Article — Artikel

Vulture rescue and rehabilitation in South Africa: An urban perspective

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ABSTRACT

South Africa is home to 9 vulture species, of which 7 are endangered. While the cause of the population declines remains largely speculative, a vast amount of effort has been dedicated towards the protection of populations by ensuring sustainable and safe food sources for the various colonies. Limited focus was placed in the past on efforts related to the rescue and/or rehabilitation (R&R) of injured birds and the release of these birds back into the wild. This paper provides an overview of the causes, the impact and success of 3 organisations involved in R&R efforts of vultures in the Magaliesberg mountain range and surrounding areas over a period of 10 years. Study material included 162 Cape griffon (CGV) and 38 African white-backed (AWBV) vultures. Datasets include the number, sex and age of birds received, the reason the vultures were brought in for R&R, surgical interventions performed and outcomes of rescue efforts. The CGV dominated the rehabilitation attempts. Results further show that a large number of apparently healthy birds were presented for veterinary treatment. The R&R data clearly indicate that the major cause of injuries was birds colliding with overhead pylons, as a high number of soft tissue and skeletal injuries were observed. The study also shows that successful releases of rescued birds are possible. It is concluded that urbanisation has had a major negative impact on vultures around the Magaliesberg mountain range.

Keywords: African white-backed vulture, Cape griffon vulture, *Gyps*, Magaliesberg, rehabilitation, rescue, vultures.

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INTRODUCTION

Vultures are characterised by their large size, large featherless heads, curved beaks and are known for being high fliers[17]. They are further differentiated from other raptors by being predominantly carrion feeders that only resort to predation in times of extreme food shortages[5,13,17]. Being scavengers, vultures are important components of healthy ecosystems where their major contributory ecological role is to devour carcasses thereby preventing the spread of diseases[8,16,17,24]. The family is made up of the old-world (accipitrid) and the new-world (cathartid) vultures with the former, also known as griffon vultures, being the true descendants of the vulture species. The latter, such as the condor and black vulture, have evolved from the stork family[1,30]. Despite their important role in ecosystem health, vulture numbers throughout the world have declined at a rapid rate with southern Africa being no exception, having 7 of the 9 species listed in the Red Data Book[4,9,12,14,15,18,24,26].

Of the 9 vulture species in southern Africa, the Cape griffon vulture (*Gyps coprotheres*) (CGV) and the African white-backed vulture (*G. africanus*) (AWBV), are the most abundant, with the former being near-endemic only to this region[9,30]. The CGV is currently listed as vulnerable and the AWBV near-threatened with the latest estimates placing the AWBV at 270 000 individual birds in Africa and the CGV at approximately 4000 breeding pairs in southern Africa[9]. While the AWBV and CGV are of markedly different size (5.5 kg *versus* 9 kg), the species share a number of similarities that include lifetime pairing, breeding once a year with on average the production of 1 egg per year[17]. Phylogenetic studies suggest that the 2 species are genetically closely related[28]. Unconfirmed reports from Namibia suggest interbreeding between the 2 species to produce hybrids (Rare and Endangered Species Trust (REST), Namibia, pers. comm.). The only major difference between the 2 species is their nesting sites as the CGV nests on cliff faces while the AWBV prefers nesting in trees.

Both species face major threats within the southern African region that include poisoning, electrocution, power-line collisions, habitat destruction, insufficient food resources, disruption of breeding sites and the illegal collection of body parts for traditional medicine[2,6,10,11,17,20]. In an effort to prevent the decline in the number of birds, various initiatives to contribute to the conservation of the species were put in place. One of these initiatives is the so-called vulture restaurants, which in collaboration with the local farming community provide carcasses to vultures to supplement their food resources[17,20]. Other efforts include educational material such as posters and booklets advising farmers on the use of eco-friendly products and creating awareness around vulture poisonings, attempts by the national energy provider (ESKOM) to research and erect vulture-friendly pylons, the promotion of vulture ecotourism and the rescue and/or rehabilitation (R&R) of injured or poisoned birds collected in the field. This paper focuses on the causes, the impact and successes of rescue and/or rehabilitation (R&R) efforts of birds as a valid component of vulture conservation in southern Africa in a semi-urban environment.

MATERIALS AND METHODS

Study area

The study area in Pretoria and the Magaliesberg mountain range is semi-urban and under intense housing development, e.g. a major golfing estate is present 1.5 km from a major breeding area on the Magaliesberg cliffs (Figs 1 and 2). This area is home to 10 % of the total CGV population and includes approximately 400 breeding pairs on the cliffs[7]. AWBVs are not known to breed within the study area.

