UK) for egg-laying birds can be useful. Calcium phosphate is not always a good calcium supplement for birds of prey as it can cause an imbalance in the bird. Vitamins can have a short shelf life and should be kept according to the manufacturer's recommendations and used within date.

## Special Dietary Requirements

Young birds of prey require the same food type as adult birds, but far more of it. During the breeding season plentiful supplies of food should be available to the rearing pairs, particularly after the first week when the young birds start to grow quickly. As discussed before, the best rule of thumb is that if all the food has gone, give more but if some is left after dark, feed slightly less. Care should be taken the food is being taken by the vultures and not by pest species such as rats. The only down side to *ad lib* feeding is that it can cause parent birds to only feed the choicest meat, rather than the whole food item and this can lead to calcium deficiency. This is where the bone scraps are vitally important.

Sick birds should immediately be removed from enclosures and taken to specially-designed sick quarters and fed accordingly. Always go with a gut feeling if you are concerned that a bird is 'not right' and catch it up and check it over. By the time vultures show serious signs of not being well, it could be too late! A very good food supplement diet for sick birds needing force-feeding and unable to hold down solid food is a proprietary food made for recuperating cats called Hills A/d Diet®. With care and experience this can be given with a crop tube and will keep sick birds going for some time until they are able to return to a solid diet. Usually 20-30 ml/kg bodyweight is given every two hours until the bird shows signs of returning strength and appetite. Such proprietary or liquid foods can be stored un-refrigerated until opened, but must be kept refrigerated once open, and used within 48 hours.

**Sick birds should always be seen by an experienced veterinary surgeon as soon as possible.**

## Breeding

Prior to the breeding season the nest ledges will have been cleaned and some nests ready-built. In the run up to nesting sticks and other nesting material should be added very regularly to the aviaries. Once birds start to nest build they will use a surprisingly large amount of materials.

If nest building is observed, adding of small amounts of new nest material, fresh greenery, and dry grass towards the end of nest building may help to encourage interest. The material should be placed in the enclosure on the floor with the minimum of disturbance.

In most records on breeding behaviour of *Gyps* vultures researchers state that there is little noticeable change in their behaviour prior to breeding. They sit together, there may be mutual preening and they may shadow fly together - one vulture mirroring the flight of its mate, (beautiful to watch).

The usual food-passing, calling and display of many of the raptors appears to be absent in vultures. However nest-building, mutual preening and, hopefully, copulation should all be watched for and noted. Most *Gyps* vultures generally make a low creaking/grating/hissing type noise during copulation, which can last between 15 and 30 seconds. At Pinjore they have learnt that copulation is in fact quite noisy, so by listening carefully they can tell if birds are mating in a certain aviary. Without doubt having CCTV cameras in enclosures means that birds can be watched and behaviour monitored, so that breeding behaviour can be observed early on. Mating can take place several times per day prior to the female laying an egg.

Increased monitoring is required prior to and during the breeding season, especially during the morning and evening. Building nests for the vultures can help to stimulate breeding activity. A

variety of materials should be offered but woods that splinter easily should be avoided. (*Pinus roxburghi*) is often used in the wild). The vultures add green plant material to nests so this should be offered regularly during the breeding season. Nest sites should offer variety including both ledges and platforms. A variety of sites should be available with more than enough opportunities for each pair to nest. All nesting sites should be accessible from the outside of the aviary.

During the first/second breeding season it was decided that colonies/pairs should be allowed to breed undisturbed/un-manipulated. This proved successful. After this point manipulation of the productivity was carried out, but for first time project managers we would always suggest that the first couple of breeding seasons you leave it to the birds.

Once a interventionist/manipulation policy is instigated eggs can be candled to determine fertility of eggs. This should happen between 10 - 14 days after laying to determine fertility and development. *A strategy needs to be decided upon and agreed by all for egg manipulation and management.* Training in incubation is a requirement prior to attempting artificial incubation. Eggs going beyond the due hatching date should be left for about 15 days after the due hatch date before removing from the nest. These should then be investigated to establish fertility or cause of death. Female vultures may assist the hatching of the chick. If eggs are left unattended by parents for periods of more than a few hours then consideration should be given to removal of the egg for incubation and the placing of an artificial dummy egg in the nest.

When young hatch they may not begin feeding immediately. It may take up to two days for chicks to start feeding. After that point interference should be considered. Nest surfaces are important for providing grip in order to prevent splaying of the legs. Chicks that appear to have been abandoned by the parents should be removed for artificial rearing. A decision-making process needs to be established in advance of these problems occurring. Once chicks have fledged they should be left in with the parents until the start of the next breeding season, at which time juveniles can be removed if necessary. However we would advise that juveniles are kept with adult birds to help them to mentally mature and learn acceptable vulture behaviour.

### **Artificial Insemination**

For this project and any project working with single egg layers **DON'T CONSIDER IT!!!**

Artificial insemination is almost impossible to use on species that lay a single egg, as the laying of the first egg is normally used to initiate AI. We consider that to imprint birds specifically at this stage would be morally wrong and although forced semen collection can be initiated, it has serious welfare concerns for the birds involved unless handlers are very experienced. As females cannot be forced to come into breeding condition to accept the semen, this makes the exercise utterly pointless. At this stage of the programme as we are starting to be successful, it is deemed totally unnecessary and unacceptable for breeding management.

### **Eggs**

Following a period of mating, which can be anywhere from one week to one month, *Gyps* vultures lay one large, off-white egg. They usually start sitting as soon as the egg is laid, although it is noticeable that many birds do not sit consistently at first. This does not appear to affect the viability of the egg.

One problem to be watched for is egg lethargy in the females. Often females can look sick or ill just prior to laying eggs. This can lead to difficulties as on occasion the female is actually ill rather than in egg lethargy. Care should be taken at this time to ensure that egg laying females are not suffering from infection or egg binding. If females are sitting for an unusual period on the ground, rather than perched or on the nest area, catching up and checking them should be a matter of course. Handling of females

that might be due to lay imminently or are suffering from being egg bound should be undertaken with extreme care. Sudden bouts of cold weather can cause egg binding, particularly in enclosures facing into chill winds.

Bird staff should start to monitor nest sites some time before egg laying occurs. This means climbing up to check the site and will eventually habituate birds to bird staff being near to the nest site (and should also give the date of first lay).

### **Incubation**

Incubation - special disinfectants may need to be used for incubators. F10 is a standard used widely. Artificial incubation is potentially useful for a number of reasons; double clutching to increase productivity, rescue for eggs that are deserted, having chicks to give to infertile pairs. Contact incubation is most effective for starting fresh eggs, which may then be transferred to forced air incubators of differing humidity to maintain weight loss.

### **Natural incubation, egg manipulation**

In normal circumstances, established, experienced pairs of birds are perfectly capable of incubating, hatching and rearing without assistance. However young or inexperienced pairs may need some assistance in the first few seasons. With endangered species it is sometimes useful to help inexperienced parents as many things can go wrong and when trying to produce high numbers of birds for conservation programmes, egg and young manipulation may become important and desirable.

Some birds are naturally clumsy with eggs. If a pair shows signs of breaking eggs examine the nest area carefully. If a second clutch is not required a dummy egg can be substituted for the parent birds to continue incubating. Turned wooden eggs make excellent dummy eggs. Better still, if guaranteed safe health-wise, infertile goose eggs will work very well. However, if it is required for the pair to replace the removed egg by recycling, then they should be left with nothing to sit on. All shards of any broken egg should be removed.

If the plan is to allow the birds to achieve a whole breeding cycle unaided, eggs from pairs of birds that have not been known to produce fertile eggs should at least be checked for fertility after the first ten days of incubation.

### **Egg retrieval, candling, egg returning**

Disposable thin rubber gloves should be worn for handling eggs to avoid contamination. Vultures are not normally aggressive by the nest and the incubating bird will probably just fly off. The staff member should carefully remove the egg into a softly-lined, secure and clean container, making sure that the egg is secure. If the eggs are only going to be candled rather than removed, but it is going to take more than a few minutes, a dummy egg can be left in the nest. If not, then returning the egg quickly will be sufficient.

Returning eggs should be done in the same manner with two people, one to concentrate on the birds and one to manage the egg. It is not advisable to remove eggs at night as birds may not return to incubate. Once the egg has been returned the enclosure should be left well alone to give the birds time to settle. This process is best achieved with the absence of people and well before dark.

Most good commercial egg-candlers will give out enough light to candle all but the densest of raptor eggs. Bird staff should gain experience in candling eggs by learning on chicken eggs before testing the eggs of endangered species. Gentle handling of eggs is the key as rough handling can cause internal

damage to the attached embryo. At all times whilst eggs are being handled sterile conditions must be ensured.

If the egg is fertile and the pair is to be allowed to hatch it naturally then the egg should be returned to the pair as soon as possible in the manner described above. If the egg is clear, (i.e. infertile), then it is best to try and recycle the birds, thus giving a second chance in the same breeding season. Should a dummy egg have been placed with the female during egg candling this will have to be removed, leaving the birds with no egg which should, in most cases, stimulate second attempts at breeding.

