

Visitors to nests of Hooded Vultures *Necrosyrtes monachus* in north-eastern South Africa[§]

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Hooded Vultures *Necrosyrtes monachus* are critically endangered but little is known of their year-round use of nests or whether other species usurp Hooded Vulture nest sites. We investigated visitation rates by Hooded Vultures and other species (including potential nest predators and usurpers) to examine their effect on Hooded Vulture breeding success. We present observations of 33 species recorded by camera traps at 12 Hooded Vulture nests over a total of 93 nest-months (2 095 nest-days). Several pairs of Hooded Vultures visited their nests regularly during the non-breeding season, some adding nesting material, highlighting that pairs visited their nest(s) year round. Egyptian Geese *Alopochen aegyptiaca*, potential usurpers of raptor nests, were present at occupied and unoccupied Hooded Vulture nests, but we recorded no usurpation of nests by Egyptian Geese and they had no impact on vulture breeding success. Hooded Vulture breeding failure was linked to two species only: camera-trap imagery recorded one case of predation of a vulture egg by a Chacma Baboon *Papio ursinus*, and one case of a Martial Eagle *Polemaetus bellicosus* predating a vulture nestling. We recommend expanding the Hooded Vulture nest monitoring programme to include more pairs.

Les visiteurs des nids des Vautours charognards *Necrosyrtes monachus* dans le nord-est de l'Afrique du Sud

Les Vautours charognards *Necrosyrtes monachus* sont en danger d'extinction, mais on sait peu de leur utilisation annuelle des nids ou si d'autres espèces usurpent leurs nids. Nous avons étudié les taux de visites par les vautours charognards et d'autres espèces (y compris les prédateurs potentiels des nids et les usurpateurs) pour examiner leurs effets sur le succès reproducteur de ces vautours. Nous présentons des observations de 33 espèces enregistrées par des pièges à caméra dans 12 nids de vautours charognards sur un total de 93 mois au nid (2 095 jours au nid). Plusieurs couples de vautours charognards ont visité leurs nids régulièrement hors la saison de reproduction, certains y ajoutent du matériel de nidification, soulignant que les couples ont visité leur(s) nid(s) durant toute l'année. Les Ouettes d'Égypte *Alopochen aegyptiaca*, usurpateurs potentiels de nids de rapaces, étaient présentes dans les nids occupés et inoccupés des vautours charognards, mais nous n'avons enregistré aucune usurpation de nids par ces Ouettes et qui n'avaient aucun impact sur le succès reproducteur des vautours. L'échec de la nidification des vautours charognards était lié à deux espèces seulement: l'imagerie de caméra-piège a enregistré un cas de prédation d'un œuf de vautour par un Babouin chacma *Papio ursinus* et un cas de prédation d'un Aigle martial *Polemaetus bellicosus* sur les oisillons des vautours. Nous recommandons d'élargir le programme de surveillance des nids des vautours charognards pour inclure plus de couples.

Keywords: *Alopochen aegyptiaca*, Chacma Baboon, Egyptian Goose, Hooded Vulture, Kruger-to-Canyons Biosphere Region, Martial Eagle, *Necrosyrtes monachus*, nest visitors, *Papio ursinus*, *Polemaetus bellicosus*

Introduction

Hooded Vultures *Necrosyrtes monachus* are in decline due to a variety of anthropogenic threats, including intentional and unintentional poisoning, for trade as bushmeat, and

the illegal trade in vulture body parts for traditional medicine (Ogada et al. 2012; Muboko et al. 2014; Buij et al. 2015; Ogada et al. 2015). Hooded Vultures were once widespread

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throughout the Afrotropics (Mundy et al. 1992), but their decline has been so rapid and widespread (Ogada and Buij 2011) that in 2015 the species was uplisted to Critically Endangered (BirdLife International 2015).