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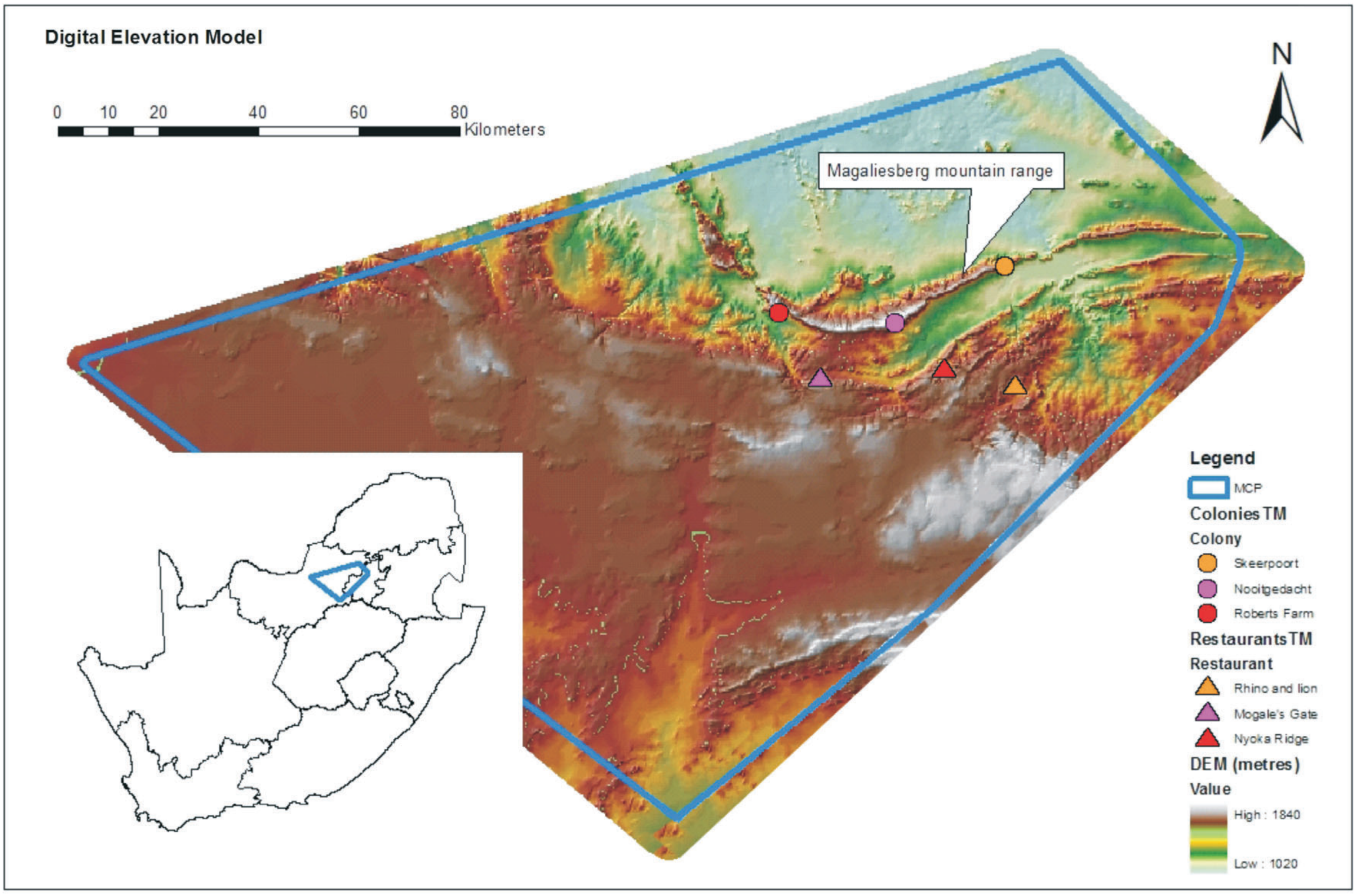

Fig. 1: **Illustration of the 3 colonies of Cape griffon vultures that have featured widely in rehabilitation efforts. The 3 colonies are found along the Magaliesberg mountain range. The 3 restaurants are areas where the birds are routinely fed. The Magaliesberg mountain range runs into Pretoria city, which lies approximately 20 km due east of the vulture colonies**.

