

Monitoring Vultures by Cellular Tracking Devices

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Summary

In December 2005, The De Wildt Cheetah & Wildlife Trust's Vulture Unit initiated a project to fit cellular tracking devices onto rehabilitated vultures ready for release. A total of 35 vultures were released during 11 different release operations. 12 Vultures were released with cellular tracking devices (ctd) while 23 vultures were released without ctd. All 35 vultures were marked with patagial tags and numbered SAFRING metal leg rings. AWT-GSM GPS backpack cellular tracking devices (African Wildlife Tracking, Pretoria, RSA), using a harness made of nylon ribbon and tygon tubing and patagial tags (Axxon, RSA) were fitted to three vulture species, namely; a Lappet-faced vulture (*Torgos tracheliotos*) (n=1), African-White-backed vultures (*Gyps africanus*) (n=3) and Cape Vultures (*Gyps coprotheres*) (n=8). The 23 vultures without cellular tracking devices were all CV's. The released vultures spent anywhere from less than 4 months (n=24) to more than ten months (n=11) in captivity. The released vultures were monitored for as long as possible and the monitoring only stopped when dead or weak vultures were recovered or the tagged vultures no longer sighted. Thirteen birds died or were recaptured in a weakened state, with one disappearing altogether; of which 11 were in captivity for 10 months or more. The birds that spent 4 months or less in captivity flew off. One of these later drowned, 2 were electrocuted, and two removed their cellular tracking device (ctd) via the 'weak' link, all within 2 months of release. One of the vultures fitted with a ctd. is still being tracked. The ctds functioned as specified with three readings per day. More readings per day would give a better indication of the route flown but should be weighed up against a decrease in battery life and thus the long-term usefulness of the device. It appears as if the success of these vulture releases can be attributed to the period of time the birds were held in captivity, namely 2 months or less having the best success. Factors that may be negatively affecting the success rate of released vultures include fitness (decreased fitness over time held in captivity), disorientation (releasing vultures far from where they were originally found) and excessively fat vultures (increased fat to muscle ratio over time in captivity).

Introduction

Several research projects involving various species of vulture have been conducted over the last three decades in southern Africa e.g.: Pesticide levels and eggshell thickness in Cape Vultures (Grant *et al.* 1979); Electricity Tower design and bird mortality by electrocution in Africa (Ledger 1980); Energy requirements and food resource of the Cape Vulture (*Gyps coprotheres*) in the Magaliesberg, Transvaal (Komen 1981); Post-fledging dependence periods of Cape Vultures at the Potberg colony (Robertson 1984); Mortality of blow-fly larvae (Diptera: Calliphoridae) in the digestive tract of vultures (Braack 1984); A review of raptor persecution in southern Africa with special regard to farming communities (Chittenden 1985); Status, nesting and nest site selection of Cape Vultures in Lesotho (Donnay 1990); Vulture distribution in Botswana (Borello 1987); A study of the Bearded Vulture (*Gypaetus barbatus*) in southern Africa (Brown 1989), Vultures and the trade in traditional medicines (Cunningham 1990), Mass African White-backed Vulture poisoning in the northern Cape (Anderson 1993), Mortality of African White-backed Vultures in the North-West Province, South Africa (Anderson 1995). Yet there are still several aspects about vulture biology and ecology that we do not understand. These include survival of released birds, flight capacity, land use, dispersal/ dispersion and home range sizes (Boshoff *et al.* 1997).

The success of a release back into the wild is reflected in the wellbeing of the free-ranging vulture over an extended period of time. It is not known what the overall survival rate is of released rehabilitated vultures. Because vultures are not restricted in movement by structures such as fences, human habitation or high mountain ranges, their follow-up monitoring by way of observations are difficult, if not impossible. The use of a cellular tracking devices, where the exact

location of each bird fitted with a tracking device can be plotted, offers an effective way of monitoring the released vulture during the critical period following release, until successfully foraging over the next few months. Only the expense of the device prohibits its use with the release of every vulture.

