Cape vulture (*Gyps coprotheres)*
Captive-Breeding Protocols

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This is a living document which will be altered and improved as we learn more about the preferences of the species and parameters for success. Always cite which version is used and be sure to check our website www.vulpro.com for the most updated copy.

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Introduction

The Cape Vulture (*Gyps coprotheres)* is southern Africa's only endemic vulture species and with only approximately 3,700 breeding pairs in 2013 (unpublished data), are of conservation priority. The Cape Vulture has steadily declined across is range since the species originally received conservation attention some 40 years ago and has thus been listed nationally as TOPS (Threated and Protected Species) and internationally as CITIES II.

Formerly breeding in Namibia, Zimbabwe and Swaziland, the Cape Vulture now only breeds in South Africa, Lesotho and Botswana. Populations continue to decline in those remaining countries as a result of numerous threats including loss of habitat from expanding human developments, power line collisions and electrocution, direct and indirect poisoning, lack of available and safe food, disturbance at roosting, breeding and feeding sites, capture for traditional medicines (*muti*) and ignorance about the species. A future threat now identified and expected to further reduce our vulture populations are wind farms in Lesotho, Kwa-Zulu Natal, Drakensberg region and the Eastern Cape.

It is with the ever present danger of losing Cape Vultures throughout most of southern Africa that VulPro initiated its captive breeding programme in 2011. At the time of writing, VulPro houses over 100 non-releasable Cape Vultures, including thirteen successful breeding pairs, with others coming up to breeding age very soon. This programme's objectives are to provide healthy chicks for population supplementation and reintroduction into areas and countries where the species historically bred but no longer breeds or where the population continues to decline, reducing the viable breeding numbers to below sustainable levels.

This document highlights captive-breeding protocols as set out by VulPro and is based on our experience. This is a living document which will continually be updated as we learn more. It is in no way a reflection of what works for all species and is only based on our experience with the Cape Vulture.

Breeding Enclosure Design

Housing 48 non-releasable adult Cape Vultures and with cliff ledges to house 20 nesting sites, the enclosure includes an 18m wide artificial south facing cliff (fig 1 and 14) with stepped style breeding ledges which range from one to five and a half meters high. The stepped style allows for one-winged birds to hop onto the ledges and make use of available spaces between ledges to reach their chosen breeding ledge. The more versatile birds are able to fly and land directly on their chosen breeding and roosting ledges.

Figure 1: VulPro's captive breeding enclosure with a naturalistic South facing step-style cliff.

While this cliff design has facilitated successful breeding and closely mimics the birds' natural habitat, we have encountered multiple issues with this design and recommend several changes. One-winged birds access higher ledges on foot, attempt to fly off the cliff, and have injured themselves in the subsequent fall. We recommend a design which would separate high ledges from low ones, denying the one-winged birds access to high ledges. Some low ledges which are accessible on foot receive high amounts of traffic from birds attempting to gain access to their higher nest ledge. The traffic causes disturbance which is a potential threat to egg and chick safety. Separating the ledges and/or designing single access routes for each ledge would eliminate traffic disturbance. Some pairs, especially inexperienced ones, will roll their eggs out of the nest. We recommend all sides of each ledge contain a 20 cm lip with drainage holes to eliminate the threat of parents rolling eggs off the cliff face.

The enclosure is 40m long by 18m wide (fig 2). The long rectangular shape allows chicks to fledge from their breeding ledge and fly to and from the artificial cliff and the end of the enclosure, gaining some degree of muscle development and flight fitness. The walls of the enclosure have strips of shade netting running from top to bottom to ensure the vultures see the ends of the enclosure and avoid injury. An enclosure for mass capture of wild individuals is self-contained inside the enclosure. Bear in mind the mass capture enclosure takes valuable space in the breeding aviary, particularly when young birds fledge and is a potential obstruction and collision risk for flying birds. The reason behind constructing the capture enclosure in this way is to improve our capture success and to make the wild captured birds at ease during the capture process. We tried to take both captive and wild birds into account here.

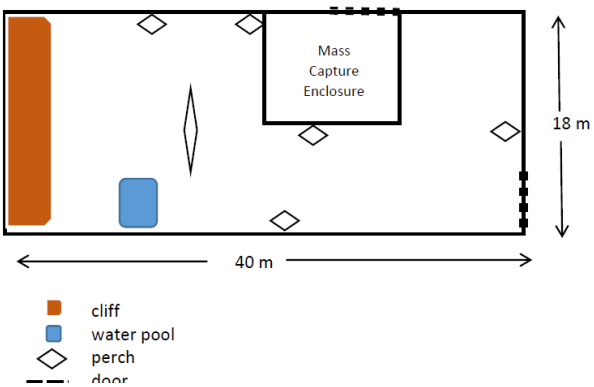

Figure 2: Layout of VulPro's captive breeding enclosure showing the location of the encompassed wild mass capture enclosure, cliff, water, and perches.