Participating organisations

The 3 organisations that contributed data to this study are the De Wildt Cheetah and Wildlife Trust (De Wildt), the National Zoological Gardens of South Africa (NZG) and the Vulture Programme of the Rhino and Lion Wildlife Conservation NPO (R&L). While undoubtedly vulture rehabilitation is occurring throughout the country, there was a concerted effort by these organisations to dedicated vulture conservation in the region. For the purposes of this study, rehabilitation was defined as the process of restoring sick or injured birds to a normal life by therapy and ensuring fitness prior to final release back into the wild. Rescue is similarly defined as rehabilitation, except that these birds were not released into the wild. The former was ascertained as a result of the tagging process which allowed for the resighting of released birds. To obtain an understanding of the management of the birds during rehabilitation, a description of each of the facilities follows:

De Wildt Cheetah and Wildlife Trust (*De Wildt*)

De Wildt focuses on cheetah conservation and breeding. In addition, endangered species such as the African wild dog and vultures are part of the collection. Vultures at this facility include CGVs (n = 50) and AWBVs (n = 8) that are housed in five 5 m × 10 m × 3 m (L × B × H) aviaries. The birds are mainly grounded with limited flight. Artificial perches comprising tree stumps and wooden logs are provided. The facility has housed birds for nearly 20 years, with animal record keep-

Fig. 2: **Photograph showing the development adjacent to the cliffs of the Magaliesberg, where the vulture colony resides**.

ing extending back to 2002. Data are captured into a purpose-built Office Excel (MS Office) spreadsheet. Individuals of both vulture species were presented to the facility for rehabilitation and were either collected by De Wildt staff from the Magaliesberg colony and surrounding areas or received from outside organisations where more advanced veterinary care was lacking.

Veterinary care of injured birds was provided by a full-time veterinarian at an on-site veterinary clinic. Injured birds were housed in individual pens until released into the wild. For specialised veterinary procedures, assistance was provided by the Exotic Animal Clinic at the Onderstepoort Veterinary Academic Hospital (OVAH) run by the Faculty of Veterinary Science of the University of Pretoria. In most cases, after receiving specialist care, vultures were returned to De Wildt facility for after-care.

National Zoological Gardens of South Africa (NZG)

The NZG has a record of housing, conserving and exhibiting wildlife that extends over 100 years. The facility has a large aviary (30 m × 20 m × 5 m) (L × B × H) housing both CGV and AWBV. The aviary mimics a natural environment with a number of natural trees as well as a raised cliff with ledges suitable for breeding. Birds presented to the facility for rehabilitation originated from collections made by NZG staff and the public from the Magaliesberg colony and surrounding areas. In addition, the organisation accepted AWBVs as well as CGVs from their satellite facility in Lichtenburg which has an active vulture restaurant frequently used by both vulture species.

An on-site animal hospital and 3 full-time wildlife veterinarians are responsible for the daily health care of the animal collection. It also has an extensive animal record-keeping system linked to the International Species Information System (ISIS). As with De Wildt, the more specialised veterinary procedures were referred to the OVAH whereafter birds were returned to the facility for after-care. Rehabilitated birds were either included in the animal collection or traded within the zoo community. The NZG has been successful with the captive breeding of both vulture species since 2002 and in particular the artificial incubation of eggs and hand-rearing of nestlings.

Vulture Programme of the Rhino and Lion Wildlife Conservation NPO (R&L)

The R&L was established in 2006 with the aim of adding an important conservation component to vulture rehabilitation, especially investigating the survival rate of newly released rehabilitated vultures. The facility has a number of different enclosures of various sizes, all of which are fitted with perches. The largest of the enclosures (40 m × 9 m × 7 m) (L × B × H) was sponsored by Eskom and enables the birds to fly to some extent to increase their fitness prior to release. Birds presented to the facility for rehabilitation were either collected by staff from the Magaliesberg colony or surrounding areas whereas mainly AWBVs requiring more advanced veterinary care were accepted from other organisations.

The facility also has 6 enclosures (3 m × 3 m × 6 m) (L × B × H) for the housing of individual injured or sick birds while recuperating. All veterinary treatments are provided by the OVAH or the Veterinary Department at the Johannesburg Zoological Gardens. All birds kept or released are identified using patagial tags on each wing (Fig. 3). The tags have visible numbers as well as contact details to facilitate monitoring. This facility follows a strict release protocol by returning birds they personally collect to the wild within 7 days of recovery after receiving treatment.

Data collection

Data collected include the number, sex and age (adult, subadult and juvenile, nestlings) (Table 1)[17] where possible for all birds received for rehabilitation. Injuries were classified as soft tissue or skeletal injuries (fractures), exhaustion or poisoning. Surgical interventions where necessary were described as amputations (removal of 1 or both wings), fracture repair (surgical pinning), birds that died during surgery (anaesthetic death) and birds euthanased for ethical or welfare reasons. The outcome of rehabilitation was assessed as the number of birds released. Data were collated from the patient records maintained by the respective organisations over the specified 10-year period and presented as the number and percentage of birds handled by each organisation.