A number of vultures from the De Wildt Vulture Unit were made available for the Pilot Study, the aim being to both test the effectiveness and suitability of the new cellular tracking devices for monitoring vultures post-release as well as to get an indication as to the expected success of released birds previously kept in captivity for various periods of time.

Materials and Methods

Eleven Release operations were performed, the first being 4 December 2005 and the last on 26 May 2006.

Release operations

The release operations took place from different localities, *i.e.*: In the North West Province: Lichtenburg Game Breeding Centre (LB), Nyoka Ridge (NR) and Nooitgedacht (NG); in Limpopo Province: Blouberg (BB) and in Mpumalanga: Moholoholo (Moh).

Cellular transmitter

The "AWT-GSM, GPS backpack" cellular tracking devices (African Wildlife Tracking, Pretoria, SA) features an internal GPS with GPS accuracy; longitude, latitude; temperature; date and time; heading and speed readings. Over its expected 7–12 month lifespan the device will send some 1000 readings. In future the new devices will include altitude and VHF telemetry. Physical specifications of the unit are length 80 mm x width 45 mm (at the bottom) and 52 mm (at the internal antenna) x height 34 mm, mass: 240 grams. The design and position of the harness are not deemed to inhibit copulation. The housing construction is lightweight fiberglass-wax packing. Three stainless-steel loopholes, used for harness fitting, are built into the unit. Two loopholes are on the long sides in the front and one in the middle of the short side at the back of the unit. The unit is sealed against changes in temperature and humidity.

Harness mounting and materials

Each tracking unit was secured to the bird by means of a snugly fitting harness. Nylon ribbon, sewn together at one side (making it double), was selected for the harnesses on account of its strength, small diameter, lightweight and minimal stretch potential. The ribbon was threaded through transparent plastic (tygon) tubing with a small inner diameter (3mm) to prevent chafing to the bird's skin. One ribbon length of 2,5m length was threaded through two tygon-tubing lengths of 610 mm. A "weak link" was fitted to the middle of the ribbon between the two lengths of tubing and fitted to the stainless-steel loophole at the back of the unit. The weak-link was designed to deteriorate, disintegrate and slide off the bird after eight to twelve months (the maximum estimated operation time of the batteries of the cellular transmitters). It is made from a short length of pure cotton cord, doubled over and rolled, then sewn together to form a ring with an outstretched length of approximately 35mm. Quick-setting super-glue is used carefully to seal and smooth all knots on the weak link.

Although knots were avoided in the design where possible, one knot was necessary to connect the unit to the harness. This double-knot is made at a stainless steel loophole on the front of the unit to avoid chafing and slippage. The knot is secured by sewing it together with tooth-floss, also ending in a double-knot and then sealed and smoothed carefully with quick-setting epoxy glue and super-glue.

The positioning of the cellular transmitter on the bird's back is important and should be fitted above mid-back between the shoulders. The harness comprised three fitting zones: front of transmitter to sternum; sternum to above tail (lower back); and above tail to transmitter at the weak link. Each region is checked for tightness in the progressive fitting phases. The harness is secured with a steel crimp (10mm outer diameter) at the sternum and above tail and a smaller

steel crimp (7mm o.d.) on the weak link. The harness should not be too tight in the sternum area as this could cause breathing difficulties. It must be loose enough to allow the crop to swell during feeding. However, the harness must also not be too loose as the bird can easily become entrapped in the excess strings. It must also be remembered that the bird will preen the harness very close to the skin. One finger between the sternum and harness is sufficient to allow for excesses when the harness is preened in (Diekmann 2004).

As body sizes differ among birds, it is not possible to produce custom-fitted harnesses beforehand. Efficient fitting equipment is therefore necessary, including large bird-ringing pliers equivalent to the crimp lug size; "leatherman" type of pliers, used in conjunction with the ringing pliers to reopen crimps that might have been over-tightened during fitting; and sharp slim-line scissors (surgical type) to trim the plastic tubing to individual size on the bird (Diekmann 2004).