VulPro's is fortunate enough to be located on property well suited to host a vulture restaurant, or wild vulture feeding site (for advice on proper vulture restaurant locations and management, see Wolter et al. 2014). There spacious property is located 20 km to a wild Cape Vulture breeding colony. VulPro's vulture restaurant is 20 m adjacent to the breeding and mass capture enclosures. The restaurant attracts free flying wild Cape Vultures and dozens of other avian species, giving the captive vultures and captive-bred chicks the opportunity to observe wild behaviors and build relationships with the wild birds.

Seven captive bred chicks from VulPro's colony were released at the breeding centre in February 2015. At this time, we feel releasing at the centre does not provide the best chance for captive-bred chick survival. The chicks had access to regular and safe food supply, predator-free roosting locations, and were allowed to stay on site until they decided to forage and explore. However, at the time of writing, nine months post-release, none of the chicks have foraged outside of VulPro's vulture restaurant. To prompt natural foraging behaviour and flight skills, we aim to construct a release site on the Magaliesberg cliffs. All chicks will be translocated around 7 months old and released around 4 years old.

Adult Health Management

There are many aspects of Cape Vulture behaviour which must be addressed to maintain a mentally and physically healthy captive population. A few key points are addressed here, but by no means is this a comprehensive document.

Adults must be individually marked for monitoring purposes, as many management decisions are based on knowledge of individual and pair behaviours. VulPro marks each adult with patagial tags. To date we have had no problems with patagial tags in the breeding enclosures or marked wild birds.

Pair formation and enclosure density

Cape Vultures appear to be particular about their mate choice. In our experience, you can't place any male and female together and expect them to pair with time. Adults need multiple individuals to choose from and some may never choose to pair. It is crucial to know the sexes of the birds in the enclosure. Heavily skewed sex ratios may lead to single sex pairings which can be misleading and confusing.

Our adult population in the captive-breeding enclosure is not static. Every year we add sub-adults and adults from another large communal flight enclosure if they display mating behaviour (mounting, vocalizations, etc.). We closely monitor all individuals' behaviours and note possible pair formations. Due to the limited size of our captive-breeding enclosure, we will remove individuals from the captive-breeding enclosure which show no interest in mating. We conduct these translocations with bird behaviours and season in mind. For instance, we do not add or remove any individuals from the breeding enclosure past the time when nests are forming and aggression and nest site defence is increasing, which in southern Africa is around late April.

We house 40 to 50 total individuals in the enclosure including thirteen pairs which are already breeding. This is the maximum total individuals we recommend should be allowed for an enclosure of corresponding size.

Pair formation may take anywhere from a matter of days to multiple years. Any individual which shows preference for other vultures (roosting close together, allo-preening, or occasional mounting) should be left with the other individual for at least a few years before determining it will or will not breed.

Disturbance

The goal of VulPro's captive breeding programme is to produce healthy individuals for release. During the breeding season and whenever chicks are present, we enter the breeding enclosure to clean the water pool and drop food and nesting material at the entrance of the enclosure. Other interactions are kept to a bare minimum and are only acceptable for purposes of ensuring chick and adult health. We do not recommend allowing any breeding enclosure to be open for public access. We have noted increased stress responses and a decrease in copulations around the time of disturbance events (pers. observation).

Safe Food Provisioning

We provide safe (toxic drug and lead-free) and fresh whole carcasses (livestock and game), not small meat pieces. In this aspect we are very lucky to have companies, farmers and individuals who donate safe carcasses. Vultures obtain all their nutrient requirements from whole carcasses and the presence of whole carcasses simulates their natural feeding behaviours. We feed every third day during the non-breeding season and on a daily basis when any chick up to approximately 4.5 months old is present in the enclosure.

The carcasses absolutely MUST be free from veterinary drugs such as pain medication, antibiotics, anaesthetics used in darting and drugs used for euthanasia. Lead bullets should not be used to kill the animals as it might result in lead poisoning from fragments present in the meat (Cade 2007; Grund 2010). You must know and trust the source of your carcasses and be aware of any prior drug treatments provided.

Calcium Supplementation

Thin egg shells and chicks with bone deformations or broken wings have been noted in the wild (Mundy 1992), other captive breeding programmes of *Gyps* Vultures (online van de Meer accessed 14 May 2014) and in our captive-breeding programme. To combat these occurrences, we provide bone chips no bigger than 10 cm (fig 3) in the breeding enclosure year round. While small chicks are present, smaller chips must be made available. We are in the process of examining the seasonal and sex differences in bone chip consumption, but it is clear that the birds readily consume the bone chips and feed them to their chicks. We suggest the size of the bone chips should be made smaller when supplementing smaller vulture species.