The same method for determining the age of vultures widely used by the vulture fraternity (although not statistically validated), was applied by all 3 facilities. This method makes use of external characteristics listed in Table 1. The De Wildt and R&L birds were sexed according to the general morphological characteristics of the head (non-validated method). Females have a narrow head (as seen from the lateral canthus of the eyes) with egg-shaped dome at the top of the skull, while the males have a more triangular, flattened head with more prominent eye sockets (Fig. 4). The NZG makes use of laparoscopy and more recently DNA technology using Polymerase Chain Reaction (PCR) to determine sex[7]. Genomic DNA was isolated from blood collected in EDTA tubes using the Qiagen DNeasy Blood and Tissue kit®. Amplification of the CHD1 gene was conducted using primer sets; 2550F: 5′-GTTACTGAT TCGTCTACGAGA-3′and 2718R: 5′-ATT GAAATGATCCAGTGCTTG-3′[27]. PCR amplification was carried out in a total volume of 25 $\mu\ell$ and included a no template control as well as positive controls for a male and female bird of known sex. PCR was conducted with Promega go *Taq* DNA polymerase®, which has a 1 × buffer containing 10 mM Tris® HCl (pH 9.0), 50 mM potassium chloride (KCl) and 0.1 % Triton® X 100. The final reaction conditions were as follows: 1 x PCR buffer, 1.5 mM $MgCl_2$, 200 $\mu\ell$ of each 2′ deoxynucleotide triphosphate (dNTP), 5 pico mol (pmol) of each of the forward and reverse primer, 0.25 units (U) *Taq* DNA polymerase and 10 ng genomic DNA template. PCR cycling were as follows: Denaturation for 2 minutes (min) at 94 °C , followed by 30 cycles of denaturation for 30 seconds (s) at 94 °C, primer annealing for 30 s at 50 °C and extension for 2 min at 72 °C, followed by final extension at 72 °C for 10 min. PCR products were added to tracking dye and were separated by electrophoresis in a 2 % agarose gel for 45 min at 100 volts in 1 x Tris-Borate-Edta buffer (TBE).

RESULTS

A total of 163 CGVs and 38 AWBVs were received during the specified period by the 3 organisations. Age distribution for the CGV showed that 43.5 % were adults, 1.2 % subadult, 44.7 % juveniles and 9.4 % nestlings. The AWBV had a very similar distribution of adults and juveniles at 41.18 % and 47.6 % respectively. The sex ratios was evenly distributed for the CGV, and skewed towards males for the AWBV (Table 2).

De Wildt attempted rehabilitation of 85 (52.5 %) of the CGVs, mainly adult males (Table 2). The majority of the CGVs (n = 33) collected were recorded as power lines or pylon injuries which resulted in soft tissue injuries and in more severe cases, in fractures and ultimately amputations (Tables 3 and 4). In total, 26 of the 33 CGVs presented from power-line injuries required more advanced surgical intervention (Table 4). It is also interesting to note that a large proportion of birds were presented for minor reasons such as apparent exhaustion (n = 27) or birds picked up following heavy rain (n = 22).

A total of 17 (52.5 %) AWBVs were

Table 1: **Methods used to age vultures, based on external characteristics.**

Feature	Cape griffon			African white-backed		
	Adult vulture	Juvenile vulture	Subadult	Adult vulture	Juvenile vulture	Subadult
Iris	Straw-yellow	Black	Black	Black	Black	Black
Neck skin	Appears bluish in colour and naked for much of its length	Coloured pink to magenta		They have long necks covered in thin downy feathers. Neck skin is black.	Thickly covered in downy white cotton wool. The skin is yellowish-green with number of black spots, with bare patches on either side of the crop.	
Head	Facial skin has a hint of blue. Head is covered in short white 'hairy' feathers which generally point backwards.	Head is covered in woolly down		The down on the head is hairy looking. Bill and head skin are black.	Thickly covered in downy white feathers. The skin is yellowish green with number of black spots which coalesce in front of the eye.	
Feathers	Contour or body feathers are plain creamy-white. Long scapulars and tertiaries down the adult's back are also distinctive in this regard, each having a broad white edge and a central blackish-brown patch. The naked 'eye' patches have a bluish skin which is often tinged with red around the perimeter and they are surrounded by white down.	The naked 'eye' patches on the either side of the buggy crop and high-lighted by their surrounds of white down, having the same skin colour as the neck. Contour feathers are pointed, streaked and generally browner in colour.	Features of the adult plumage slowly appear, but not all at once. Contours have a central black patch and the secondaries acquire pale undersides. Later the streaking almost disappears.	The adults are variable in colour, a few being off-white and the most being variations of dark brown. The down on the head is hairy looking. The contour feathers are uniformly coloured and usually plain, with the last row of upper-wing coverts being plain blackish brown. The back of the animals are pure white.	The body and wing contour feathers are slate coloured with each feather having a white midrib.	New feathers are rounded. The ruff disintegrates and the contours show a paler hue from the 3rd or 4th year. In the 4th year, white feathers also appear on the back to completely change by 6 years age.