A minimum of five people per team is needed to fit a transmitter to a vulture. No anesthetics are used so one person is holding the head, one the legs and two the wings (one on each side of the crate). The fifth person is fitting the transmitter with the harness onto the bird. The bird needs to be turned over from its back to its stomach several times to ensure the correct tightness of the harness and good cooperation is critical to avoid injuries both to the bird and to the handlers. A vulture can inflict serious injuries with its beak if the head is not held well by the handlers. The fitting operation is done as quick and smooth as possible to minimize stress to the bird.

Results

All released vultures, with and without cellular tracking devices, from De Wildt are included as from 4 December 2005 until 26 April 2006.

Release No 1: Lichtenburg (Northwest Province), 4/12/2005

The first four vultures with the cellular tracking devices were released at approximately 12:30 during a hot summer's day with minimal cloud cover.

Results: *R 1- LB*

The movement and performance of the four vultures after the first release at Lichtenburg was monitored via the Hawk software on the internet as well as eight visits to the Lichtenburg Game Breeding Centre. The end result of each bird is given below.

*Bird No 1 (cell. unit AM86; Release No 1; LB): Lappet-faced Vulture (*Torgos tracheliotos*)*

We suspect that this bird was poached by the farm workers given their negative attitudes towards vultures. The bird was last seen on the neighboring farm, Elandsfontein of Mr. P. Lombard on 8/1/2006 (35 days post release) where the workers suggested killing the bird because it would bring trouble to them. The last coordinates were received on the 8/1/2006 opposite this farm across the tar road where we searched but could not find the bird. New coordinates were received on 2/2/2006 where the device was found broken in a quarry hole opposite Mr. P. Lombard's farm. There was no sign of the bird.

The maximum distance recorded between two transmissions was 3,04km. The maximum distance recorded from the vulture restaurant (release site) was 6,14km. The cumulative distance between the recorded positions over the first month post release is 22,7km.

*Bird No 2 (cell. unit AM87; R 1; LB): African White-backed Vulture (*Gyps africanus*)*

The bird didn't move away from the vulture restaurant and was found dead by LWBC staff on 7/1/2006 (34 days post release). We suspect the bird died from starvation and uncertainty in its new free-roaming environment.

The maximum distance recorded between two separate transmissions was 0,381km. The maximum distance recorded from the vulture restaurant was 0,301km. The cumulative distance between the recorded positions over the first month post release was 3,3km.

Bird No 3 (cell. unit AM88; R 1; LB): African White-backed Vulture (G. africanus)

The bird was found poisoned 8 km outside of the release site at Lichtenburg on a cattle farm (17/1/2006 – 44 days post release). The bird was very weak and in a coma type state. After intensive care, the bird has survived and will not be released again due to the possible damages caused by organophosphate poisoning and its second poisoning case.

The maximum distance recorded between two transmissions was 3,8km and the maximum distance recorded from the vulture restaurant was 8,3km. The cumulative distance between the recorded positions was 17,6km.

Bird No 4 (cell. unit AM89; R 1; LB): African White-backed Vulture (G. africanus)

The bird never moved away from the vulture restaurant. A neighbouring farmer Mr. P. Lombard (28/1/2006 – 55 days post release) found the cellular device in the road behind the vulture restaurant. There was no sign of the bird but the device smelled of a rotten carcass. According to the damage on the harness, a jackal probably bit off the device

The maximum distance recorded between two separate transmissions was 0,417km. The maximum distance recorded from the release site was 0,393km. The cumulative distance between the recorded positions over the first month post release was 8,3km.

Discussion: *Release 1 – Lichtenburg*

The cumulative distances between the recorded positions for the first month post release for all four birds ranged from just over three to just under 23 km. The birds could have covered much greater distances between recorded positions, however this is unlikely, as the second position of each day was recorded at a time that it is expected that the birds would be soaring.