Figure 3: bone chips provided are no bigger than 10cm

We manually break dried bones with a sledge hammer. These bones are from adult carcasses only, taken from remains at our vulture restaurant. We supplement a combination of vertebrae, ribs, crania, and scapula as they are easier to break manually than long bones.

Nesting Material

Figure 4: Rhus lancea *branches*

Figure 5: Cape vulture gathering nesting material, Rhus lancea branches, from the entrance of the enclosure.

VulPro provides nesting material for the birds to build their own nests. We place the material on the ground at the entrance of the enclosure for the birds to fetch and build their own nests to their particular liking and requirements. Provisioning nest material is an easy way to add enrichment to the captive birds, allowing them to display instinctual behaviors of gathering and nest building.

Nesting material needs to be free from harmful chemicals and must be safe for the birds. We use a specific fast growing tree *Rhus lancea* (fig 4) as it has proven to be non-toxic. We cut thin branches complete with leaves so the birds have flexible stems and soft leaves with which to build their nests (Fig 5). The twigs and branches provide the hard base and the leaves a comfortable lining for the nests. The birds will also use feathers and uprooted grass form the enclosure floor to further line the inside of the nest. Thus, when cleaning the breeding enclosure during the breeding season, we recommend that feathers be left for the birds to use. We will occasionally supplement cut grass or other organic materials for variety, but the birds show a clear preference for *Rhus lancea* branches.

Figure 6: This nest took the pair weeks to build and reaches one meter high.

We have seen that each breeding pair is unique in their nest building requirements. Some will build large nests, up to one meter high (fig 6), while others prepare nests which are basic and more closely resemble wild nests. Details of the nature and location of the nest for any given pair is recorded by VulPro staff. We provide nesting material daily starting in early March in southern Africa, or once habitual copulations are noted, and for the first 2 months of breeding and then reduce to every second day during egg incubation. We then reduce provisioning further to twice a week once all of the chicks have arrived.

The ability of a pair to successfully incubate an egg and rear a chick depends on the quality and stability of their nest. We have lost eggs because they rolled out of inadequately shaped nests. This is avoidable by monitoring the shape of the nest, especially close to the expected egg lay date. Each nest must have a cup, not necessarily deep, but with enough concavity to keep an egg from rolling. We have excavated a cup in existing nests using a stick with great success. Some inexperienced pairs produce an egg but fail to construct any nest due to neighbouring vultures stealing their nesting material or a lack of gathering material. This occurs rarely, but should be addressed as aiding these pairs with nest building will allow them an extra season of practice incubating an egg and rearing a chick. Ideally these issues can be identified early and some permanent structure could be added (tire, nest box) which will add a lip to the nest (fig 7), protecting the egg from rolling off the cliff entirely. We do not advise adding any permanent structure any later than the first month of regular copulations (April in southern Africa), as the disturbance of construction is too great. We have successfully added a nest box lined with AstroTurf as well as a fully formed nest made of *Rhus lancea* branches held together with two cable ties (fig 8). These additions were crafted prior to adding them on the cliff, so implementing them required minimal disturbance. Our choice of nest supplementation material is entirely pair dependent. Some pairs readily accept a next box or tire, while others react aggressively toward the object. It may be necessary to attempt supplementing multiple nest types before one is accepted. However it is far better to make sure that all nest ledges are safe for eggs. We recommend all sides of each ledge contain a 20 cm lip with drainage holes to eliminate the threat of

parents rolling eggs off the cliff face. We also recommend laying a bed of river sand on the floor of each ledge. This sand needs to be changed yearly.

Figure 7: A permanently fixed tire provides a stable nest on this ledge

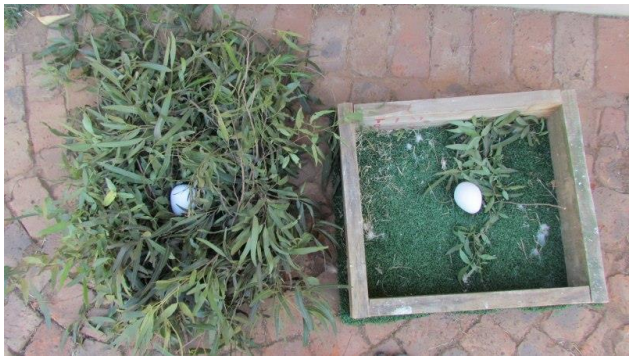

Figure 8: Artificial nests provided to various pairs to retain the egg on the nesting ledge. Pre-fabricated nest with Rhus lancea branches (left) and nest box lined with AstroTurf (right), both with a dummy egg.