Not all birds will recycle but this has been achieved in Pinjore. There have been pairs that have recycled, leading to a fertile egg and subsequent young. Usually the recycling takes about a month, sometimes even longer. Some birds may not recycle, but if the first egg was infertile, nothing is lost in terms of fertility.

If recycling is required the egg should not be left with the parents for much longer than 14 days before removing or candling. Once the bird is further into incubation recycling becomes less likely.

If an egg is found to be fertile but the pair of birds has never reared, it may be advisable to artificially incubate the egg or use tested foster parents. If artificially incubated the young bird can be hand-reared for a few days before returning to the parents. A slightly older, stronger and more experienced, chick is easier for the inexperienced parent bird to manage.

Breeding birds must be left a dummy egg if young are to be returned. Birds will not accept young if they have not been sitting on an egg of some description.

If double clutching is to be used as a strategy to produce more young of endangered species it is useful to have spare pairs of birds to act as foster parents.

During natural incubation nests should be monitored daily by CCTV to check the incubating birds are well and that the egg is not broken. A moment of listening may tell the bird staff when the young has hatched as they can sometimes be heard calling. It may be necessary to have two people approach the nest site and leave one silently there while the other retreats again. This may give the chance to see the egg, but some birds are very loathe to leave the nest. Checking at feeding times may help.

As all pairs of birds are different common sense should be used to access each pair and decide on the best course of breeding management.

Without a doubt, raptor eggs have a higher percentage hatch if the eggs have had some natural incubation for the first week to ten days. This does not have to be by the parent bird. If absolutely necessary, well-managed (health-assured) broody hens will successfully incubate eggs. The hens must be kept in clean, dry conditions well away from the vultures and be used to being handled prior to and during incubation. Recently, the use of the new Contact incubator by Brinsea appears to be better at incubating fresh eggs.

## **Candling**

Whether an egg is fertile or not can be seen by candling. Commercial egg-candlers can be used to candle vulture eggs but be careful not to hold eggs over the light source for too long as the heat might damage the embryo. If fertile, the development and growth of the embryo inside can be monitored. Gentle handling of eggs is vital as rough handling can cause internal damage to the embryo. Hands must be clean and disinfected. It is recommended that keepers gain experience by candling chicken eggs before handling those of endangered species. Photographs showing embryo development can be seen in Anderson Brown (1979).

## Egg storage

Fresh eggs that have received no incubation can be stored for short periods. However unless absolutely necessary this practice is not advised. Egg hatchability will decline after a few days. It is recommended that raptor eggs be stored only if proper storage conditions are available and then for no longer than five days. Eggs should be kept in a dry, stable room. Commercial chicken eggs are stored at 60F (15C) at a relative humidity of 75 - 80%. The Peregrine Fund have had good success storing eggs for short periods, with their large end uppermost and turning them through 90 degrees at least twice daily on a horizontal axis.

Following is the updated Incubation Protocols worked out and written by the incubation team on the India Project.

## Incubation protocols for the India Vulture Conservation Breeding Project 2011

*Please bear in mind that this is a **DRAFT** protocol, however, this is a living document subject to change, additions and alterations as new information and experience is gained over the years. Incubation temperatures, humidity, turning and handling of eggs will be subject to change as our procedures are refined down with experience. Not all eggs will behave in the same way. Regular contact with ICBP and its incubation staff is important in the early years, with full information on the eggs such as fresh egg weights where possible, date of first incubation, weight loss and so on. Regular contact does not mean once a month, it means that during incubation contact must be made every three days, or more if there are problems. In artificial procedures with captive breeding nothing is set in stone, there will always be variables, so it is important for all concerned to be open-minded.*

## Incubator Room

All people responsible for incubation should enter the room only after sanitising their hands with soap and water for at least 20 seconds, and dry your hands thoroughly with paper towels. It has been found that good hand washing is as good if not better than many hand sanitizers. If using an alcohol sanitizer, the sanitizer should be allowed to evaporate before touching the eggs.

Wearing of apron and slippers dedicated to use in the incubator room should be observed, these should be kept outside the incubator room.

Always sanitize hands with a good hand wash and always make sure your hands are completely dry before handling eggs or any of the equipment in the incubator room. Once hands are washed, avoid touching things that commonly carry germs, such as tap handles, door knobs, light switches and the like. Use a paper towel as a contact barrier if necessary.

Just before the beginning of each season, disinfect the incubation room from ceiling to floor and all incubators inside and out, plus their parts thoroughly, being very careful not to get water on any electrical parts, before switching them on. This can be done with F10® disinfectant. Don't forget to dilute to the recommended dilution on the containers.

Regular monitoring of the incubator room as well as the incubators, for a stable temperature and humidity is crucial. Checking every hour should be more than sufficient to do this. Even more **crucial** the electricity supply must be made as safe as possible in terms of power cuts and power surges.

The temperature of the incubator room should be maintained between 19-22°C. If the temperature falls below 18.5°C, the air-conditioner in heating mode should be put on and be kept running till the temperature stabilises at 19-22°C. The air conditioner could be switched off thereafter.

Humidity in the incubator room should be maintained as low as possible, no more than 50-55% RH. If the humidity rises above 55%, switch on the exhaust fan till the humidity level falls to 50%. It could be switched off thereafter.

### **Egg collection**

Once sufficient experience by the vulture team has been gained and the decision to manage the breeding with artificial incubation has been taken, we anticipate that all first clutch eggs of the three species will usually be collected. The second clutch may be reared by the adults on the nest.

Any eggs that are laid should have ideally 10-14 days of natural incubation unless laid on the floor or parent birds have a history of breaking eggs or inconsistent incubation. This will mean that all collection dates will be open but no one egg should have more than 14 days of natural incubation. *(Leaving eggs for 21 days is likely to reduce the chance of a second clutch being laid. 12-14 days of parental incubation should be sufficient to assure optimum hatchability and establish an appropriate egg weight loss trend. SK)*

If, after all the first clutches have been collected, a bird recycles with her second clutch on the ground (and only if there is not enough room in the incubators and if the said female is not incubating properly), this egg should be removed, marked properly and if possible placed under a female who has been sitting for at least a week on her second clutch. This should only be done if there is no room in the incubators. No egg should be placed under a female who has not yet laid and been sitting properly. A dummy egg should be placed under any female whose second clutch has been removed for whatever reason as she could, at some point, have the chance to rear.

The egg must be removed before hatching and when there is enough space in the incubators, the surrogate parent must not be allowed to hatch both eggs. Putting more than one chick in with single egg layers such as California condors has been found not to work. Parent birds preferentially feed only one chick and chicks may exhibit siblicide.

Eggs can be moved between incubators if:

- a. an egg is losing too much weight,
- b. an egg is not losing enough weight,
- c. an egg has been cracked and repaired or is otherwise compromised,
- d. if there is a problem with a particular incubator.

Eggs of all three species may, if required, be incubated together in a common incubator as long as they are well marked and identifiable. Eggs with dirt on the shell should be incubated separately IF possible avoiding physical contact with other eggs.

Egg collection should be completed as quickly and efficiently as possible; minimising jarring or getting an egg wet or dirty.

The collector should always properly wash and dry his or her hands before collecting eggs.

The collector should carry a blunt pencil with a soft lead (a natural make non-toxic pencil is fine), with him or her and number the egg, according to the nest site, before removing it from the nest.

The egg should be collected, handled, carried and kept in the incubator in the same position as it was found in the nest and handled with the greatest care. Joggling or jarring eggs is extremely detrimental to their health.

After collection the egg should be placed in a clean, dry and disinfected container with a padding of cotton wool or millet inside to prevent egg from rolling. Dry rice is also an acceptable item to use to transport eggs from enclosure to incubator.

### **Egg examination and Candling**

**Always remember that particularly with thick shelled eggs like vultures candling does not always tell you if an egg is fertile or not.**

After collecting any egg from the nest it may, if very dirty, be rubbed with a dry clean Scotch-bright® scrubber or paper towel very lightly to remove the loose dirt. Cleaning with F10 or any wet material must not be done. Care must be taken to avoid damaging the cuticle layer of the egg. Wet faeces, urates or blood should be allowed to dry rather than wiped off to avoid pressing it into the pores of the egg.

Each egg should be put into an incubator for at least one hour after removing to ensure it is warm. It may be candled any time after that, i.e. once it is warm and settled. However, if there are any suspect eggs or ones that might have damage they should be placed into an incubator on their own so that, during the warm up period, there is no risk to other eggs.

a. Candle the egg to check for any damage such as cracks, dents or holes. If there are, these will need to be sealed with non-toxic white glue. A cracked egg can be repaired by using Fevicol® (white glue). An egg with a large break or dent may also need to be patched with white tissue paper or white paper towel and glued to prevent further damage. Use only enough glue to seal breaks in the shell as excess glue will interfere with weight loss and respiration. Eggs that are leaking albumen or blood may be repaired but those leaking yolk cannot be saved. Repaired eggs must be placed on paper towels in a container in the incubator until the glue is completely dry. Once the glue is thoroughly dry the egg may be placed in the incubator's turning tray.

b. Check whether the egg shows signs of development or whether it is obviously clear (infertile). For anticipated incubation periods of 52 -57 days signs of development should be evident by 9 - 14 days. Never remove a clear egg, i.e. one with no signs of development, before it has had at least 14 days of incubation in the incubator. It is no bad thing to put potentially infertile eggs into a separate incubator for longer just to be absolutely sure.