The total distances covered after the release of the four birds at the LGBC may be described as being unexpectedly low. There are many thoughts as to the poor movements of these birds: (1) Orientation of vultures into new areas could be a cause; (2) The bird's fitness appears to be a big problem and is a big concern for future releases; (3) The weight of released vultures. Excess weight could also be a reason why the birds are unable to fly normally; (4) The period of time vultures are kept in captivity before release – major factor in the fitness and weight of releasable birds.

(All the birds from Release No 2 to Release No 11 were Cape Vultures (*Gyps coprotheres*)).

Release No 2: Nyoka Ridge (Northwest Province), 13/12/2005

Bird No 1 (without cell. device):

A juvenile CV was rescued from the Hartbeespoort Dam (8/12/2005) and rehabilitated at De Wildt. He was released at Nyoka Ridge without a cellular device after four days in captivity.

Release No 3: Nyoka Ridge, 23/12/2005

Bird No2 (without cell. device):

A second juvenile CV was rescued from the Hartbeespoort Dam (20/12/2005) and rehabilitated at De Wildt. He was also released at Nyoka Ridge without a cellular device after two days in captivity.

Results: *Release 2 & 3 - Nyoka Ridge*

The birds flew off and disappeared. No further movement data for these two birds are available as no monitoring devices were fitted.

Discussion: *R 2 & 3 - NR*

It is expected that these 2 birds have survived given the short period of time held in captivity, thereby possibly experiencing no muscle loss.

Release No 4: Nyoka Ridge, 6/1/2006

Seven CV's were released at Nyoka Ridge around midday. All seven birds flew only a short distance and landed in the grass on Nyoka Ridge and the neighbouring farm on the eastern side. Only one bird was attached with a cellular tracking device (unit AM88).

Results: *R 4 - NR*

Bird No 5 (cell. unit AM88; R 4; NR):

The bird was recaptured at Nyoka Ridge (14/1/2006) as it was dehydrated and becoming weak. The bird was returned to De Wildt & kept in release enclosure. This bird had only covered 0,442km maximum distance per day and only moved 1,6 km from the release site at Nyoka Ridge. The cumulative distance covered was only 2,8 km after 8 days.

Bird No 3 (without cell. device; R 4; NR):

The bird was found dead underneath a powerline at Nyoka Ridge (14/1/2006 – 8 days post release).

Bird No 4 (wo c d; R 4; NR):

This bird flew away from Nyoka Ridge after a few days. No movement data of this bird is available because it was released without a cellular device.

Bird No 5 (wo c d; R 4; NR):

This bird was recaptured at Nyoka Ridge (17/1/2006) due to severe starvation, dehydration and possible injured leg. It was rehabilitated at De Wildt again and is back in captivity.

Bird No 6 (wo c d; R 4; NR):

The dead bird was found at a reservoir on the cattle/sheep farm (Hamman Meats) south from Nyoka Ridge on 31/01/2006 while searching for AM88. Farmer Teuns Hanekom said the bird B013 drowned a week earlier in the reservoir.

Bird No 7 (wo c d; R 4; NR):

It was found dead on 13/1/2006 due to a powerline incident on Nyoka Ridge.

Bird No 8 (wo c d; R 4; NR):

This bird appeared to have difficulty in taking off and therefore was collected and taken back into captivity (8/1/2006).

Discussion: *R 4 – NR*

Three birds (No 5 with unit AM88 and No 5 & 8 without devices) showed poor movement after the release, and were therefore recaptured and returned into captivity. One bird (No 6 without device) drowned in a farm reservoir a few days after being released. Two birds (No 3 & 7) appeared to have been electrocuted having being found dead underneath powerlines. Only one bird (No 4 without device) was not found and no post release data is available for him. Again we suspect that the birds are experiencing a degree of unfitnes and were held in captivity for too long.