Eggs and Incubation

Two or three days before the vultures lay their eggs, their behaviour changes slightly. The female becomes more lethargic and lies on her nest with increasing frequency. Egg lethargy can be nerve wracking for managers as the female may look ill prior to laying. Habitual monitoring of bird behaviour is very important in this stage. If a bird looks unable to get up, then intervention needs to occur in case of egg binding. This is not common, but one cause seems to be very cold winds during egg laying. Both male and female become more aggressive and will hiss and bite when another bird or a human gets too close to their nest.

Cape Vultures like many other vulture species only lay a single egg, so once the birds have laid, a decision must be made to leave the egg or remove for artificial incubation. Generally, VulPro tries to leave eggs with experienced breeders who have proven their ability to successful incubate dummy or real eggs. If a pair is not attentive to the egg or allows it to roll off the nest, VulPro will replace the egg as soon as possible with a dummy egg. We use a piece of painted wood in the appropriate shape (fig 9) coated with lead-free white paint. One pair successfully accepted and incubated a white painted rock of the proper size and weight, but irregularly shaped

Figure 9: false nest made for educational purposes, displaying a dummy wooden egg (left), real egg shell (right), and hatched egg displaying blood vessels and inner membranes.

In general, newly paired parents are not attentive to the egg or chick, may not incubate properly, and may allow eggs to roll out of inadequately built nests. Appropriate nesting and parental behaviours increase with age and experience. We recommend behaviours be closely monitored and management decisions reviewed annually based on evolving pair behaviours. Only pairs which have successfully incubated a dummy egg through the entire incubation period are allowed to incubate a real egg the following season.

Double Clutching

Depending on the circumstances and history of each pair, VulPro will make the decision to 'double clutch', or remove an egg from a nest without replacing it with a dummy egg. This removal of the egg should induce copulations and nesting behaviours, and the pair may produce a second fertile egg. Our captive Cape Vulture populations re-lay on average at 37 days (range 24 to 69 days) after removal of the first egg.

Some pairs have proven that they will not successfully double clutch. Either the pair does not copulate and lay a replacement, or the second egg has never been fertile. In the case of these pairs, VulPro will not consider double clutching again and will only replace the egg with a dummy egg. We never double clutch a pair in their first laying season.

If any eggs are infertile we remove the pair's dummy egg to double clutch to see if the second attempt produces a fertile egg. In this case a pair can incubate another pair's fertile egg and raise the emergent chick. Thorough record keeping of each chick's parentage is **absolutely essential**, especially in programmes which aim to retain chicks within the breeding programme. Our goal is to ensure every pair that can raise a chick incubates either a real egg or a dummy egg because a pair will not accept a chick if it has not been incubating an egg.

Swapping the egg

During the egg swapping process the birds are very aggressive. Some pairs are more aggressive than others. Multiple staff members may be required to safely monitor the surroundings and distract or handle aggressive birds, but generally we collect the egg using only two staff members. Keep in mind that you need to be in and out of the enclosure in the shortest safe time possible to minimize disturbance. A third person should stay outside the enclosure, watching for safety concerns and help open and close the gate. A full face shield must be worn, especially in an enclosure like the step-style cliff where vultures are present at eye level. Often a soft-bristled broom can be used to gently prod the incubating parent off the nest.

Figure 10: labelled egg with direction marker for determining degrees for manual rotation.

You should always have clean hands prior to going into the aviary, and the egg should be placed safely in a clean box of cotton wool, leaving it in the same position as you picked it up. It may be possible to remove and replace the egg while one tolerant parent remains at the nest, but usually we flush the birds to gain safe access to the egg. We remove the real egg from the nest before adding the dummy egg. This ensures the real egg is not damaged during the placement of the dummy. We mark and number the egg with a pencil (fig 10) and weigh the egg immediately on arrival to the incubation room. Placing a single line on the pointed end of the egg helps identify the degrees of rotation when turning by hand.

Artificial Incubation

We use a Grumbach hatching incubator set at 37.4 C and 50 % relative humidity (Fig 11). Our ambient humidity in southern Africa during Cape vulture incubation season (April to August) is extremely low, approximately 25%. Incubator settings may need to be adjusted outside our recommended settings, based on regional ambient conditions. Temperatures and humidity settings will vary depending on the situation, the type of incubator used and the species being worked with.