The Hooded Vulture was once relatively understudied (Piper 2004), but since 2005 there has been an increase in the number of publications on the species (Allan 2015). This work includes studies on the trade in Hooded Vulture body parts in West and Central Africa (Atuo et al. 2015; Buij et al. 2015), and on urban vultures in Ghana (Annorbah and Holbech 2012; Gbogbo et al. 2016), Uganda (Ssemmanda 2005; Ssemmanda and Pomeroy 2010; Pomeroy et al. 2012, 2015) and The Gambia (Jallow et al. 2016). There have also been vulture surveys in Niger and Chad (Wacher et al. 2013), a study on Hooded Vulture poisoning in Zimbabwe (Muboko et al. 2014), an investigation into Hooded Vulture breeding success in Burkina Faso (Dabone et al. 2016) and studies on the feeding ecology and abundance of vultures, including Hooded Vultures, in Kenya (Virani et al. 2011; Kendall et al. 2012; Kendall 2013; Odino et al. 2014). Recent studies on Hooded Vultures in north-eastern South Africa have focused on the species' breeding ecology (Roche 2006; Monadjem et al. 2016).

Nest usurpation (*sensu* Lindell 1996) is defined as one species taking over the occupied nest of another species for breeding purposes, and there are various examples of nest usurpation involving raptors (as perpetrators and/or recipients) in the scientific literature (e.g. Brown 1965; Poole and Bromley 1988; Ewins et al. 1994; Ontiveros et al. 2008; Sumasgutner et al. 2016). Some raptors build alternate nests that they use if their nests are usurped, and there are cases in which nest usurpation does not influence raptor breeding

success (Margalida and García 1999; Ontiveros et al. 2008; Sumasgutner et al. 2016). Little is known about which species predate and usurp Hooded Vulture nests. In addition, little is known of whether or not Hooded Vultures visit their nest(s) year round, or if other species make use of Hooded Vulture nests during the non-breeding season. We aimed to address these gaps in our knowledge and investigate, for the first time, whether Hooded Vulture nests are visited by mammals and other bird species throughout the year.

Materials and methods

Study area

The study took place from August 2015 to December 2016, and was conducted in and around the 2.6 million ha Kruger-to-Canyons Biosphere Region. This Biosphere Region, which was established in 2001, spans parts of the Limpopo and Mpumalanga provinces of South Africa, including part of the Kruger National Park, and it comprises various smaller, privately-owned nature reserves, rural settlements, and land used for copper mining, farming and forestry (Coetzer et al. 2013). Hooded Vultures generally build nests above 15 m, in tall trees with densely foliated canopies, which hide their nests from potential predators and nest usurpers (Roche 2006). Nests were found in June–July 2015 by conducting nest searches on foot along the Olifants, Blyde and Ga-Selati rivers (Figure 1), in teams of two to eight people. In South Africa, Hooded Vultures have undergone a rapid range contraction (Mundy 1997), with a current estimate of 50 to 100 breeding pairs in the country (Allan 2015). Egg laying dates for Hooded Vultures in southern Africa peak in June and July, although egg