Smelling the egg is one way of telling if it is going bad. If there is an obvious bad smell put the egg in a separate incubator away from others until you are sure it really is bad. If an egg starts to ooze, usually an amber colour fluid, remove it completely from the incubation room and open it outside, preferable in the open air. It is advisable to cover it with a towel before opening as they can be somewhat explosive! After bad smelling eggs are removed from an incubator, the machine should be thoroughly disinfected, away from the incubation room, prior to future use.

Candling must be done with extreme caution. The egg-candler can be very hot and exposing eggs to overheating is detrimental to their viability. Eggs should be exposed to the heat for the minimum length of time, no more than 3 seconds continuously, and should be moved very carefully as they are turned. Rough or quick turning while candling can damage or kill the embryo. Care should be taken to make sure that the eggs are not turned round and round while candling. 180 degrees is usually all that is necessary (unless looking for cracks and dents as you will want to look at all sides of the egg).

After candling for each three second interval use the palm of hand to help dissipate heat from egg as the hands are cooler than the candler light.

During candling, if an egg is not looking as it should be place it in one of the separate incubators that are running particularly for suspect eggs. Never remove an egg from incubation until you are 100% sure it is not alive - you might be wrong! Once the decision has been made to remove an egg from all incubation open it as soon as possible for egg necropsy.

Egg candling may be done daily or at a minimum twice per week, always taking care that egg does not get too hot from candling or get cooled while out of the incubator. However candling should be done at a minimum interval of 3-4 days (remembering to disinfect the aperture of the candler after each candling session or after every dirty egg). Eggs may be candled more frequently if there are specific concerns, to keep an eye on weight loss and once the hatching process has started in order to monitor progress.

To keep a check on weight loss eggs need to be weighed daily, at the same time each day.

The eggs should be turned manually through 180 degrees, each time in the opposite direction following the marks on the side of the eggs, three times a day. With discussion we are suggesting that the eggs are rotated whilst on their sides, as parents would do, rather than end over end.

For weighing the egg should always be placed horizontally (on its side) and not vertically i.e. not with the rounded end on top and pointed end at the bottom, on to the black ring (remembering to disinfect the ring at the end of each weighing session or after every dirty egg). The first weight, i.e. the weight when the egg is brought into the incubator room for incubation (taken after at least one hour of being warmed up in an incubator), is very important. Eggs take several days to stabilise, so the first few weight readings may not give you enough information to know which way the weight loss is going. Therefore begin adjusting humidity to correct egg weight loss trend only after four days - assuming that you are weighing every day. Start to plan your action from the third weight onwards.

Before placing the egg in the incubator, mark the eggs with a blunt pencil only. Eggs should be marked on two sides, i.e. opposite sides. (All four sides of the egg could be marked for convenience, but this will only be necessary if using the Contac incubator.) A decision needs to be made to regularise what is to be marked on eggs, identification number/ lay date/turning arrows are all options.

While turning the eggs manually in all the incubators, the eggs should be turned from side to side, i.e. around the long axis of the egg, in fact the natural way the bird would do it and not end to end. **ALWAYS turn eggs very slowly and carefully**

Eggs should be turned at a fixed time every day. A tentative time schedule of 07:30, 13:30 and 17:00 hrs. would be ideal.

In case one of the birds lays her first egg on the ground, remove it immediately. Feel it on your cheek. If it is cold it may not yet have been incubated. If you are 110% sure that the egg has had absolutely no incubation whatsoever, then bring it in the incubator room, leave it on a black ring on the marble top for 8 hours, this will bring it up to room temperature slowly. Then place it in an incubator running at 36.7 or 36.9 degrees C (98.0 or 98.5 degrees F).

However, if there is a chance that the egg has been incubated and has got cold for some reason, then place into an incubator straight away. If it appears warm on the cheek put it in an incubator straight away at the normal incubation temperature.

Have the incubator room and all incubators cleaned and disinfected and at least two incubators switched on and running well from two weeks prior to the expected laying date of the first egg in your project (in Haryana - this is November 1<sup>st</sup>). The incubators need to be running and settled before any anticipated eggs. Egg laying dates may get earlier over the years, so factor this into your incubator room plans.

An Octagon can hold a maximum of 4 eggs at a time. This would mean 6 incubators set aside for incubation only. Ideally, one or two incubators should be kept running to accommodate any unexpected eggs laid, or for any suspect eggs or such emergencies. Another incubator should be run wet which can accommodate eggs which are losing too much weight and another incubator which can work as a hatcher. That gives an optimum working total of nine Octagon Incubators at the time of writing

### Incubator settings

All incubators should run on an independent UPS (Un-interrupted power supply) for each incubator. This is crucial, and must be tested and working properly well before any eggs are expected.

To ensure that temperature displayed by the LED's in the incubators as well all other thermometers are the same have a mercury thermometer also placed inside the incubator with the mercury facing the centre of the incubator. Mercury almost never lies. However mercury thermometers need to be recalibrated by comparing to ASTM (certified) thermometers every year. If the mercury has separated in the thermometer, it may be re-joined by placing in the freezer. Never place a thermometer under hot water for there is a good chance of breaking it. If the mercury has not re-joined after being in the freezer do not use it anymore.

Initially, a vulture egg should be put into a totally dry incubator i.e. 28-30% RH. If eggs are losing too much weight they will need to be moved to an incubator running at a higher %RH to reduce the weight loss. (This may well change with experience over time, be prepared for change if the situation requires it.) *(Humidity under parents in the nest is not necessarily the same as ambient humidity in the area. The combination of bird, egg and substrate creates a microclimate in the nest. SK)*

At this time we are using only the Octagon incubators and the temperature of these incubators for incubating known vulture species eggs should normally be set at 36.7°C or 36.9°C (98.0°F or 98.5°F) on the mercury thermometer.

However it may be advisable to start to vary the temperature in different incubators from between 36.4C - 36.9C (97.5 - 98.5F), and monitoring the progress of the eggs and the quality of the hatch to define the optimum temperature for these three species of vultures. If variations exceed these limits, the incubator thermostat may be malfunctioning and eggs should be moved to a different incubator until the problem is identified and corrected.

When we start to utilise the Contac Incubators, (summer 2012 trials will begin) we are going to need to work on differing temperatures as it is a different concept of incubator.

Incubation temperatures may well be adjusted over time with experience in these three new and important species - be open minded about it and work with the weight loss as a good indicator and the viability of the chick once hatched. Never forget that the first three to four years will be a learning curve - to be learnt from!

Each egg should be kept at the same temperature, either 36.7 or 36.9, throughout incubation, until transfer to the hatcher. Temperature for any individual egg should not be changed during incubation.

When we use the Contaq Incubator turning should be set at alternate setting and the turn angle maximum and turn angle minimum are set at equal limits of approx. 12 - 15 seconds.

Besides the alternate turning in the Contaq **as well as Octagon** incubators, vulture eggs should be turned manually three times a day around the long axis (not end over end).

The display unit in the Contaq Z6 should always be read at least half an hour after the turning of eggs (or the lid of the machine being opened) has happened as this means that the incubator has time to settle after its last turn.

In order to go back on a setting in a Contaq incubator, press 2 and the settings take a step backward.

Outsides of all incubators & hatchers should be disinfected weekly. *(It is not a good idea to use disinfectants inside incubators during incubation. Thorough disinfection of incubators prior to incubation and after a dead egg has been removed, along with a strict sanitation protocol for the incubation facility is sufficient. SK)*

Any water used in the incubators or hatchers to increase humidity should be filtered water and can be a very weak solution of F10 (1.5ml of F10:1Litre of filtered water) included. Once all the incubators have external humidity modules the water should be changed daily.

Always place eggs in even numbers in an Octagon for balance. Every time you add an egg to the Octagon, the temperature may require adjusting. *(An egg that is not warm will take a few hours to come up to incubation temperature and may cause the temperature inside to be lower temporarily, particularly in a small incubator such as the Octagon. The temperature should not be adjusted until the incubator has had time to recover temperature. SK)*

Move eggs to hatcher when the embryo has internally pipped or the embryo can be heard vocalizing, which will be approximately 3-5 days before expected hatch date. Hatcher settings should be 36.4-36.7°C (97.5-98.0°F) (0.5°C or 1.0°F lower than the incubator temperature), with higher humidity (70% or higher) once eggs are externally pipped except for eggs that have too low % egg weight loss. All is subject to tweaking.

### **Weight loss and manipulation in eggs**

Raptor eggs have been hatched in incubators at varying temperatures, but the most used and seemingly most successful is 99.5F or 37.5C with between 30 and 35% relative humidity. However this may need to be changed if an egg is either losing too much weight or not enough. All known species of birds should lose 18% of the fresh egg weight by the time they hatch with 15% of this weight loss should have occurred by the time the egg has pipped.