Early in the breeding season as copulations are becoming more frequent, around mid to late April in southern Africa, the incubator is thoroughly disinfected, attached to an uninterrupted power supply, and

turned on to become ready for egg arrival. At this time, VulPro operates with two Grumbach incubators. Ideally a bare minimum of two incubators should be available so that one unit can house suspect eggs or eggs which require a slightly different ambient environment (see more information below).

Figure 11: Incubator set to 50% RH and 37.4 C

If the vulture eggs are too large to rotate fully with the automatic turn facility, they need to be turned manually 180 degrees three times per day. VulPro turns the eggs alternatively clockwise then anti-clockwise, without lifting the egg from the incubator. Never rotate the egg in one direction only. Rotating the egg in just one direction will suffocate the chick by the twisting of the umbilical cord. Turning manually three times a day is a sensible procedure as it means you are closely and physically monitoring the eggs and the incubators. Occasionally an egg may have an infection, and the feel and smell of the egg will be different. By turning three times a day you can monitor this regularly and then swiftly remove any suspect egg (either remove and discard entirely or to a second incubator if available) to remove the risk of cross infection with healthy eggs. We recommend that the door of the incubator be opened as little as possible, to minimise changes in the climate inside the incubator. When eggs are turned and monitored, the current incubator settings (temperature and humidity) should be recorded and level of distilled water noted and refilled if necessary, as well as the time and any comments about the eggs.

We weigh all the eggs when brought to the incubator and continue to monitor egg mass loss daily. This insures the eggs have the appropriate constant rate mass loss. In calculations, the day the egg is laid is counted as development day zero (Mundy, pers. comm).

We use an egg mass loss equation adapted from *Gyps fulvus* captive breeding efforts (Hoyt 1979; online van der Meer accessed 14 May 2014) and have found it to be a useful guideline, as *G. fulvus* eggs are indistinguishable to Cape Vulture eggs (Mundy 1992). Some eggs display mass variation above and below expected values (fig 12) but generally our egg mass loss closely follows expected values, producing healthy chicks.

W1 = (length* width*diameter) * 0.000548
W2 = W1 *0.85
Estimated daily mass loss = (W2-W1)/54

W1 is the estimated mass at the date of laying and W2 is the estimated mass at internal pip. 0.000548 is a species specific constant for *G. fulvus* eggs.