collected, most of which were adult males (Table 2). Of these, 10 were presented as a result of power-line injuries and the rest were mainly healthy with the exception of 1 chick which had fallen from a nest (Table 3). A large percentage of the AWBVs presented with injuries that required surgical interventions. This high incidence is most likely attributable to birds requiring advanced veterinary care that were collected from outside the Gauteng and North West Provinces by rehabilitation agencies. One bird was brought in for organophosphate poisoning. This specific vulture was treated with fluids and atropine and eventually recovered. In total 40 (47.1 %) CGVs and 3 (17.6 %) AWBVs were ultimately released and the rest remained in captivity (Table 5).

The NZG received a total of 32 (19.8 %) CGVs comprising 94 % adult birds of which most were males. Injuries were mainly due to suspected pylon collisions as the birds were found on the ground in close proximity to power lines (Tables 2 and 3). The NZG released 2 CGVs following treatment (Table 5). The AWBVs presented to the NZG were mainly healthy birds received from welfare organisations (Tables 2 and 3). One of the AWBVs was diagnosed with skeletal abnormalities (cortical thinning with decreased radio density) that were consistent with a calcium deficiency. The other was brought in due to a pylon injury and the 3rd was rescued after being kept as an exotic pet. The latter had its wings clipped and was not able to fly. There is no history as to how the wild bird ended up as a pet. None of the AWBVs required surgical intervention for their rehabilitation (Table 4).

The R&L accounted for 45 (27.8 %) and 10 (26.3 %) of the CGVs and AWBVs respectively, comprising mainly juveniles and nestlings. Of this a large number were received after rainy conditions which also explains the high percentage of unknown sexes for the CGV at R&L (Table 2). Although 66 % of the CGVs were received due to an inability to fly, no detectable anatomical injuries were found on clinical examination (Table 3). These birds recovered within 2–3 days after having been fed. Seven birds had to be euthanased due to severe wound contaminations and severe complications (myiasis and bacterial infection) (Table 3). In 1 incident 6 AWBVs were presented for suspected arsenic poisoning. These birds originated from a colony of 15 birds of which 9 were found dead (dead birds are not included in this study). Arsenic poisoning was diagnosed from necropsy results which showed haemorrhagic gastroenteritis, clinical signs of excitability of the live birds and recovery following treatment with penicillamine. The R&L released a total of 21 of the 45 (46.7 %) rehabilitated CGVs and 7 of the 10 AWBVs (70 %) (Table 5).

DISCUSSION

The aim of this study was to describe the efforts to rescue and/or rehabilitate vultures in the Magaliesberg area of South Africa by 3 organisations. Although the AWBV is the most abundant vulture species in southern Africa[9], rehabilitation was dominated by the CGV within the 3 centres. This most likely reflects a difference in the behaviour of the 2 species, in that the AWBV nests in trees, and the CGV on cliffs. The Magaliesberg mountain range running through the greater Pretoria area and Gauteng region provides ample nesting opportunities for the CGV.

In total, 63 (38.9 %) CGVs and 10 (26.3 %) AWBVs were rehabilitated, while 68 (42.0 %) CGVs and 25 (65.8 %) AWBVs were retained in captivity. The reason for the greater skew towards retaining a bird in a captive environment stems from the huge responsibility and effort that rehabilitation requires. For rehabilitation, the

Fig. 3: **Adult Cape griffon vulture with a patagial tag on the right wing, metal ring on the right leg and a telemetric tracker on the back. The picture illustrates the ease of identification that the patagial tags offer over conventional rings, especially at distance**.