Often the most difficult thing to measure is the fresh egg weight (FEW). Unless each egg is weighed as it is laid it impossible to know the FEW of eggs removed from parents after say 10 days of natural incubation. A useful formula from the Peregrine Fund prepared by Burnham is the best method to use. By **carefully** measuring the egg, using callipers (several times in differing areas as no egg is perfectly symmetrical), for both the length and breadth the following formula can give an estimated FEW.

$W = Kw (LB^2)$  where  $W$  = fresh weight  
 $Kw$  = observed weight  
           coefficient for peregrine  
           eggs (0,0005474)  
 $L$  = Length of egg (mm)  
 $B$  = breadth of egg (mm)

A sample calculation for an egg 50mm long, 40mm in breadth would look as follows:

$W = Kw (LB^2)$   
 $= 0.0005474 (50 \times 40^2)$   
 $= 0.0005474 (80,000)$   
 $= 43.79$  grams

This calculated FEW can be in error by as much as 2%. However, this is not normally enough to affect the hatchability of healthy eggs. Although this formula has been worked out for Peregrines it seems to work well for other species.

Eggs begin to lose weight as soon as they are laid. Thus, by various calculations the estimated, desired weight loss can be approximated. By weighing all the eggs at regular intervals bird staff can see whether or not to change the humidity in order to increase or decrease weight loss.

Eggs should be weighed daily at the same time of day. Egg weight loss should be monitored and shown on an Excel file in graph form on the computer.

An estimated 14 to 16% weight loss in vulture eggs during incubation to pip could be considered normal. Weight loss of 19% and above or weight loss below 13% would require attention. Weight losses at the time of hatching could be 18% or more. However by this time it is not really that relevant! Weight loss is always related to pipping and not to hatching. As experiences are gained with these three species actual weight losses will be reviewed. *(Comment - these percentages seem high. For Gyps coprotheres at Los Angeles, the goal is 14% weight loss from fresh weight to external pip, plus or minus 2% at most. Andean condor eggs with higher weight loss than this have required hatching assistance. SK)*

If an egg is losing too much weight, it needs to be moved to an incubator running at a higher relative humidity to reduce weight loss. This shows why weighing eggs regularly is so important. The humidity needs to be increased by whatever method works in the incubator in use at the time. The incubation person should be versed in what is required to increase humidity when needed.

Similarly if an egg is not losing enough weight, it needs to be moved to a drier incubator to increase weight loss. If the egg still does not lose enough weight, a small hole of 1-2 mm may be drilled at the blunt end into the air cell to further increase weight loss. This would be if the predicted weight loss is less than 14% - then drilling eggs around 25-27 days of total incubation is one way of increasing weight loss. Drilling will be required only if the weight loss is very low. *Once the eggs are drilled they require weighing every day till they pip.*

If an egg that has been drilled and that has not lost enough weight pips internally then leave it in the incubator till it pips externally and continue in the same incubator for another 12 hours. Then it needs moving it to the Hatchmaster with water beneath. However, if after drilling it has lost too much weight after internal pip, move it immediately to the Hatchmaster with water beneath to avoid it losing excess weight.

Once an egg has pipped internally move it to a Hatchmaster, set 1.0°F/0.5°C below the incubation temperature and at the same humidity as during incubation. Once the egg is externally pipped humidity should be increased to 70% relative humidity or higher as needed. This is to prevent membranes from drying. If more than one egg is in the same hatcher, humidity should be increased as soon as the most advanced egg is externally pipped.

If two eggs are hatching in the same hatcher they should be placed in separate compartments. (These can be easily made of cardboard or mesh, and can just be a ring large enough for the egg to move around during hatching and tall enough to keep the chick safe and inside the ring. This ensures that chicks do not get mixed up.)

If the egg has lost the right amount of weight and pips externally in the incubator move it to the Hatchmaster hatcher or an Octagon without a cradle which is running at 36.4-36.7°C (97.5-98.0°F) and 70% relative humidity.

Once the chick has hatched it should remain in the hatcher for 6-12 hours to rest and dry. Once it is able to maintain sternal posture and respond to stimulus it may be moved to a Hatchmaster or other brooder with water which is set at 35.0°C (95.0°F). It will remain here for 3-4 days, after which chicks should be moved to the brooder boxes which are set at approximately 90°F. Reduce the temperature by a degree every day till the brooder is at 21°C (70°F) after which it runs at 21°C (70°F) continuously while they are being brooded.

### **Disinfecting Incubators**

It is enough to thoroughly clean the incubators and disinfect at the beginning of the breeding season, and then afterwards only clean the outsides during use. Only if an egg has gone bad or exploded should the incubator be thoroughly cleaned again. A strict sanitation protocol for the incubation facility must be sufficiently comprehensive, including wiping down all surfaces in the incubator room on a regular basis. If incubators do have to be cleaned, remove them from the incubator room and clean them elsewhere in a clean environment. Afterwards they can be returned and then wipe over the outside once back in the incubator room.

Cleaning an incubator and its parts with a diluted mixture of F10 with filtered water (1.5ml F10:500ml filtered water) is recommended.

In a Conraq Z6 incubator, the warm air balloon can be cleaned by inflating it by pressing the button on the inside of the black knob. Remove the drawer and then press the button on the inside of the knobs and the balloon inflates and can be wiped with the help of a clean wet cloth dipped in F10 diluted solution.

Incubators must be disinfected before and after incubation.

Example List of equipment (at Pinjore March 2011)

1. Eight octagons
2. Four Hatchmasters
3. Thermometers
4. Hygrometer
5. Foam
6. Weight loss chart
7. Porcelain holders
8. Perforated bowls
9. New skin

At the end of every breeding season all equipment should be evaluated to make sure it is in good repair. Any parts that need replacing should be replaced at that time rather than waiting until the start of the next breeding season. It is sound practise to have on hand as many extra spare parts as possible, including not only incubator parts but also thermometers, hygrometers etc. At least one month before incubation of eggs for a new season is likely to start all equipment should be checked to see it is still working.

**\*\***  
*It is advisable for staff or technicians responsible for incubation to gain experience on chicken eggs through every stage of egg handling and incubation before going on to more important species.*

### Incubation Periods

Incubation periods for *Gyps* vulture eggs range between 55 and 57 days. It is strongly recommended that all eggs thought to be viable are given continued incubation at least one week over the known incubation period, and probably a little longer.

### Hatching

Some chicks will become very vocal close to pipping and whilst still in the egg. Sometimes movement can be seen as the embryos start to get active. However, others make no sound or movement until the pipping process has begun. By hand-turning on a regular basis, pipping eggs should be spotted soon after the shell has been cracked.

Once an egg has pipped it should be moved to another incubator for hatching. Turning ceases and the egg should be placed so that the pip is uppermost. The hatching incubator is run at the same temperature (99.5F or 37.5C) but the relative humidity is raised to 55 to 60%. After the egg has pipped there will be an interval of rest for the chick. Some will enlarge the pip area to a hole and can be seen moving whilst others may have no movement until actually starting to turn in the egg. This period can be very worrying for the technician, but patience is needed, particularly by those new to the experience. Interference too early is often not needed and can be fatal to the hatching chick. Once the embryo starts to turn in the egg the hatching process should only take from ten minutes to an hour. It has been noticed in Israel that the parent birds of Eurasian griffon vultures will help the chick by breaking off parts of the egg shell once the chick has made the initial hole. However technicians should not try this until they have some experience in hatching eggs as it is very easy to kill chicks by damaging the membrane too early.

If the hole has become too enlarged before turning commences the membrane may start to dry out and cause the embryo to become stuck and unable to move. Spraying with a fine mist of warm sterile water or painting with a soft, wet, sterile paintbrush can help the membrane to become loose. The hole can be 90% covered with damp tissue or even a tiny piece of Micropore® tape, (removing some of the stickiness by placing it on the back of the hand several times).

Once the chick has hatched the navel should be swabbed with an iodine based disinfectant, always using the right dilution specified. Never spray the embryo with a propelled spray, always administer the disinfectant with a cotton bud or clean tissue.

The hatched chick can be left in the hatcher until dry or moved to a brooder straight away. A newly hatched chick has an oddly shaped head, a bulbous neck and very protruding eyes. All this will settle down within 24 - 48 hours. Some chicks may look distended due to insufficient water loss, but this will dissipate if the chick survives.

## Problem Hatching

Some eggs will prove more difficult than others. However, only through gaining experience will the technician will be able to judge really well when to assist hatching embryos and when to leave well alone. Assisted-hatch chicks are usually weaker in the first few days of rearing, may need extra care and even a course of antibiotics.

The general rule of thumb for the inexperienced is to leave the egg pipping for sixty hours before attempting to help the embryo to hatch. As experience is gained assistance can be given earlier if required. If the egg that is experiencing problems is candled and the air sac marked on the shell with a felt tip pen, small parts of the shell can be removed with forceps. Be careful not to pull off any shell touching the membrane.

Once the membrane is exposed, if it is touched with a wet, sterile paint brush full of sterile, warm water the blood vessels will be exposed. Then the technician can see if the blood supply is still flowing or has closed down. By gently touching the most obvious vein with the tip of a damp small paint brush and then removing this will become very obvious. Completely closed down vessels contain no blood, Once that happens it is usually safe to carefully remove the embryo.