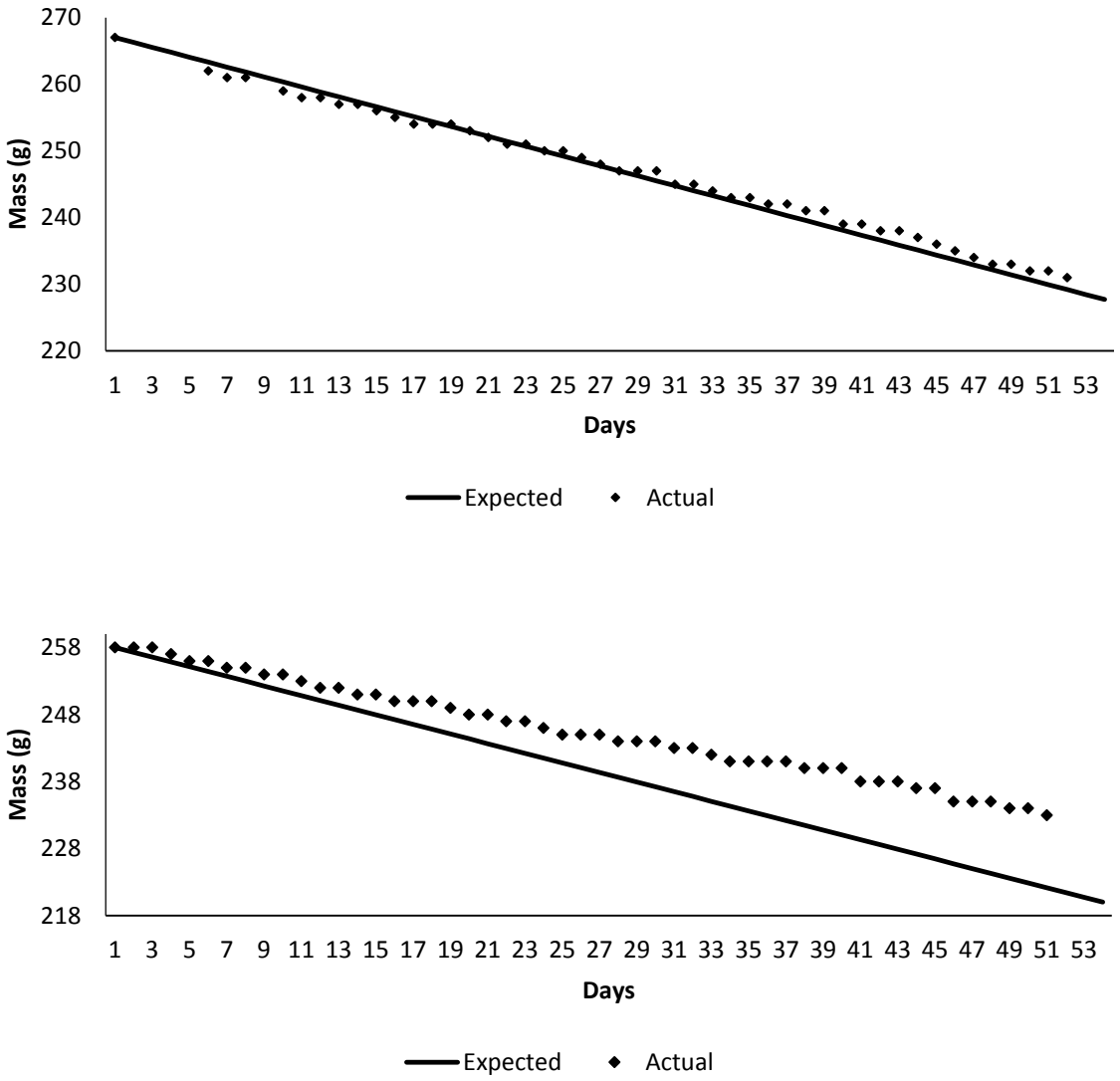

Figure 12: Graphs show the masses of 2 eggs during artificial incubation in contrast to the expected mass values. The top graph depicts an egg which mass closely followed expected values. The bottom graph depicts egg mass which was consistently higher than expected values. Both healthy eggs hatched and were raised to fledglings.

The mean duration for wild Cape Vultures from egg lay to external pipping is 54 days (Mundy 1992), counting the date of egg lay as day zero. VulPro's naturally incubated eggs fall within this range. VulPro's artificially incubated eggs generally develop more quickly and internally pip at a mean of 50.5 days (n=22). Artificially incubated eggs take an average of 2.4 days from internal pip to hatching (n=13, unpublished data). The process from external pipping to being fully hatched can take less than or more than 48 hours. Some chicks hatch quicker and others take longer, it is not an exact science.

Cracked eggs are at risk of infection which enters into the egg, resulting in chick septicaemia or bacterial infection in the blood. Cleaning the egg with F10 (diluted 1 ml to 250 ml) prior to sealing the crack will reduce infection risk (Samour and Naldo 2008). The crack can be sealed with a small piece of tissue paper and craft glue. The glue should cover the smallest surface area required. Ideally a separate incubator should be available for cracked and compromised eggs, as incubating compromised eggs separately reduces

transmission of bacterial infection between eggs (Kuehler and Witman 1988). A second incubator also allows cleaning of incubators during the breeding season. *E.coli* infection has resulted in Cape Vulture chick deaths; infection has most likely been introduced through a crack in the egg (unpublished data).

Candling

We candle the eggs to determine fertility and monitor proper egg development. We candle every few days in first few weeks, then only once a week once advanced development is noted. Fertility is usually noted by development day ten, but may be seen as early as day seven. Eggs showing no signs of fertility should not be discarded immediately but if they are not fertile by approximately day twenty one, we recommend removing them from the incubator to avoid contaminating other eggs. A separate incubator is very useful for housing these suspect eggs. Eggs should be removed from the incubator immediately if they begin to smell, the shell changes textures or changes in any fashion.

It is important to candle every egg periodically as fertile eggs can still die and potentially contaminate other eggs in the incubator. Detecting these eggs as early as possible can help identify any environmental variables which may have caused the death, allowing you to fix the problem in the future (see above mention of bacterial infection and contamination). Candling can be done more often without detriment to the chick as long as it is done carefully. It is vital to move the egg slowly when candling particularly in the early stages of development. Rough handling will kill the embryo.

Returning the chick

Previously from 2011-2015, we returned the eggs to their parents as soon as the chick began to internally pip. However, our 2015 breeding season had limited success with multiple pairs killing the chick as it was hatching. We were advised by expert advisor and founder of the Asian Vulture Crisis' vulture breeding programmes (Jemima Parry-Jones, ICBP UK) to return the chicks after a period of 10 to 22 days after hand-raising. We tried this method for the first time in 2015 with great success. Returning the chicks when older is important because they are stronger and able to withstand some harassment from the parents during the swap. They will have spent the most critical time of development (hatching and newly hatched) in the care of people, increasing overall survival rates. We have tried returning younger chicks, i.e. few days old with limited success. One chick was suffocated by parents who were not properly caring for the chick. They incubated the chick instead of brooding over it. This type of injury/death can be avoided with returning larger, strong chicks to the parents. There is no concern with imprinting this species, as long as the chick is returned to the parent within the timeframe stated, younger than three weeks.