Release No 5: Nyoka Ridge, 28/1/2006

Bird No 6 (with unit AM88) and Bird No 7 (with unit AM87) were both juvenile CV's found dehydrated in the Skeerpoort area. Both birds were held in captivity for approximately two months at De Wildt before their release. The release took place at 10h15 on a very cloudy day in between unexpected rainfall.

Results: *R 5 - NR*

Bird No 6 (cell. unit AM88; R 5; NR):

Initially he remained around the release site for a few days. Then he flew to Nooitgedacht. He started moving southwest past Magaliesburg, Derby between Klerksdorp and Potchefstroom and spent some time near Klerkskraal Dam, from here moving direction Koster and then Swartruggens. On 1/3/2006, 32 days post release, the bird was found sitting in a dead tree on a

cattle farm 9km southwest from Koster. He sat in this tree for four days due to heavy rainfall in the area. The following day he started moving towards Swartruggens and then to Mathopestad, near Derby where he remained until the 10th of March. On 13/3/2006, 44 days post release, he was at Pitsane, south of Lobatse (Botswana) and the next day at Goodhope, west of Pitsane. On 15/3/2006 he was north of Masibi – east of Makgobistad (Botswana) and crossed the border back into South Africa just west of Setopo near Mafikeng (16/3/2006). On 17/3/2006 he was south from Willowpark – west of Zeerust and on the 19th near Ottoshoop.

On the 22nd I searched for the bird at this last locality east from Slurry – southwest from Zeerust. I found the bird by himself in a camelthorn tree (*Acaia erioloba*) with wing tag B020, but without the device on his back. He flew off with the right leg hanging slightly down but circled into a thermal and away. I searched for the device around the tree and the last coordinates but couldn't find it. On my way to Slurry and back to Pretoria the farm manager, Gerrie Senekal phoned in connection with the device. His worker, Jerry had found the device in the morning at a cow carcass where the vultures were feeding on the farm Twyfelhoek (Hannes & Corra: Owners). He then picked it up and took it back with him. I turned around to collect the device and took it back to Pretoria. The device was intact but the harness was broken at the weak link.

On 15/3/2006 the bird was the longest distance away from the release site (Nyoka Ridge) at 254,5km in Botswana. The maximum distance covered per day was 92,2km (straight line between two locality readings). The cumulative distance covered by this bird was 1053,9km. These distances were determined for the period between the release date, 28/1/2006 and the date of the last locality reading when the cellular device was picked up at a cow carcass, 22/3/2006, 53 days post release.

Bird No 7 (cell. unit AM87; R 5; NR):

This bird was seen flying between other birds, *i.e.* Abdim's stork, cattle egret etc. on the neighbouring farm (Gromer). When the locality readings indicated that the bird was not moving we tried to find the bird on this farm, but the farmer refused to give us permission to enter his farm. They said that because we were working with vultures, we might spread diseases like New Castle sickness to their chickens. Eventually after begging for the third time to search for the bird, it was found dead on 14/2/2006, lying on its back underneath a powerline (Gromer). He was probably electrocuted.

The maximum distance per day was 0,7 km and maximum distance from the release site (NR), 2,3 km. This bird only flew 3,5 km cumulative distance during that week since his release until he died.

Discussion: *R 5 - NR*

Bird No 6 (with unit AM88) were the first bird that flew as expected all released vultures would. The data retrieved from his locality readings is giving us the first idea on flying distances per day, flying speed, home range etc. The two-month time period in captivity might just have been short enough to prevent the bird from getting unfit and overweight before being released.

Bird No 7 (with unit AM87) might have been attracted to the neighbouring farm (Gromer) by the large numbers of Abdim's stork, cattle egret, sacred and glossy ibises and blacksmith plovers feeding on the poultry dung and old chicken food from the chicken farm. This was the third vulture found dead underneath powerlines since our first release 4/12/2005.

Release No 6: Nyoka Ridge, 2/2/2006

Seven CV's were released, only one with a cellular tracking device. This release also took place during the heavy rainfall period although it was not raining during the afternoon of the release.