If the blood is still flowing, cover the hole with the exposed membrane with damp tissue and place in a still air incubator, (not a forced air as this will dry out the embryo too quickly). Keep checking until the blood flow has ceased. If helping out a chick do not remove straight away from the lower part of the shell. Ease the chick to one side and see if the yolk sac has been retracted. If not then leave the embryo in the lower half of the shell until it has - this could take another twelve hours. To keep the embryo from sticking or getting infection the lower half of the shell can be gently damped with a mild disinfectant solution. The chick will be prone to getting cold at this stage, so deal with it either in a very warm room or on a waterproof heated pad. Keep the temperature of the still air incubator at 99.5F or 37.5C until the chick is safely out and dry and warm.

All problem chicks will need extra care and probably extra fluid usually given orally with a crop tube, which is a technic that all keepers should learn as it is often used in sick adult birds.

## Development and Care of Young

### Brooding

Newly hatched chicks should be placed in a still air incubator or brooder running at 95.0F or 35C. This temperature can be reduced by 1 degree Fahrenheit or 0.5Centigrade. a day until the secondary down comes through and young birds are able to thermo-regulate, or are returned to parents or foster parents.

Newly hatched birds should be put in containers that are designed to hold legs neatly tucked under the birds. Splayed legs can happen in a matter of twenty minutes if birds are kept on the wrong surface. A plastic 1/2 gallon ice-cream or margarine container or a similar wooden container, which is what is used in India, with at least two inches of sand formed into a hollow with a fist and covered in two pieces of kitchen towel is ideal. This should be placed in the brooder at least 24 hours before



needed and will provide a warm and stable nest cup for young birds. The kitchen towel can be replaced after each feed and the cup in the sand can be reformed. At Pinjore a wooden container has been designed with the top wider than the base and with a soft towel. There are various different sizes and this works very well until the young are big enough to be put together in groups in a larger brooder.

If rearing a number of young vultures it is probably easier to have several brooders at constant, known, temperatures and move the growing young rather than altering the temperature of one brooder. Overheating can kill very quickly. A good, tested thermometer should be reading the temperature close to the young at all times. A steady temperature in the brooder room makes the rearing of young much easier. It is not advisable to have young in the same room as incubating eggs as young birds are considerably less clean than eggs and cross infection could occur.



Various brooding methods have been tried. Still air incubators - although these are excellent they are only suitable for the first few days of life or problem young. Alternatives include disposable card-board boxes with heat lamps or washable plastic containers such as water tanks with the bottoms cut off and either overhead heat lamps or low heat plastic veterinary recovery pads underneath containers. Other options include heated water pads ("K-Pad"® - available in USA) that young can move up to or away from. All have their merits and breeders should find out which is most suited to their needs and budgets.

As long as care is taken to keep young clean, warm, well fed and on surfaces that will allow the correct growth and avoid feet and legs slipping, that is all that is needed.

Young that are too cold will huddle together and cry. Young that are too hot will pant, spread out away from one another and also cry, but it is different noise. Experience will soon tell the technician what is needed. Over-heating is more likely to lead to weak and ill young. Supplemental heating should not be required after 10 days if the ambient brooder room is at 70F or 21C.

Containers should be washed daily to remove build-up of faeces.

Once vultures are about three to four days old and are doing well they should be moved to brooders where they are unable to see staff. The rearing facility in Israel has a box facing out into an aviary. The box has a wire front and a heat lamp overhead, with a nest below. It opens from the rear, but has two holes for hands and arms so that the young can be fed without seeing staff. The head of a dead vulture can be nearby and outside, in the aviary, are a couple of live adult vultures so the young can see them and recognise them early on. On occasion the adult vultures will start to interact with the hatchlings, which will bode very well.

The young can stay in these boxes until they are starting to stand up and require more room for wing exercise. Then they will need to be moved to small enclosures where they can remain until joining the large group.

Where possible we are going to attempt to return young to parents for rearing. This takes time, patience and nerve, but is well worth it in the long term.

At approximately 10 days old the chicks should have at least one hour's direct sunlight per day. This is important for them to be able to assimilate Vitamin D. As they will normally be hatching before the summer when the sun is dangerously hot they should be able to be put in the sun safely. However great

care should be taken to make sure they do not get too hot or too cold. Indirect sunlight through glass or Perspex® is not suitable. Only direct sunlight has the required amounts of ultraviolet light.

## Feeding



More chicks are killed by overfeeding than any other cause. It is best to leave the first feed for at least twelve hours and sometimes longer if the chick is showing no signs of hunger. Newly hatched chicks that look distended with fluid should be left without food until the stomach is flaccid and soft to the touch.

A mixed diet of finely minced or chopped meat is suitable. Rats or rabbits, skinned and gutted with feet, and head removed make excellent food for young vultures. Meat from goats, cattle, buffalo, horse and donkey (if the source is known and the animal completely free of drugs) can also be used

but, in the case of the large animal food, crushed bone **must** be added. The bones will be utilised by all but the youngest of chicks and these can be pushed to one side when feeding for the first couple of days. A probiotic supplement giving the beneficial bacteria and microbes should be added to the feeds for several days for young chicks. 'Avipro Paediatric'® made by Vetark is specially designed for this purpose and contains a starter kit for newly-hatched birds at their first feed.

According to Mundy (1992), on investigating the diet of Cape Vultures they assessed that to get a healthy calcium:phosphorus ratio in the diet a chick there should be 8g with every 500 g of meat, which means that they probably consume approximately 300g of bones during development. Interestingly, in studies where calcium was given to produce bone abnormalities over-feeding of bone chips led to birds regurgitating bone chips that were not useable in digestion. This would give a small safety margin if over-feeding calcium.

Using forceps small pieces of minced food can be offered to the chick, which should raise its head to accept feeding. Chicks will respond to the food being brought in slowly towards the beak at about their eye level and should attempt to snatch the food from the forceps, Very young vultures may need to have the beak touched as food is regurgitated by the parents on arrival at the nest. Young chicks are pretty inept to start with, missing the food, or falling over. However they soon get strong enough to take food more easily.



Damping the food for young vultures makes feeding a little easier and keeps young birds from getting dehydrated. Four feeds per day is sufficient to give good weight gain and growth rate. This can be reduced to three feeds and then two as the young birds grow. To keep a check on the health and growth of young birds they must be weighed regularly.

## Casting Materials

Casting materials to allow the young bird to form pellets for regurgitation need to be used very carefully with vultures. As the adult birds bring food

to the nest in their crop and they appear to leave skin and fur behind at the carcass out of preference, casting material is not vital in the early stages. In fact it can cause impaction of the stomach. It is a mistaken idea that casting material is important but it is to be remembered that the vitamins, minerals and so on are obtained by the chicks from the correct diet and not the material that is brought up in a casting. It is vital to feed the bones and minerals that come with mincing whole, yet gutted and skinned animals. Fur need not be introduced until the birds are almost adult, standing and pulling meat for themselves from whole carcasses.

## Supplements

Added vitamins and calcium can be very useful. Many collections may have to use frozen food items and some of the goodness is lost in this process. A good multivitamin supplement should be added in powder form on the food - do not exceed recommend doses. "Calcium" has to be used carefully as sterilised bone flour can cause imbalances in phosphates. The most highly recommended is Nutrobal® (Vetark:UK) which seems to work well in raptors without causing any problems if used as directed.

## Water

Young vultures do not drink until they have left the nest and can reach water for themselves. However, they not only obtain water from the meat they eat but also the parents drip an oral secretion onto the food while feeding the young. As stated earlier, damping or dunking the food prior to feeding the chicks with either water or a Ringer's solution will stop dehydration and assist growth of young.

## Age of returning young to parents

Once young birds have reached 10 to 12 days, are looking healthy and are feeding well they should, wherever possible, be returned to parents or foster parents.

If this is not possible then all through the rearing the young should have as little in the way of contact and handling from the humans caring for them. Puppets shaped to the colour and build of the adult bird can be used to assist in avoiding any severe imprinting on the bird staff. Most species will learn to pick up food for themselves at about 10 days old and vultures are very quick at learning this. It is recommended that young that are being totally hand-reared are encouraged to feed themselves as quickly as possible in order to minimise their time of exposure to human interference.

If the young are going to be put back not so much care is required to avoid human contact as it will soon be forgotten once the birds are being reared by their parents. If returning the young is left much longer than 14 days they will be mobile enough to try to get out of the nest in fear when they first come face to face with their parents.

First time parents are an unknown quantity. Bird staff should always make sure that they have plenty of time set aside on the day chosen to return young. Birds will have to be watched for several hours, possibly for one or two days, to check that all is well. Some birds are really difficult to monitor as they will not do anything while under observation. These birds can may to be watched from a distance with binoculars or using CCTV.

