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DISPERSION

IMMATURE CAPE VULTURE *GYPS COPROTHERES* BREAKS SPECIES RANGE RECORD

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Introduction

Endemic to southern Africa, the Endangered Cape Vulture *Gyps coprotheres* has the smallest distribution of any old world vulture (BirdLife International 2015). Mundy et al. (1992) suggested that the northern limit of the species distribution was at 18°S in the west of Africa (in southern Angola) and at 16°S in the east (in southern Zambia) – the most northern substantiated sighting being in Lochinvar National Park, Zambia, at 16°S, 27.15°E. However, the global population of Cape Vulture has declined by 87–94% over the past three generations (Ogada et al. 2016); and breeding and non-breeding populations are thought to be extinct in much of the species' former distribution (BirdLife International 2015, Wolter et al. 2017). Cape Vultures face several human-induced threats including power-line collisions and electrocutions, indirect and direct poisonings, and hunting for superstitious purposes. Fragmented breeding populations persist in Botswana and South Africa; but only non-breeding populations persist in Namibia and Zimbabwe (Wolter et al. 2016). Cape Vultures are thought to be extinct in Angola, Zambia and Mozambique.

Satellite telemetry has enabled us to track the movements and dispersion of Cape Vultures. To our knowledge, foraging ranges have been analysed and data published from 45 Cape Vultures, tracked with both Argos/GPS and GSM/GPS (Bamford et al. 2007, Phipps et al. 2013, Rushworth & Krüger 2014, Kane et al. 2016, Howes 2016). Three of these studies compared foraging ranges between mature and immature individuals and found that these differed greatly. Using minimum convex polygons (MCP), Bamford et al. (2007) showed the foraging range of an immature individual was an order of magnitude higher than the mean foraging range of five mature individuals (482,276 km^2 vs. 21,320 km^2). Phipps et al. (2013) also used MCP and calculated the mean foraging range of four immature Cape Vultures as 492,300 km^2 and that of mature Cape Vultures as 121,655 km^2. Using 95% kernel utilisation distribution (KUD) methods, Kane et al. (2016) calculated a mean foraging range of 295,379 km^2 for 13 immature individuals and 110,181 km^2 for 15 mature individuals. Greater foraging ranges in immature Cape Vultures, compared to mature Cape Vultures, are not surprising because mature (breeding) vultures are restricted to foraging areas surrounding their breeding cliffs. Immature vultures can therefore avoid intra-specific competition, particularly with mature vultures, at carcasses further removed from breeding colonies (Hirschauer 2016, Mundy et al. 1992, Duriez et al. 2012).

Here, we present telemetry data for a single immature Cape Vulture with notably northerly movements and a large foraging range.

Methods

A Cape Vulture fledgling of six to seven months old came to VulPro's rehabilitation centre in North West Province, South Africa, on 18 December 2014. The vulture had been found on the ground inside the Marekele National Park, Limpopo Province, which protects the second largest Cape Vulture breeding colony in southern Africa. The vulture was unable to fly due to bad weather but was also dehydrated, emaciated, and showed signs of possible head trauma (i.e. the tip of

his beak was chipped). The vulture's condition was severe, causing seizures. We treated the vulture as a critical case and it made a full recovery. We released the vulture from VulPro on 9 February 2015. The day before release, we fitted the vulture with patagial tags (017) and a PTT-100 50g solar patagial Argos/GPS manufactured by Microwave Telemetry, Inc., Columbia, Maryland, USA. The satellite transmitter measured GPS locations (accurate to ±18 m), altitude, course and speed every two hours between 07:00 and 19:00 (UTC+02:00) and at 23:00 (UTC+02:00). Data was collected over 617 days between 9 February 2015 and 18 October 2016. We calculated foraging range size using a minimum convex polygon (MCP) as well as 50% and 95% kernel utilization distribution (KUD) methods with default reference bandwidth *h* following Worton (1989). We conducted analyses using the adehabitatHR package in R statistical programme (v 3.2.0, R Core Team 2013, Calenge and Fortmann-Roe 2013). The vulture was alive and transmitting data when this paper went to press in April 2017.

Results

Over the 20-month observation period, the Cape Vulture visited seven countries (Figure 1). We calculated its total foraging range using a MCP to be 2,066,350 km^2. Its total foraging range using 50% and 95% KUD was calculated to be 367,655 km^2 and 1,946,409 km^2, respectively. We inspected the range using a 50% KUD for clusters of locations and found three main regions preferred by the vulture: 1) the Magaliesberg Mountains, South Africa; 2) central Namibia; and 3) northern Botswana, Caprivi region of Namibia, far south-eastern Angola, and far south-western Zambia (Figure 1).