The swapping event is critical for the success of this protocol. Each pair and individual bird will react differently. Some adults can react violently within seconds after returning the chick, resulting in chick injury or death. Approaching the incubating pair can be dangerous for staff members and should be attempted only with proper safety gear, a soft-bristled broom, face shield, and potentially multiple staff members depending on the pair (see 'Swapping the egg' section above).

Each situation is assessed based on parental behaviors toward people, toward each other, and toward the egg. For example, for one pair we may decide that only the female should be present on the nest at the time of swap, another pair it may be essential to flush both individuals, make the swap, and let them return to find the chick after people have stepped away. These decisions are made with understanding the birds' behaviour as well as trial and error. Regardless of the exact process and which birds are present, it is critical to monitor the adults' reaction to the chick and to remain close enough to intervene in seconds if the adult becomes violent toward the chick; they have the potential to kill the chick in one bite. Vultures have their own unique characters and personalities; therefore, not every pair is as forgiving to human interference. For this reason, hand-raising the chick to three weeks old might not be possible with each pair and we will thus revert to our first protocol: either allow the parents to naturally incubate, hatch, and raise their own chicks or swap the dummy egg for the real egg just after the chick internally pips. This decision is only

based on knowing the individual breeding pairs and what they will accept. The goal for every case is to give the chick the best possible chance of survival.

With all that being said, typically you will be able to tell quickly if the reintroduction was a success or not. The parents will be excited, confused, and stressed. But, if successful, they will acknowledge the chick's presence and should start brooding within a few minutes. It is also very important to monitor closely for the first 24 to 48 hours to determine if both parents are feeding the chick.

Chick to Fledgling

Calcium is crucial for proper chick bone development. It is vitally important to provide either intact small adult carcasses from which the parents can extract small bones or ready crushed bones, or better still both so the birds have options. We provide crushed adult ungulate bones at the entrance of the enclosure for parents to collect and feed the chicks. Bones from young individuals should not be provided, as these bones have lower calcium content than adult bones. Bone chips are provided year-round for the adults. However, when chicks are present in the enclosure, it is important to provide chips small enough for them to consume.

From the moment of hatching to fledging, approximately 4.5 months, we provide safe and fresh whole carcasses (livestock and game), not small meat pieces, on a daily basis for the breeding pairs to feed their chicks. Vultures obtain all their nutrient requirements from whole carcasses and the presence of whole carcasses simulates their natural feeding behaviors.

The carcasses absolutely MUST be free from veterinary drugs such as pain medication, antibiotics, anaesthetics used in darting and drugs used for euthanasia. Lead bullets should not be used to kill the animals as it might result in lead poisoning from fragments present in the meat (Cade 2007; Grund 2010). Carcasses of animals that have died of a natural disease may be good, when available, as we suspect this helps in exposing the chicks to natural elements and diseases which they will encounter in the wild, however you must know and trust the source of your carcasses and any prior drug treatments provided.

Fledglings

After all of the chicks have successfully fledged, we reduce our carcass feeding to every third day as vultures do not need to feed daily. We place the carcass at the entrance of the enclosure and all birds, including fledglings, will visit to feed. At this stage, the fledglings are still dependent on their parents for protection and sometimes feeding.

At about eight months of age, we separate the fledglings from their parents to another large communal flight enclosure. This enables the development of independence from the parents and allows the birds to develop their strength and dominance which they will need for survival in the wild. This enclosure is kept out of sight of the public. Only wild birds which are being temporarily housed for rehabilitation are in this enclosure; tame birds are not housed in this enclosure.

We have as yet to determine the optimum age for their release but we hope this will become clear within the next two years. In other similar *Gyps* species, it seems older birds integrate into wild populations more quickly (18 months to two years old may have higher short-term survival than first year birds.)

All releasable captive-bred vultures are tagged on both wings for re-sighting purposes and, for the first 5 years, every captive bred vulture released will be fitted with a GPS tracking device. In order to monitor each chicks movements and where need be, improve our methods and gain insight into their survival, it is imperative that we understand post release behaviours, survival and if problems or fatalities occur, the reasons for these.

Monitoring Captive Breeding

To further our understanding of captive breeding and advise updated management decisions, it is important to record both habitual and noteworthy behavioural observations from the breeding enclosure. Each vulture inside VulPro's breeding enclosure is marked with individually numbered tags on both wings, allowing for monitoring of individual birds and breeding pairs. We have not seen any health or safety concerns with the use of patagial tags on these captive birds. They rarely remove them and preen the area around the tag, but in general the birds do not seem bothered by their presence.