Two bird staff, both wearing heavy-duty gloves, should be available to return the young. Those ready to be returned should be placed in a bowl for ease of carrying to the aviary. Returning the young is much the same as taking eggs. One person fends off or moves with the net and watches the female, while the other removes the egg and replaces it with the young. If the parent birds have been sitting on a dummy egg this need not be handled carefully. However if the birds have recycled and are sitting on a fertile second egg great care must be taken in removing it. A moment standing still by the nest ledge to watch the first reaction of the parent birds is advisable. If you are really lucky, the female will immediately come up to the nest. Watch for her 'balling' (curling her toes underneath) her feet and she may even

cover the youngster straight away. The enclosure should still be observed as the reaction of the male has to be assessed before bird staff can relax. If the female takes to the young it is rare for the male to cause problems. However it can happen and should a young bird be picked up or bitten by either of the adults action must be taken. Bird staff should run towards the enclosure and bang loudly on the side while someone goes in to rescue the youngster.



What more often happens is that the two adults will sit away from the nest, watching the new young and probably wondering what has happened to their egg. The bird staff can only watch and wait to see if either parent will go down to the young. It can be a good idea to leave fresh food on the side of the nest to encourage feeding.

Eventually most birds will show some sign of reaction. It is very rare for birds to completely ignore the young and refuse to sit or feed the young. If that does happen a decision has to be taken whether or not to leave the young in the nest overnight. That will probably depend on the weather conditions. If it is very warm and the bird staff can be around at first light to monitor the enclosure then the young can be left. One day without food will not harm them at this stage and sometimes the calling done if they get a little cold or hungry will bring a favourable response from the parents. More than two days probably means that a different approach will be needed the following season and the young will have to be removed and placed elsewhere.

A bad reaction from a parent does not necessarily mean that they will never be a good parent - it just takes more time and management to get things right for that individual pair. Once a pair has made it as successful parents it makes things much easier, so that the effort put into achieving results is well worth it.

Do not forget that if the egg removed is the second clutch it should be swiftly and carefully taken to the incubators and placed there safely, while others watch and safeguard the returning of the young.

### Foster Parents

In the case of the vulture project it is essential to use only other pairs of vultures to foster young. However it may well be possible to get parents to rear two young rather than the usual one. This practice should be restricted only to experienced parent birds that are thoroughly proven at rearing chicks in captivity and at a later date in the project when there may be a need.

### Monitoring

Once young are successfully accepted by parents or foster-parents they should be monitored to check there are no problems.

Great care should be taken entering aviaries or nest areas once the chicks are close to flying. Young birds jumping out of the nest too soon can injure themselves.

### Marking of birds

All birds should be uniquely marked; marking can be carried out using microchips, leg bands and patagial tags. Leg rings can be difficult to read at a distance because of the long feathering on the

flanks obscuring the rings in perching birds, the accumulation of dirt on the ring and distances involved in the larger aviaries. Patagial tags constructed of vinyl impregnated vinyl and are very clearly visible, although they can tear out. The cost/benefit of using these tags needs to be assessed and smaller patagial tags may be better than large ones.

An implanted transponder or microchip will make the bird easily identifiable long term and must be done in serious breeding programmes. The transponders in vultures are usually placed under the skin of the pectoral muscles or into the muscles, using aseptic technique and closing the injection hole using tissue-glue. Ringing and micro-chipping can be carried out soon after fledging but patagial tags, if required, can only be fitted at a later date, post-fledging. DNA fingerprinting, if available, could be used to identify individuals.

## **Population Management Social Structure**

Initially we considered that colony aviaries would ideally contain only adults. However we now feel that a mix of ages is useful as the young birds learn from watching adult breeding behaviour. When breeding space is at a premium it may be better to have juveniles and sub-adults maintained in separate aviaries as they can dominate the feeding in colony aviaries. A further option would be to have some non-breeding adults in with these juveniles and sub-adults. There is also competition with juveniles and sub-adults for perches and breeding ledges. Unpaired birds or pairs producing infertile eggs (especially young birds) should be given at least two or three breeding seasons before changing around or trying to force pairings.

Vultures cannot be reliably sexed visually as they are not hugely dimorphic. DNA sexing, using PCR on samples of blood, feather follicle or from the wet inside of a recently-hatched egg, with cross-reference to samples from known-sex birds, can be done and is being actively validated, researched and now carried out at the Pinjore centre. A proposed morphological alternative could be measuring the thickness of the tarsus but this is not yet confirmed. There are some behavioural differences, especially associated with the breeding time, but these may not be completely diagnostic for determining sexes (and after several breeding seasons we are very much aware of the durability of same-sex pairings).

## **Species Management Programmes**

Apart from the European Endangered Species Programme (EEP) for *Gyps bengalensis*, run by EAZA, there are no other official SSPs for these birds. Initiating coordinated breeding programmes in India and elsewhere within the birds' range is essential. These managed breeding programmes should be run along the studbook format as used by regional zoo associations around the world. A breeding programme coordinator should be appointed and careful demographic and genetic analyses must be carried out for the population. This is the most effective way of retaining managed genetic diversity and ensuring the future viability of a captive population.

## **General Handling**

Most vultures are nervous when their enclosures are entered, so enclosures should only be entered when absolutely necessary. If birds are to be caught up this should be done as quickly as possible. The bird staff will soon learn which of a pair is more nervous and that bird should be caught up first to avoid it damaging itself. Bird staff should wear tough coats and a good quality falconry glove when entering enclosure. As stated before, all birds should be caught up using a net. The net should be of a soft small mesh material and quite deep. If the net is too shallow the birds will bounce out of it. Where enclosures

are very high a long handle should be fitted to the net. Centres should have a couple of nets in stock at all times for catching up. The large vultures should always have two people per bird for any catch-up.

### **Catching / Restraining**

Catching vultures in a large colony aviary is not easy, it is stressful for the birds and the keepers. At least two people, each with the previously-described nets, enter the aviary. As the birds move one will eventually make a mistake and land on the ground and is then quickly netted.

Vultures are one of the birds most likely to inflict damage to people if handled incorrectly. However, there is greater danger to the bird through injury or stress during the catching and restraining process. Vultures, both large and small, can be difficult to handle. When upset they will vomit up the contents of their stomach, with unerring accuracy, so they should not be fed on the day of catching up and elective catch-ups should be scheduled a day or two after the last feed. As they can inflict very nasty bites their heads should be restrained gently but firmly in the net first by one person. The other then tucks the wings into the bird's body, holding the wings and body with one hand and the feet with the other. The head should be held gently but firmly so as not to inhibit its breathing, if a vulture shows signs of wanting to vomit or regurgitate it should be allowed to do so, taking care that it does not choke or aspirate regurgitated food. Should the person holding the head release it for any reason the other handler should immediately release the bird as his/her face may be in danger. There is a preference by some staff to wear American-style baseball caps. Anecdotally, birds whose head slips a handler's grip tend to go for the peak of the cap rather than the face. Protective glasses or sunglasses are also worn by some staff as vultures will peck at the eyes.

Whenever holding the feet of any bird one finger of the hand should always be put between the legs. Thus any pressure can be felt on the finger, avoiding too much pressure accidentally breaking a bird's leg.

Birds should ideally be held either upright or on their fronts, with being on their sides a third option. They should not be held on their backs unless being examined by an experienced veterinary surgeon. Birds with respiratory problems should not be held or placed on their backs unless absolutely necessary and then only for the shortest times and while being monitored.

Using a well-fitting falconry hood can calm most birds down and stop them trying to bite. The occasional bird will be more upset by the hood, but this will only become apparent with experience and understanding of the individual bird. Hood designs and use are still being researched. However it is also effective to place a glove or a towel over the head of a bird to produce a similar effect as fitting a hood.

Great care should be taken when catching up female birds prior to or during the egg laying period as poor handling can cause severe damage to the bird and the egg.

In a recent study it was found in some species of raptors that holding them physically for more than 20 minutes dramatically increased their body temperature. Thus, lengthy periods of physically-restraining birds should be avoided

### **Staff Safety**

When handling vultures regularly, particularly the larger species, bites and scratches are inevitable. Bird staff should make sure that they are up to date with any inoculations such as tetanus and that any cuts are properly cleaned and covered as soon as possible.

## **Research, record keeping and studbook**

The opportunities for research and monitoring at the centres are enormous, already huge strides have been made in research on behaviour of breeding birds. At Pinjore - birds' behaviour is monitored 3 times a day, especially during the breeding season. At least once a week all the nests are watched for an entire day. Behaviour at feeding times is recorded to look at which birds are feeding. Perch utilisation and nesting ledge utilisation is recorded. Pair formation is recorded. Water quality is monitored. Meteorological information is taken, temperature and humidity. Details of age, moult patterns and morphometric data are taken. CCTV is utilised in many of the enclosures giving valuable data on the breeding and the birds behaviours. There is monitoring of the chicks and much interesting data is being gained. All of this data is stored electronically and backed up once a month. Now the project is underway and breeding has commenced serious consideration should be given to utilising specific programmes designed for storing and querying such data such as ARKS/ZIMS. Dominance recording especially related to displacement at carcasses could be recorded. Each bird has a health record file, with its history (capture details), marking details, quarantine blood and faecal results, also any veterinary treatment - include normal blood and heart rate/respiration rate values.

When isolated birds are kept then food consumption is monitored are charts are kept.

Genetic management of the studbook is vital. Though there are current constraints due to restrictions on transferring birds between States the management should look beyond the three centres and view them as an integral population. SPARKS currently offers a management option with ZIMS being a potential future option, with BNHS managing the studbook.