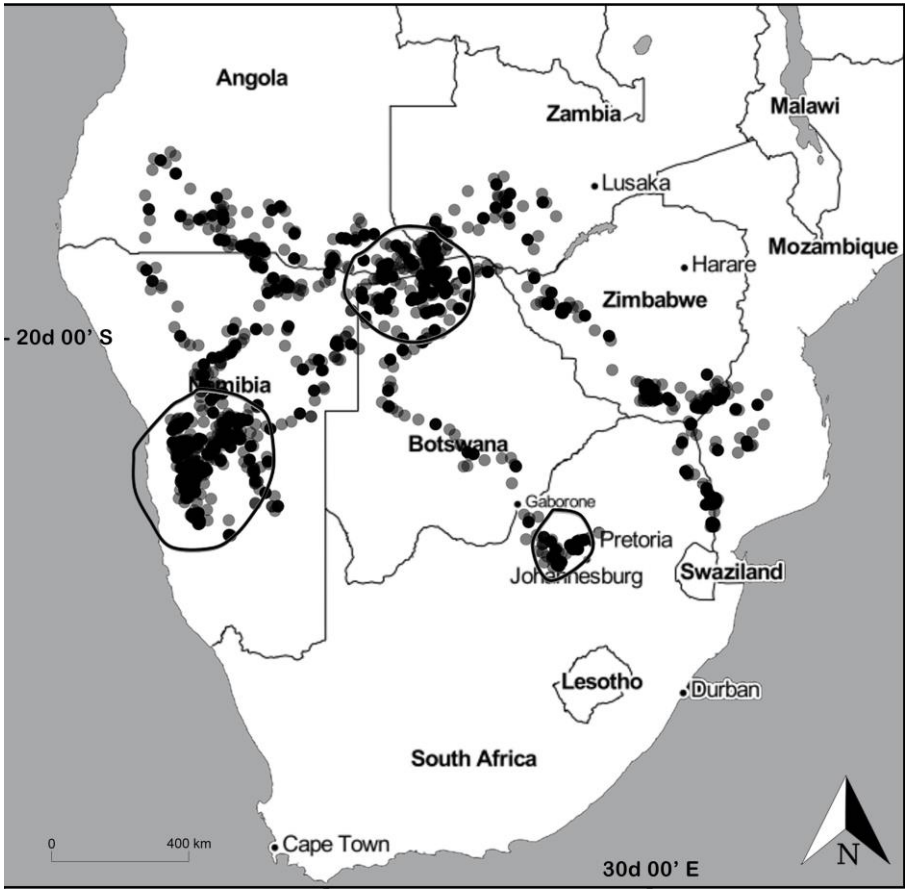

Figure 1. Cumulative range map for Cape Vulture 017 from 9 February 2015 until 18 October 2016. Black circles indicate the contour outline of the 50% KUD analysis.

The vulture spent two months following its release north of VulPro in the Magaliesberg Mountains. In early April 2015, the vulture travelled in a north-westerly direction through Botswana, northern Namibia and south-western Angola. On 30 April 2015, the vulture reached 14.45217°S, 15.18550°E in Angola, which was its most northerly position recorded and marked the end of its north-westerly wanderings. For the next five months, the vulture travelled eastwards through southern Angola, the Caprivi region of Namibia, south-western Zambia and northern Botswana, including, but not exclusively, the Okavango Delta. In Zambia, the vulture reached

15.18867°S, 25.48500°E on 1 August 2015. Starting on 4 October the vulture travelled around central Namibia for eight months. On 16 June 2016, the vulture travelled in a north-easterly direction through northern Namibia, south-eastern Angola, the Caprivi region of Namibia and southern Zambia, reaching 15.70050°S, 26.67233°E, before heading south into eastern Zimbabwe on 10 July. For the next three months, the vulture travelled through eastern Zimbabwe, northern Mozambique and eastern South Africa.

Discussion

The foraging range of the Cape Vulture examined here is the largest recorded for the species; indeed, it is more than four times larger than that the previous record holder, which was the immature individual examined by Bamford et al. (2007). That immature Cape Vulture tagged in Namibia and examined by Bamford et al. (2007) retains the title as the most northerly known ranging Cape Vulture, having ventured into Angola to latitude 14.383°S and into Zambia to latitude 15.968°S (J Mendelsohn pers. comm. January 2017). However, the vulture examined here broke the record for the most northerly location in the east of the species distribution, during one of its northward wanderings.

The immature Cape Vulture examined here focused its foraging in three main areas: one was an area where this species is known to breed (Magaliesberg Mountains, South Africa); another was an area where this species no longer breeds, but is known to regularly forage (central Namibia); and another was an area where this species was considered probably extinct (northern Namibia and Botswana; BirdLife International 2015)

The latter two of these areas – central Namibia; and northern Namibia and Botswana – were also favoured foraging areas of the immature Cape Vulture examined by Bamford et al. (2007) and by Mendelsohn & Diekmann (2017), which might suggest an importance of these areas for immature Cape Vultures, originating as far away as eastern South Africa. Furthermore, the Cape Vulture examined here spent considerable time foraging in Angola, Zambia and Mozambique, three countries where this species is considered extinct or probably extinct.

The vulture examined here reveals not only the vast distances that its species will travel to forage, but also the need for concerted international conservation action throughout southern Africa to preserve its species. Based on the location the vulture was collected for rehabilitation, it was assumed to have fledged from the Kransberg colony in the Marekele National Park, South Africa. While writing this article, the vulture was only 150 km from this suspected natal colony. As several other Cape Vultures have been recorded returning to their natal colony to breed (Hirschauer et al. 2016), we excitingly await this vulture's return to the region.

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