Bird No 8 (with unit AM89) was a juvenile female CV from the Skeerpoort area and was held in captivity for only one month before the release. Six CV's, Birds No 9 – 14 (without devices) were all juveniles. Bird No 9 was a male from Skeerpoort area and was held in captivity for one month.

Birds No 10 – 14 all came from Blouberg and were all male except Bird No 11. Only Bird No 13 was held in captivity for around two months while the rest were held for around three weeks.

Results: *R 6 - NR*

Bird No 8 (cell. unit AM89; R 6; NR):

Bird No 8 (AM89) remained in the area for a few days, probably because of heavy rainfall, and then flew towards Nooitgedacht. She moved south from here but remained on a farm near Magaliesburg. She was fed meat by a lady on this farm and probably stayed in the area due to persistent rain. Once the rain ceased the bird began moving again southwest and covered quite some distance before drowning in a farm reservoir between Bothaville and Leeudoringstad. She was found on 23/2/2006 on the farm of Mr. Japie Grobbelaar.

This vulture's maximum distance per day was 73,8 km. It flew 211,5 km away from the release site. The cumulative distance covered before drowning was 286,5 km.

Six CV's without cellular tracking devices were released together with Bird 8 (unit AM89). At least three birds were seen circling in a thermal and flying towards the CV colony in Magaliesberg (Leopard Lodge area) within an hour after their release. The other three were also gone after an hour but they were not seen when they flew away. No further movement data of these six birds are available.

Discussion: *R 6 - NR*

We expect that the six vultures without cellular tracking devices have a good chance of survival. Since the start of this study (3 months) Bird No 8 (AM89) was the second vulture that drowned in a farm reservoir. No steps or tree stumps were placed on the inside of the dam for animals/birds to get out.

Release No 7: Blouberg (Limpopo Province), 6/2/2006

Nine juvenile CV's were released at Blouberg (Near Alldays). These birds had been in captivity for approximately 3 weeks. No cellular devices were available to fit onto any of these birds but all had patagial tags.

Results: *R 7 - BB*

All nine birds flew out of the crates and away. No further movement data of these birds are available.

Discussion: *R 7 - BB*

Again we suspect that these nine birds will survive given their short period in captivity before the release.

Release No 8: Nooitgedacht (Northwest Province), 15/2/2006

One juvenile CV from Blouberg was attached with cellular tracking device (AM87) after being in captivity for 2½ months at De Wildt.

Results: *R 8 - NG*

Bird No 9 (cell. unit AM87; R 8; NG):

The bird flew down in the kloof shortly after the release from where we didn't see it again. Unfortunately the bird managed to reach the weak link and bite it off. The device was found (17/2/2006) 20m high in a tree, 593 m from the release site and the bird gone. No further movement data of this bird is therefore available.

Discussion: *R 8 - NG*

We now know that the device comes off easily without entangling the bird in the device once the weak link breaks off.

Release No 9: Nooitgedacht, 22/2/2006

One juvenile CV from Blouberg was attached with the cellular unit AM87 and released after being in captivity for just over two months. This bird injured his beak on the enclosure fence whilst in captivity at De Wildt. The uneven edge of its beak was cut smooth before the release. The temperature was mild with 7/8s cloud cover. The bird flew down in the kloof shortly after the release.

Results: *R 9 – NG*

Bird No 10 (cell. unit AM87; R 9; NG):

The bird flew down in the kloof and slowly moved further south from Nooitgedacht. It remained in the area during the first two weeks after the release, probably due to the extensive rainfall. It was seen sitting on the lawn with Abdim's stork and blacksmith plovers on the farm Grasslands south of Nooitgedacht (2/3/2006). The bird appeared to be healthy.