## **Reporting systems**

All centres must disseminate information between themselves (internal communication), exchanging information in a standardised way and regularly. This information can, where relevant, be disseminated to the public.

## **Emergency planning**

After several years at Pinjore, Buxa and Rani we have learnt it is important to consider important local threats or risks, such as floods from rivers, bee attacks, elephants etc. Centres need to ensure that lists of contacts and reaction times, holding boxes in case of an emergency evacuation of aviaries, alternative food supplies, disease outbreaks (appropriate veterinary support), appropriate drugs held on site) are all available. Sample protocols should be put in place.

## **New Arrivals and Quarantine**

It is advisable that all new birds entering the programme, from whatever source, should be maintained in isolation for a minimum of 45 days. The quarantine facilities should, as previously stated, be 5km from the breeding centre and serviced as a separate unit.

## **Considerations for Health and Welfare**

As a general rule vultures are resilient. If kept in enclosures that are warm, dry, well-ventilated, species-suitable and fed on a good quality mixed diet they will give very few problems in terms of health.

Probably the commonest physical problem in captive birds is “Bumble-Foot”, defined as an avascular necrosis of ventral foot tissues. This dead/devitalised tissue may be contaminated with infectious organisms, most often bacteria, making treatment more complex. For those less familiar with veterinary terms, this is an infection of the foot, usually under the centre pad, but sometimes on a toe. In the majority of cases it is caused by incorrect perching. It is difficult to treat once it takes hold and can reoccur. Birds should be removed from the enclosure and a sample of the material in the swelling taken for microbiological culture to see which drug is the best to use. The bird will need antibiotics, dressings and intensive treatment if the disease is to be controlled. Non-responsive lesions will require surgery under general anaesthesia.

Salmonellosis does occasionally kill raptors. They can pick it up through the food chain and it may be difficult to diagnose and treat in time. For the vultures this is believed to be less of a risk as they have a robust digestive physiology and are fed only lower-risk foods compared with raptors in Europe where surplus day-old poultry chicks (a high-risk foodstuff) form the bulk of many diets. An important consideration is that salmonella is vertically-transmitted. It is therefore essential for a breeding centre to be free of the disease as it will kill embryos in the egg.

Viral diseases that may affect captive raptor populations are myriad and include herpes virus, Newcastle Disease, Avian Influenza, and Avian Leukosis Sarcoma Virus.

Aspergillosis, a fungal infection affecting the respiratory tract of raptors, is a common illness in certain species. Poor ventilation and large numbers of fungal spores lead to disease, with immune-suppressed birds being pre-disposed. The spores are released into the environment from moist rotting or decomposing vegetation, e.g. compost-heaps, woodchip, bark, hay or straw. The disease is not contagious but may occur simultaneously in a number of birds that have all been exposed to the same source of infection.

Physical injuries may occur in captive birds, usually caused by a bird being upset, e.g. being caught up for some reason, aggression in the enclosure or badly-designed enclosures. It is very difficult to avoid birds hitting wire occasionally and injury to beaks, ceres and carpi can occur. These should be treated immediately. Severe injuries will mean the bird going into a hospital situation. In cases where the problem is recurrent the design and, perhaps, the wire of the enclosure, should be made safer using such materials such as Netlon®.

Any bird that is sick or ill should be blood-sampled, with haematology performed as a routine procedure. This can save time in finding the root of the problem and often the bird's life. Through the routine checking of birds by local staff with the assistance of the two vulture veterinary interns there are now comprehensive sets of data on haematological parameters. These are particularly pertinent as they have been acquired from birds held at the breeding centres and using repeatable techniques carried out in the project laboratories.

Birds should be routinely caught and health checked once a year in the aviaries. This may be done by sub-sampling some individuals from colony aviaries, (a minimum of two birds or 10% of an aviary should be checked, whichever is the greater). To avoid disruption, this sampling should be carried out ideally whilst the catching the birds for other routine husbandry reasons.

Faecal parasitological examination should be carried out twice a year routinely and also on entry and exit from quarantine facility. There are standard techniques now described and used to get repeatable results. Caution must be exercised in attributing disease to relatively insignificant parasite burdens, with treatment (usually with an avermectin) being targeted to specific individual birds. Fenbendazole toxicity has been recorded in African Gyps vultures (Bonar *et al.* 2003) and so extreme caution must be advised before considering its use.

Ecto-parasites, lice, are often noted. These tend to feed on feather and skin detritus with heavy infestations being more indicative of a bird's debility than a cause of it.

Haemoparasites have been recorded and are of unknown clinical significance. However an ill juvenile long-billed vulture responded initially to oral rehydration and chloroquine with subsequent treatment, following a relapse, of primaquine and chloroquine.

Preventative health care - vaccination should be considered for e.g. Newcastle Disease and Avian Influenza but vaccine use would be dependent on obtaining government permission, yet to be forthcoming.

All dead birds, including those found in the field, must undergo a post-mortem examination. There is a fixed protocol for collection of samples from dead vultures. The procedure to maximise the value of a carcass is as follows; put the carcass in to strong plastic bag and seal this bag to make it watertight and press out air from bag before sealing it. Repeat step 1, so the vulture is now within two strong, sealed plastic bags. Place the bagged vulture on ice packs in a cool box and cover the carcass as much as possible with ice. Seal the cool box by tapping the lid on tightly with strong sticky tape and tape all the way around the join between the lid and the box. Along with the carcass information on species, age, date, place of collection and other information should be included. Freezing a carcass precludes tissues being subsequently sent for histopathology.

Because of the risk of disease build-up and transmission, the whole top layer of substrate in aviaries should be replaced annually and the lower layers turned. Spot-cleaning under favoured perches is carried out as and when required but probably at least every 2 months. Care should be taken to ensure there are now foreign bodies in the substrate that can be ingested. Finding of extraneous materials on one site are believed to have been the sequel to the site flooding and waters running through aviaries.

#### **Disabled birds - potential problems concerning resources being taken up with disabled birds**

If disabled vultures are being held that are deemed to be non-viable for breeding purposes then consideration should be given to transferring these birds to rescue centres or to act as education birds in zoos. However all the disabled birds should be given a reasonable chance at breeding, particularly the females. These are capable of mating and have laid, though not incubated, fertile eggs that have been taken for successful artificial incubation. It would be best if such birds were not counted as the healthy wild take allowed for this or any breeding project as these birds are compromised at the outset, valuable though they may be.

#### **Collecting/ trapping of wild vultures**

Should this still be allowed on this project, only experienced trapping teams should attempt to capture vultures and permission must be sought from the CWW.

Trapping teams have comprised a minimum of 2 trappers, a veterinarian and a driver. Capture of adult vultures generally only occurs outside of the breeding season (closed seasons, during which no trapping occurs, are White-backed Vulture, November - March: Slender-billed Vulture, January - April: Long-billed Vulture, December - late March/early April). Three main techniques are used; a long collapsible, flexible bamboo pole with a coating of glue of mustard oil and *Ficus* latex is used. The glue is then removed by petroleum spirit or vegetable oil. A padded leg-hold trap is also used, the traps are covered with loose soil and placed at a distance 2.5 - 50 cm each trap is attached to a 1 Kg weight and shock absorber and is lightly buried. Using leg-hold traps is difficult because of the number of dogs which are caught around carcasses. A clap trap is also used which is a spring loaded

net approx (8' x 20') closed via a long cord and is used for catching large numbers of vultures at a carcass.

Trapping of sub-adult or known non-breeding individuals occurs during the breeding season only by using the bamboo pole technique so that particular individuals can be identified and targeted.

Nestling collection from tree nests for White-backed and Slender-billed Vultures and from cliffs for Long-billed Vulture. Experienced climbers climb to the nest, nestlings are placed into cotton bags (duffle style, 24" x 18" and smooth so that loose threads do not entangle in serrated tongue) and lowered to the ground.

### **Veterinary/health/research checks on newly trapped birds**

The first examination should be carried out immediately upon capture. As there are a limited number of birds we are allowed to collect decisions may need to be made if a nestling proves to be unsuitable for the breeding programme. Handling the vultures must be done with care. The wings, head and feet must be secured as they have powerful musculature but relatively weak bones. When caught birds are nervous and try to attack or escape. The vultures are immediately health checked for general condition and any obvious gross injuries. If dehydrated then birds should immediately be given fluids either subcutaneous or orally to re-hydrate them as quickly as possible. Handling must be gentle but firm and carried out by at least two people. Try to minimise stress and keep the vultures cool. Each bird should be given an ID that remains with it throughout, up to and including its arrival at quarantine and its provenance must be recorded.

Vultures should be transferred to individual boxes for transportation as this restricts movements of the wings.

### **2.6.3 Transportation**

Vultures travel better in completely dark boxes. Purpose-built boxes are best as none of the commercial ones are particularly satisfactory. Boxes should be slightly longer than the head to tail length of the bird intended to travel, and wide and high enough for the bird to be able to stand and lie down in comfort without banging its shoulders or head, but with insufficient to turn round.