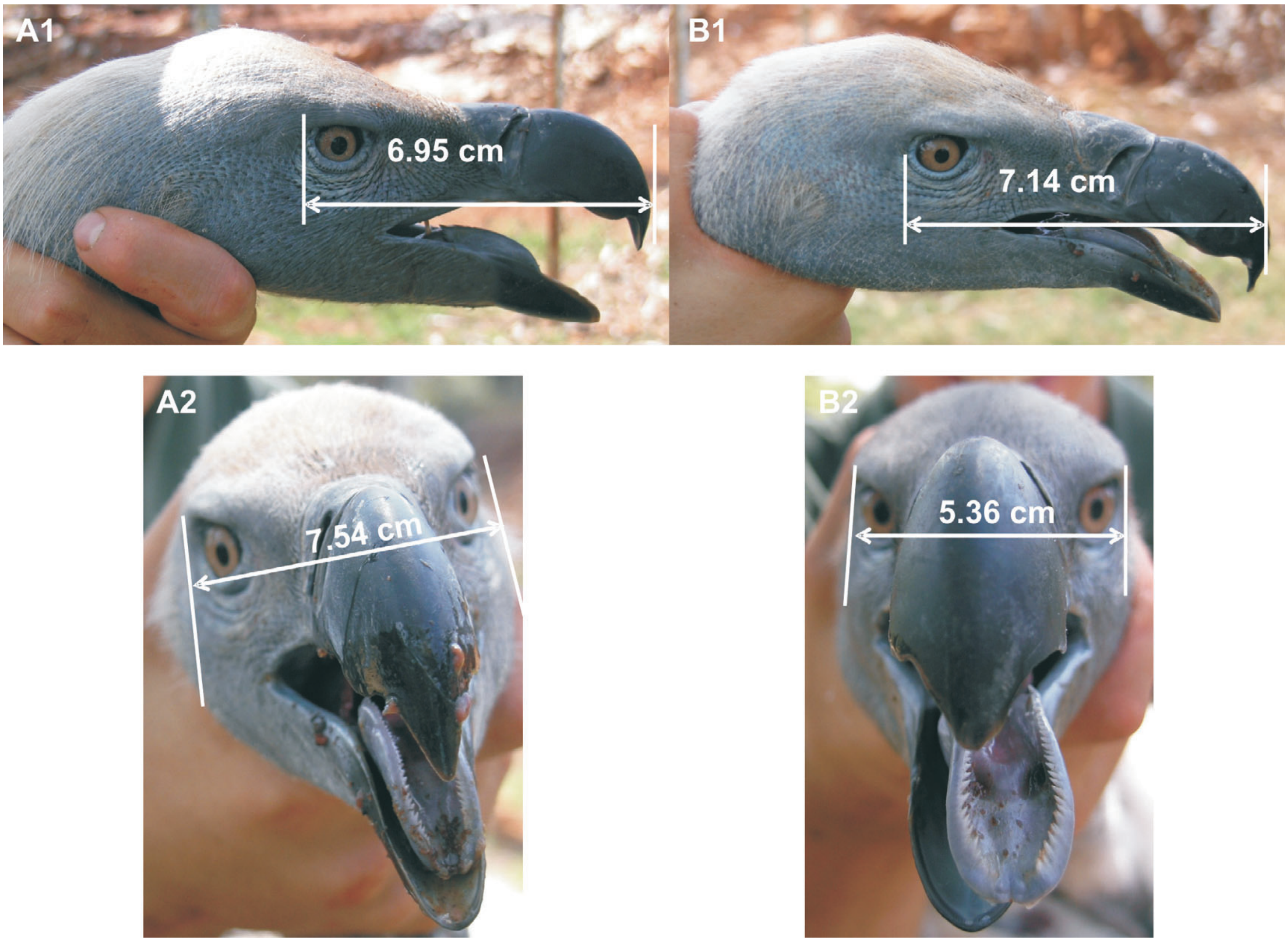

Fig. 4: **Illustration of the morphological differences between male** (A1 & A2) **and female** (B1 & B2)**. Female heads are typically longer** (B1) **and narrow** (B2), **while the male heads are shorter** (A1) **and broader** (A2)**.**

Table 2: **The number, age and sex of birds that were presented for rehabilitation. Values in brackets are percentages.**

Organisation	n	Sex: Male	Sex: Female	Sex: Unknown	Age: Adult	Age: Subadult	Age: Fledgling	Age: Unknown
Gyps coprotheres **(CGV)**								
DeWildt	85 (52.47)	38 (63.33)	34 (61.82)	13 (27.66)	37 (52.11)	39 (70.91)	8 (22.86)	1 (100.00)
R&L	45 (27.78)	5 (8.33)	9 (16.36)	31 (65.96)	4 (5.63)	14 (25.45)	27 (77.14)	0
NZG	32 (19.75)	17 (28.33)	12 (21.82)	3 (6.38)	30 (42.25)	2 (3.64)	0	0
Total	162	60	55	47	71	55	35	1