We begin monitoring when pairs start to display regular copulating behaviours, or mid-March in southern Africa. We observe the rate of copulations which advises nesting material supplementation. As copulations become more frequent we increase nesting material supplementation. Here in South Africa, at a minimum, monitoring should start two weeks before suspected egg laying, or late April as the temperatures start dropping in South Africa's winter months.

Observations are recorded using a standardized data collection sheet (Table 1). We recommend that monitoring be done from a well concealed hide, or at least from a minimum distance of 30 m from the breeding cliff to avoid disturbance/habituation of the breeding birds (and in the case of VulPro, the wild birds visiting the vulture restaurant adjacent to the breeding enclosure).

Table 1: Recommended method of recording copulation behaviors of Cape Vultures

date	time	top	bottom	location	fply (sec)	fply behaviors	mnt (sec)	mnt behavior	cop (sec)	voc?	voc ID	comments
4/11/2014	15:57	B589	B675	21	20	walk in circles	19	ruff grab	5	y	B589	B564 watches as if to harrass
4/18/2014	14:54	B589	B675	21	0		13	ruff grab	11	y	B589	
4/18/2014	15:50	Yellow Ring	B399	7	0		28	ruff grab	12	y	?	
4/18/2014	15:50	B566	B415	5	0		28	ruff grab	15	y	B566	

Non-paired individuals should be monitored as well as pairs. Captive Cape Vultures frequently engage in extra-pair copulations (EPC) or EPC attempts. These EPC attempts rarely happen on the cliff face, generally do not cause much disturbance, and should not be a major concern for management of the enclosure. They should be closely monitored, however, and if a particular individual is routinely the cause of aggression or disturbance around the cliff face it may be necessary to remove that individual to avoid future conflicts when eggs and chicks are present.

Each ledge on VulPro's breeding cliff is given a unique and permanent number (fig 14). The nest ledge of each breeding pair should be recorded. Any change in nesting ledge~~s~~ and the possible reason~~s~~ for the change should be noted. For example, when the first egg is taken from a pair, they will often move to a new site to lay their second egg, perhaps blaming the original nest for their initial 'failure'. Alternatively their neighbours might be stealing their nesting material and thus force the pair to find an alternative ledge. We recommend recording all this information with date and time of its occurrence.

Copulation frequency seems to be pair dependent. By understanding the normal behaviours of each pair, you will be more likely to anticipate egg laying and quickly identify any health concerns or abnormal behaviours and then mitigate the causes for the behaviours. As vultures typically vocalize during copulation, we recommend that the sounds of copulation are understood by observers as one can be alerted to the activity. We also believe that this sound can stimulate other couples and neighbouring pairs to copulate.

Figure 14: VulPro's artificial breeding cliff with numbered ledges for monitoring activities.

Explanation:

1. **Date and time:** Are they copulating more often in the morning or in the afternoon, closer to dawn and dusk, or in the middle of the day?
2. **Breeding pairs and their tag numbers**: Recording these details gives an idea of the sex of each individual, as generally (but not always) the male will be on the top. Occasionally single sexed pairs develop if there is a sex skew in the enclosure. These pairs behave exactly the same as a normal pair, but will not produce fertile eggs. The number of different pairs copulating in a day and how often a particular pair copulates per day should be noted.
    - Our birds exhibit a high proportion of copulation attempts outside of pairs. These interactions are not always successful and usually occur off the cliff face, but should be noted. In particular, a few paired males have formed relationships with individuals who are not their partner. In these cases, aggressive encounters at the nest are more frequent and have the potential to negatively influence the pair's breeding. It is important to note who is involved in these extra-pair copulations to assess parentage of any additional eggs found in the enclosure or nests. We have never found two eggs in one nest, but this has occurred in the wild and is suspected to result from different females laying in one nest (Mundy et al 1992).
3. **Place in enclosure:** The vast majority of paired copulations take place either inside the nest or next to it. If a pair continuously copulate elsewhere, it may be an indication the pair has changed their nest site.
4. **Duration of foreplay and copulation in seconds:** Foreplay is any behaviour noted prior to mounting. The behaviours may be as subtle as a change in body posture, and may or may not include vocalizations. Mounting starts as soon as one individual stands on the other's back. Copulation starts at the first contact of cloacas. Successful copulation takes place with the cloaca

of both vultures touching each other. Often a couple will mount but copulation is not successful, as cloacal contact is never made.

5. **Comments:** Note everything before, during or after the copulation that might be important. (for example, if copulation was attempted but disturbed by a neighbouring vulture).

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