A well-made wooden box, with no perches, but with carpet or some other non slip surface fixed on the floor and ceiling, and air-holes on either side is the best option. The box should be top-opening. A one-inch square wooden batten along the outside of each side will stop boxes being pushed close together and air-holes being blocked.

The right number of suitable boxes must be available prior to commencing the capture - one per bird. White-backed Vultures are a little smaller than the other two species so a box 2 feet x 1.5 x 2.2 feet should work, Long-billed/Slender-billed Vulture = 2.5 x 1.5 x 2.2. The box should have handles for easy carrying and no food or water should be kept in the boxes during transportation.

When being transported vultures should face the direction of the movement of the vehicle, if possible. All birds are very susceptible to heat stress and so boxes should never be placed in full sun. Vehicles should be air-conditioned for summer transports. Travelling birds during excessively hot spells should be avoided with transport being carried out during the early morning or late evening.

In India a transit permit is required by the District Forest Officer and a veterinary certificate is required to transport the birds.

Birds should be removed from boxes in secure areas where accidental escape is not possible and away from exposed areas of glass, such as windows.

### **New Arrivals**

On arrival at their destination the birds should be admitted to a quarantine facility. The identification of the vultures should be cross-checked and a history of each bird recorded including; indication of the age, location, date and method of capture, any injuries or illness noted at time of capture, any other relevant information such as vulture colony and details of the capture team.

Morphometric measurements should be taken. There is a standard protocol for this. The equipment required is: a measuring tape (30m), stainless steel rule (24”) and Vernier Callipers. The following measurements should be taken: Beak length (measured from cere to tip), Body Length (Beak tip to tail tip), Wing Span (outstretched maximum wingspan), Wing Cord (carpus to tip of primary feathers), Tarsus Length (dorsal metatarsal length), Weight.

All birds should be uniquely marked (see comments on marking under captive management).

On arrival all birds must receive an admission health check. This should assess the condition of each bird and determine a plan of action. The clinical check should include an examination for any injury and ecto parasites, an examination of body condition including checking pectoral muscles and for fat deposits. The inside of the mouth should be checked for signs of trichomoniasis, the feet should be checked for signs of bumble foot and the faeces should be screened for parasites.

### **Quarantine husbandry and veterinary checks**

Birds should be retained in isolation at the quarantine facility for a period of 45 days. All birds in a single quarantine area should arrive together and no extra birds be added until that quarantine group have completed quarantine. The quarantine area must be at a suitable distance from the other aviaries (see comments under location) and should be serviced by separate staff and equipment. The facility must be fully disinfected after use and before being used again for other birds. (Substrate and perching should be changed and all enclosure parts thoroughly disinfected). Full investigation of any disease and mortality during quarantine must take place and all quarantine groups held until any disease is identified.

Visual observation can be carried out either directly or via CCTV. Healthy vultures should be checked twice in a day. If vultures are suspected or known to be ill then they should be checked every 4 hours. Vultures should be monitored to observe their behaviour, activity and posture. The enclosure should also be checked for blood, abnormal faeces or pests.

A physical examination of the birds should take place including assessment of body condition and body weight, heart rate (beats/minute), respiratory rate (breaths/minute), (bearing in mind that this will be elevated while holding a bird). Any parasites should be collected and retained in 70% ethanol.

Laboratory examination should also be conducted with specific technical activities being restricted to trained personnel including health-screening activities such as blood sampling). The protocol includes haematological, biochemical and parasitological examination. Certain equipment is essential for this including a centrifuge machine, Sahil's Haemometer/Humocue, Neubauer's counting chamber, compound microscope, electronic balance, blood mixer, PCV reader, refrigerator and freezer. The following reagents are also required; stains, N/10 HCL, ethanol, formalin, distilled water, isopropyl alcohol, methanol, EDTA and heparin. These are all specified in the laboratory manual check-list.

For haematological examination approximately 3 -5 ml of blood should be taken from the, most commonly, the medial metatarsal vein or alternatively the ulna (wing) or jugular vein. Samples retained would be whole blood for serum and blood smears, heparinised blood for plasma biochemistry (plasma biochemistry should include aspartate aminotransferase, creatine kinase, uric acid, fibrinogen, total protein, albumin and calcium) and EDTA blood for routine haematology tests. Routine haematology should check haemoglobin, packed cell volume, total red blood cell count, total white blood cell count and differential white cell count). These are all specified in the laboratory manual. Blood samples should be archived for future use.

Parasitological examination should be conducted on faeces, or via cloacal swabs) and blood to determine the presence of parasites in order to prevent transmission of parasites between vultures. Faecal samples should be checked grossly for colour, odour and consistency. Then microscopic examination should be checked by direct, sedimentation and flotation methods for endoparasites. Cloacal swabs should be checked (or retained) for bacteriology and virology. Blood samples for parasitology should be stained with Diff-quick and examined microscopically at 40X & 100X. This is all specified in the laboratory manual.

Post mortem examination should be carried out to investigate the cause of mortality. There is a set protocol for this. The process should enumerate and document the gross changes in the organs and evaluate the disease process. Samples from non-pre-frozen carcasses should be collected and fixed in buffered 10% formalin for histopathology, stored in aluminium foil at -18°C for toxicology & virology and swabs and smears retained for bacteriology.

Once the birds have cleared quarantine they can be placed in the pre-determined enclosure at the breeding facility and the quarantine aviaries either dismantled or disinfected and made ready for further use.

### **Public Entrance to the Breeding Centres**

As the Captive Breeding Centres are specifically for the purpose of saving the species being worked with, visitations must be kept to an absolute minimum, particularly during the breeding season.

Although we understand that there will be political reasons for VIPs to visit and this is a necessary part of conservation projects, unneeded visits from groups must be avoided.

One or two of the centres could have an entrance area or welcome building where visitors can be received, entertained and informed about the work being done.

Some Centres can then be completely off limits to anyone other than bird staff or invited experts and advisors.

If CCTV cameras are in place, having a monitor in the visitor centre could be very useful and educational. An enclosure close to this area with one or two perhaps injured or non breeding birds for people to see is also useful.

Educational materials are going to be needed to educate everyone in the bird's ranges about what is going on and to gain enthusiasm and interest when releases start in the future. These can also be utilised in the visitor centre.

## Protocols

### Visitor Protocols

- Keep visitors to an absolute minimum during the breeding season
- Numbers of visitors in any one group must be limited to no more than 10 (?)
- Outside the breeding season visitors to be limited to once a week.
- **No** visitors in the incubation or brooder rooms during the breeding season
- **No** visitors near the breeding or flight enclosures
- **No** veterinary surgeons, other than those working for the project or invited by the overseeing committees, to handle, touch or attempt any veterinary procedures on any of the birds at any time
- No one to visit the centre after having been to any poultry facilities within a week of their visit.
- Bird staff and advisors should avoid visiting more than one centre in any 24 hour period unless absolutely necessary.
- Footwear should be dipped prior to entry to any centre.
- Photography and filming is only to be done only by Centre staff

### Emergency Protocols

Should be in place and written by people who understand the local area of the project site and what emergencies might occur.

### PR and Press Protocols

Should be written and agreed by the Centres and the State in which the Centre resides, with input from all collaborators involved in the projects.

### Release and monitoring

Release of birds is the eventual and vital aim of this project. There are two constraints. The first is that until the environment is safe for the birds and diclofenac and other toxic veterinary compounds are no longer used, produced or found in dead animals, release is not possible. The second is that we must be breeding F<sub>2</sub> birds prior to the release. That way we will have the confidence that we have a sustainable population in captivity to provide birds for as a long period as is required until we are sure that the releases are successful. We are confident that we will be able to meet these criteria but accept this will take time and may not be achieved before 2015.

At such time as it does happen the following headings will be discussed and the methodology addressed.

- Socio-economic factors
- Awareness and engagement of the public
- Birds
- Behaviour
- ID All individuals must be permanently marked and this may be different to the captive marking.
- Monitoring
- Intervention
- Demography
- Release sites

- Existing populations (reintroduction/supplementation)
- Resources/logistics
- Protected area status
- Facilities
- Threats
- Food availability
- Release protocols
- Construction of release aviaries

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Incubation section compiled by

Nikita Prakash

Contact nos. +91-01733-264426, 09896927001, 09416044924

Simon Brough

[broughsimon@gmail.com](mailto:broughsimon@gmail.com)

Edited by

Susie Kasielke

[skasielke@aol.com](mailto:skasielke@aol.com)

Pat Witman

[pwitman@sandiegozoo.org](mailto:pwitman@sandiegozoo.org)

Jemima Parry-Jones

[jpj@icbp.org](mailto:jpj@icbp.org)

Whole Document compiled by

Dr Vibhu Prakash

[vibhu.mathur@gmail.com](mailto:vibhu.mathur@gmail.com)

Chris Bowden

[chris.bowden@rspb.org.uk](mailto:chris.bowden@rspb.org.uk)

Richard Cuthbert

[richard.cuthbert@rspb.org.uk](mailto:richard.cuthbert@rspb.org.uk)

Andrew Routh

[Andrew.Routh@zsl.org](mailto:Andrew.Routh@zsl.org)

Jemima Parry-Jones

[jpj@icbp.org](mailto:jpj@icbp.org)