Organisation	n	Sex: Male	Sex: Female	Sex: Unknown	Age: Adult	Age: Subadult	Age: Nestling	Age: Unknown
Gyps africanus **(AWBV)**								
DeWildt	17 (44.74)	9 (47.37)	3 (27.27)	5 (62.50)	7 (33.33)	8 (57.14)	1 (50.00)	1 (100.00)
R&L	10 (26.32)	5 (26.32)	4 (36.36)	1 (12.50)	3 (14.29)	6 (42.86)	1 (50.00)	0
NZG	11 (28.95)	5 (26.32)	4 (36.36)	2 (25.00)	11 (52.38)	0	0	0
Total	38	19	11	8	21	14	2	1

R&L: Rhino & Lion Wildlife Conservation Non-Profit Organisation; NZG: National Zoological Gardens of South Africa.

major factor to consider is the fitness of the bird for free flight and survival, *i.e.* loss of muscle tone for flight and increase in body mass due to the deposition of fat from general inactivity. The R&L with a 51 % release rate assesses the fitness level of birds by their ability to fly in a large training aviary before release. Another factor that had a major impact on rehabilitation was the degree of injury, as evident from the poor release rate of birds with fractures – severe cases either required amputation or orthopaedic surgery. For both cases flight is not possible, the former for obvious reasons, while the latter usually resulted in slight bone mal-apposition that subsequently interfered with the precise aerodynamics required for sustainable long-distance flight[21]. Unfortunately, available avian orthopaedic techniques are still very inadequate to meet the precise requirements for flight.

An interesting observation from this study was the large number of apparently healthy birds presented for treatment after heavy rains. The flight feathers of the birds appear to be water-logged and these birds are unable to take off after heavy rains, which is believed to have resulted from a combination of the birds being overweight from the constant feeding at vulture restaurants (14 kg has been recorded for this region for CGV dry weight) and the feathers soaked with water. The latter is not an oddity as the popular press commonly reports waterlogged feathers as a major obstacle to flight. When the increased weight from excessive caloric intake is combined with the flight behaviour of vultures, an interesting aerodynamic challenge is faced by birds – already being heavy fliers, vultures are predominantly reliant on thermal currents for take-off, soaring and mobility in an attempt to conserve energy to compensate for their weight to energy/aerodynamic requirements for flight[19,23]. The added burden of being overweight in combination with the additional weight of the water interferes further with their flight characteristics. Unfortunately this also translates to non-flight in the absence of thermal currents, which restricts soaring to mid-mornings when the first thermals arise, *i.e.* vultures are rarely seen soaring on days characterised by overcast and cool conditions. Healthy vultures presented on rainy days also suggest that the birds were grounded and unable to fly as opposed to being injured or dehydrated. This highlights an added danger that vulture colonies have to face because of a close association with human habitation. It is likely that this would not occur in the wild and that the birds would normally return to their roosts if provided with sufficient time to fly again.

Another explanation for their non-flight may be mild poisoning that resulted from

Table 3: **Conditions managed during rehabilitation by the respective organisations. Values in brackets are percentages.**

Organisation	n	Soft tissue injuries	Skeletal injuries	Exhaustion	Compromised*	Poisonings
Gyps coprotheres **(CGV)**						
DeWildt	85 (52.47)	7 (43.75)	26 (57.78)	27 (90.00)	22 (34.38)	3 (42.86)
R&L	45 (27.78)	0 (0.00)	11 (24.44)	3 (10.00)	31 (48.44)	0 (0.00)
NZG	32 (19.75)	9 (56.25)	8 (17.78)	0 (0.00)	11 (17.19)	4 (57.14)
Total	162	16	45	30	64	7

Organisation	n	Soft tissue injuries	Skeletal injuries	Exhaustion	Healthy	Poisonings
Gyps africanus **(AWBV)**						
DeWildt	17 (44.74)	3 (50.00)	8 (80.00)	0	5 (38.46)	1 (11.11)
R&L	10 (26.32)	1 (16.67)	1 (10.00)	0	0 (0.00)	8 (88.89)
NZG	11 (28.95)	2 (33.33)	1 (10.00)	0	8 (61.54)	0 (0.00)
Total	38	6	10	0	13	9

R&L: Rhino & Lion Wildlife Conservation Non-Profit Organisation; NZG: National Zoological Gardens of South Africa.
*Birds unable to fly due to unknown causes.