On 3/3/2006 this bird was still near Nooitgedacht. From here he moved past Mathopestad, Derby (North West Province, SA, 5/3/2006) then into Botswana and was near Boritse Pan (11/3/2006, 17 days past release). He was south from Gai Pan in Botswana (South of the line between Tshane & Kokong, 13/3/2006). On 16/3/2006 he was just east of Monamodi Pans, Mabuasehubu (Botswana), then back into South Africa on 18/3/2006 just south of Middelputs, NW of Van Zylsrus. On 19/3/2006, 28 days past release, he was still in this area. This was the last locality reading from AM87 until the end of March 2006.

The maximum distance flown per day was 166,4 km, (18/3/2006) the furthest so far in this study. It flew 577 km (Middelputs, 18/3/2006) away from the release site (Nooitgedacht) and the cumulative distance covered in 25 days was 1080,4 km.

Discussion: *R 9 - NG*

Bird 10 moved well and appeared to have recovered from the beak injury. Either the ctd AM87 stopped working or the bird might have died since no new locality readings were received since 19/3/2006.

Release No 10: Nyoka Ridge, 11/4/2006

One subadult CV from Thabazimbi was fitted with ctd AM88 and released after being in captivity for 3½ months. The temperature was mild with 2/8s cloud cover. The bird remained around Nyoka Ridge after the release. This bird was very fat and the sternum couldn't be felt.

Results: *R10 - NR*

Bird No 11 (cell. unit AM88; R10; NR):

The bird remained around Nyoka Ridge after the release and was found dead underneath the powerline on 15/4/2006, probably electrocuted.

Discussion: *R10 – NR*

Again we suspect that this bird was already too long in captivity (3½ months), was overweight and unfit and remained near the release site where it was electrocuted on a powerline.

Release No 11: Moholoholo, 26/5/2006

One CV from Moholoholo was fitted with ctd AM88 and released from Moholoholo.

Results: *R11 – Moh*

Bird No 12 (cell. unit AM88; R11; Moh):

This bird moved mainly between Hoedspruit area and Komatipoort.

Discussion

Twelve birds were released with cellular tracking devices and 23 birds without. The outcome of only one bird with ctd is uncertain (8,3%) while the outcome of 18 birds without ctd's is unknown (78,3%). The outcome of eight birds with ctd's is known without doubt (80% excluding the two

birds who lost their ctd's), while the outcome of only five birds without ctd's is known with certainty (21,7%).

The cellular tracking devices functioned as specified, however with a weight of 240 grams the devices could be lighter for comfort and ease to the bird. With only 3 readings per day given the battery lifespan, this could be improved with additional readings vs. the lifespan of each battery vs. the weight of the devices. From our findings, it appears that there is a relationship between the period of time held in captivity and the time of release. The shorter the period of time in captivity, the greater the chance of survival and full recovery in the wild.

Although the rehabilitated vulture survivals after release have not all been successful, the use of cellular technology has proven in itself to be very valuable and affective in monitoring these birds. Sick, injured and dead birds have been found with the use of these devices and recovered. Their movements were easily monitored and followed, with the exception of the birds being outside of cell phone reception. The threats to released vultures can be monitored *i.e.* electrocution, drowning, etc. The ctd's can help to determine the vultures' land use, home range sizes, flying speed and even temperature.

Acknowledgements

Without the help of the following companies, this study would not be possible: ESKOM, SASOL and Computer Facilities. Africa Wildlife Tracking developed the transmitter.

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Appendix 1:

Table 1: Outcome of the Releases

Releases						
Date	No Birds	Origin	Site	Cell dev	Captive	Outcome
04/12/05	4 (1LF & 3 AWB)	LF – Wolmaransstad AWB – DeWildt, Thabazimbi, Wildcare	Lichtenburg	4	LF-1y AWB-1+y	LF: prob. poached AWB: starvation (n=2), poisoned but alive (n=1)
13/12/05	1 Juv CV	Skeerpoort	Nyoka Ridge – Magaliesberg	0	3 days	Bird flew off successfully
23/12/05	1 Juv CV	Skeerpoort	Nyoka Ridge – Magaliesberg	0	2 days	Bird flew off successfully
06/01/06	6 Juv CV 1 adult CV	Various Adult – Bloemfont	Nyoka Ridge – Magaliesberg	1	1 yr	2 dehydrated recapt; 1 couldn't fly recap; 2 electrocuted; 1 drowned in reservoir; 1 disappeared
28/01/06	2 Juv CV	Skeerpoort	Nyoka Ridge – Magaliesberg	2	2 months	1 unit bitten off after 632km; 1 electrocuted
02/02/06	7 Juv CV	5 – Blouberg 2 – Skeerpoort	Nyoka Ridge – Magaliesberg	1	3 weeks to 2 months	1 drowned in reservoir after 286km; 6 flew off successfully
06/02/06	9 Juv CV	Blouberg	Blouberg	0	1 to 2 months	Birds flew off immediately
15/02/06	1 Juv CV	Blouberg	Nooitgedacht – Magaliesberg	1	2½ months	Unit bitten off at weak link
22/02/06	1 Juv CV	Blouberg	Nooitgedacht – Magaliesberg	1	2½ months	Stopped sending SMS after 255km
11/04/06	1 subadult CV	Thabazimbi	Nyoka Ridge - Magaliesberg	1	3½ months	Electrocuted
26/05/06	1 CV	Moholoholo	Moholoholo - Hoedspruit	1		

Appendix 2:

Monitored Results:

- ➔ = Release number, site & date
- † = Died
- = Recaptured & still alive
- ➔ = Free-roaming & probably still alive

➔ R1, Lichtenburg, 4/12/05

- † 07/1/06: dead AWbV found (suspected starvation)
- 17/1/06: AWbV poisoned 8km from release site - recaptured
- † 28/1/06: device found with no sign of AWbV (suspected starvation)
- † 04/2/06: found broken device with no sign of LfV (suspected killed for traditional belief)

(Following birds all CV's)

- *R2, Nyoka Ridge, 12/12/05*
 - (without device) flew off
- *R3, NR, 23/12/05*
 - (wo d) flew off
- *R4, NR, 6/1/06*
 - 14/1/06: dehydrated - recaptured
 - ‡ 14/1/06: (wo d) electrocuted
 - (wo d) flew off
 - 19/1/06: (wo d) dehydrated – recaptured
 - ‡ 31/1/06: (wo d) drowned reservoir
 - ‡ 13/1/06: (wo d) electrocuted
 - 8/1/06: (wo d) couldn't fly – recaptured
- *R5, NR, 28/1/06*
 - 22/03/06: Device found at cow carcass near Botswana border– bird identified by patagial tag, flew away
 - ‡ 14/02/06: Device found on dead bird (electrocuted)
- *R6, NR, 2/2/06*
 - ‡ 23/02/06: Device found on drowned bird in reservoir near Leeudoringstad, 250km away from release site
 - 6 CV's (wo d) flew off
- *R7, Blouberg, 6/2/06*
 - 9 CV' (wo d) flew off
- *R8, Nooitgedacht, 15/2/06*
 - 17/02/06: Device found 20m high in tree with weak link broken
- *R9, NG, 22/2/06*
 - ‡ 19/03/06: AM87 stop sending SMS, device not found
- *R10, NR, 11/4/06*
 - ‡ 15/4/06: Device found on dead CV under powerline (electrocuted)
- *R11, Moholoholo, 26/5/06*
 - 30/6/06: Device still working well & CV still flying well

- ‡ Cause of Mortality: Starvation – 2; Electrocution – 4; Drowned – 2; Poached – 1; Unknown – 1 (device stopped sending, bird probably dead)
 - ‡ **Total: 10 (died)**
- Reason for Recapture: Poisoned – 1; Dehydrated – 2; Couldn't fly – 1
 - **Total: 4 (alive in captivity)**
- Probably still alive: 20
- Still alive: 1 (with cellular tracking device)
 - **Total: 21 (alive free roaming)**