Table 4: **Number of birds in which surgery was attempted by the different organisations. Values in brackets are percentages.**

Organisation	***Gyps coprotheres* (CGV)** *n*	Amputations	Fracture repair	Died during surgery	Euthanased due to poor prognosis
DeWildt	26 (60.47)	15 (83.33)	11 (57.89)	0	0
R&L	11 (25.58)	1 (5.56)	3 (15.79)	0	7 (100)
NZG	8 (18.60)	2 (11.11)	5 (26.32)	1 (100)	0
Total	43	18	19	1	7
	***Gyps africanus* (AWBV)**				
DeWildt	8 (88.89)	8 (88.89)	0	0	0
R&L	1 (11.11)	1 (11.11)	0	0	0
NZG	0	0	0	0	0
Total	9	9	0	0	0

R&L: Rhino & Lion Wildlife Conservation Non-Profit Organisation; NZG: National Zoological Gardens of South Africa

their feeding on a contaminated carcasses. The 1 group of toxins that could explain the clinical signs observed are the organophosphors, which are known to be inducers of muscle weakness. For the past 20 years the NZG has received a number of raptors, ranging from owls, hawks, eagles and 1 vulture (n = 28) which presented either in a state of collapse or with mild symptoms of incoordination and general weakness. Symptomatically it was suspected that these birds had ingested poison, but this was never confirmed by laboratory tests. Some birds recovered well with treatment and feeding and others died, but *post mortem* results were inconclusive of poisoning. A white-backed vulture that had collapsed and had head tremors recovered dramatically after it was treated with atropine. It is therefore speculated that general weakness in vultures could be due to ingestion of low doses of a toxin.

The rehabilitation data clearly indicate that pylons were the major cause of injuries as demonstrated by the high number of soft tissue and skeletal injuries observed. It is speculated that this may be due to the inability of the birds to see power lines, as seen in other bird species, combined with the likelihood that they are unable to gain sufficient altitude rapidly enough to avoid power lines near their foraging sites[3]. In total, 61 (38 %) CGVs and 16 (42 %) AWBVs were presented with these injuries. These observations therefore tend to support the earlier reported observations that the population declines of the CGV may be attributed to pylon injuries, but this is not necessarily the only cause[27].

Concerning the higher number of releases of rehabilitated vultures by the R&L and De Wildt, it is clear that successful release of the rehabilitated birds is possible. More importantly , it emphasises that contrary to popular belief, vultures do not immediately imprint on handlers. When the release data of R&L were evaluated for any correlation between duration within a capture enclosure to release (results not shown), none was found. Nonetheless, the release data need to be interpreted with care, as success is defined as the failure to find a vulture carcass soon after release, *i.e.* inaccuracies could result from jackal or other predators devouring dead vultures before the carcasses are found. In an attempt to better investigate the impact of rehabilitation and release for future projects if funding permits, it may be of value to attach telemetric trackers (cellular or satellite) at the point of release. For the birds on which the R&L had cellular trackers attached, the death of the released bird was established by a non-movement of the GPS tracker over a few days. The GPS trackers also to a large extent overcome the shortcomings of patagial tags that may not be sighted as a result of death, non-movement through a monitoring point or loss of the tag.

CONCLUSIONS

With the huge inputs and dedication by various organisations, there is now a better understanding of the causes, impact and success of R&R of vultures. Of concern are the rehabilitation figures from De Wildt and R&L, which account for more than 120 birds out of a colony of just under 380 breeding pairs (17 % of the total population required medical attention) recorded over the last 10 years. This study provides 1st evidence of the impact urbanisation has had on vultures from the Magaliesberg and surrounding areas. While the data clearly indicate that rehabilitation efforts are required, they may not necessarily be having their desired

Table 5: **Different outcomes of the rehabilitated birds. Values in brackets are percentages.**

Organisation	***Gyps coprotheres* (CGV)** *n*	Released	Kept in captivity	Traded	Euthanasia
DeWildt	85 (52.47)	40 (63.49)	38 (55.88)	6 (35.29)	1 (7.14)
Rhino and Lion	45 (27.78)	21 (33.33)	10 (14.71)	2 (11.76)	12 (85.71)
NZG	32 (19.75)	2 (3.17)	20 (29.41)	9 (52.94)	1 (7.14)
Total	162	63	68	17	14
	***Gyps africanus* (AWBV)**				
DeWildt	17 (44.74)	3 (30.00)	14 (56.00)	0	0
Rhino and Lion	10 (26.32)	7 (70.00)	2 (8.00)	1 (33.33)	0
NZG	11 (28.95)	0	9 (36.00)	2 (66.67)	0
Total	38	10	25	3	0

R&L: Rhino & Lion Wildlife Conservation Non-Profit Organisation; NZG: National Zoological Gardens of South Africa.

impact, as the percentage of released birds remains relatively low (47.1 % for CGV and 17.6 % for AWBV). Nonetheless, the true value of rehabilitation efforts is their ability to protect the species, as even a single bird that is saved represents continued maintenance of genetic diversity within the threatened population.

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