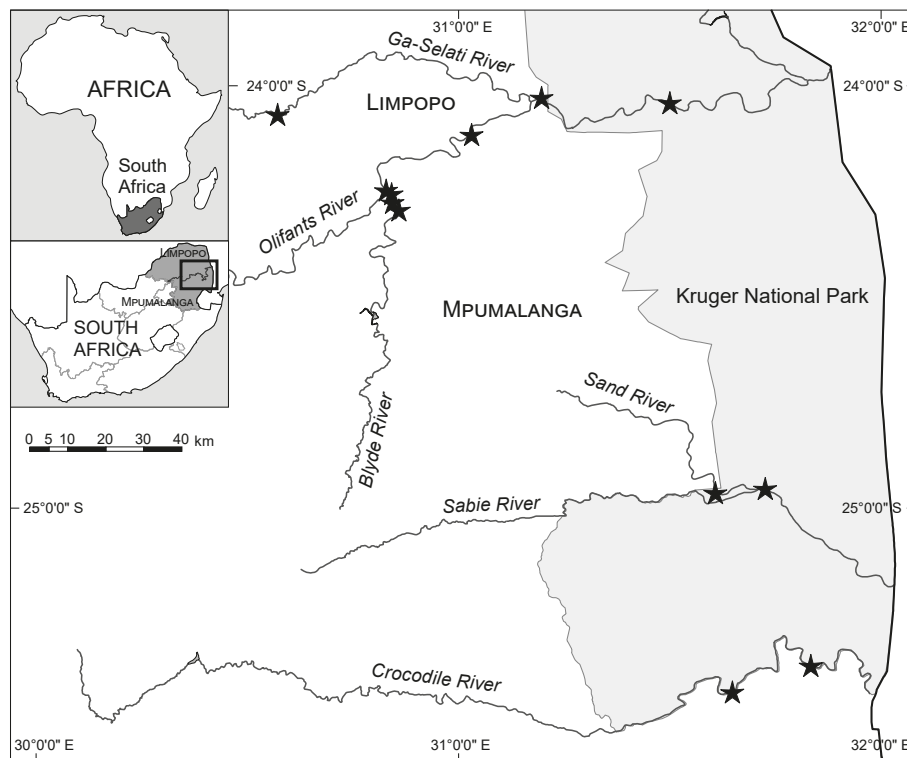


Figure 1: Location of 12 Hooded Vulture nests in north-eastern South Africa, which were monitored between August 2015 and December 2016

laying may occur from May to August (Mundy et al. 1992). In the Kruger National Park in north-eastern South Africa, Hooded Vultures have been recorded laying eggs in June, July and August (Tarboton and Allan 1984).

Camera trap installation and setup

Ltl Acorn® model 6210MC (Ltl Acorn n.d.), Bushnell NatureView HD Live View (Bushnell Outdoor Products 2013) or ProStalk PC4000 camera traps were installed at 12 Hooded Vulture nests in the Kruger-to-Canyons Biosphere Region (seven nests in 2015, and 11 nests in 2016; Table 1). The use of three models of camera trap may have affected our results slightly, as trigger times of the models differed: 0.8 s for the Ltl Acorn® 6210MC and the ProStalk PC4000, and 0.2 s for the Bushnell NatureView HD Live View. That said, the three models employed in this study are faster than 90% of other models (Meek et al. 2012). Following Wellington et al. (2014), we tested for differences in detection rates (of animals visiting Hooded Vulture nests) between camera trap models, by setting up one Bushnell camera and one Ltl Acorn camera (with the same settings) at the same nest for one month. The two cameras produced identical results, suggesting that differences in trigger time between the two camera models did not affect the results significantly.

Hooded Vulture nest trees were initially rigged by use of a slingshot and a fishing rod and reel to launch a lead fishing weight, trailing fishing line over a strong branch. A 3 mm nylon cord followed by a 13 mm static rope was then pulled through the canopy, and ropes were climbed with the doubled-rope technique (Anderson et al. 2015). Camera traps were installed 0.5–2.5 m from nests. During the breeding season, camera traps were set to take one picture every 5 min, continually, day and night (i.e. regardless of motion or heat detection), and passive infra-red (PIR) sensitivity was set to 'low'. After breeding attempts failed, and in the non-breeding season, camera traps were set to be motion-activated, taking bursts of three photographs, with a 3 min delay after bursts, and PIR sensitivity was set to 'low'. Except for the camera traps at the two nests on the Sabie and Sand rivers, if no photographs were taken while on the motion-activated setting for an entire month, then the following month the PIR sensitivity was increased to 'medium', or that particular camera was set to take pictures at 5 min intervals.

The infra-red flash was set to 'low', and batteries and secure digital cards were replaced once a month.

Analyses

We attempted to identify all mammalian (excluding bats) and avian visitors to each Hooded Vulture nest, and all snakes and monitor lizards. Other reptiles and invertebrates were not identified. We sorted camera trap pictures by year and month. We calculated the proportion of days that a species was seen at a particular Hooded Vulture nest each month, and noted whether Hooded Vulture nests were occupied or unoccupied each month. Nests were described as 'occupied' during a given breeding season if a chick was present, or if an adult Hooded Vulture was observed with at least one of the following criteria: an egg was laid and one or both adult(s) present; an adult Hooded Vulture was lying low in the nest and presumed to be incubating; a pair of adult Hooded Vultures was present on or near the nest; one or both adult(s) were present and the nest contained a lining of fresh green leaves, based on guidelines given in Postupalsky (1974). Conversely, an 'unoccupied' nest was one where an adult Hooded Vulture was present but there was no fresh green lining, or where no adult Hooded Vultures were observed at the nest, regardless of the nest contents.

Results

Twelve Hooded Vulture nests were monitored over 2 095 d, from August 2015 to December 2016 inclusive (Table 2), producing 340 368 photographs. Species of mammals and birds seen in these nests are listed in Tables 3 and 4, respectively.

Nest attendance by Hooded Vultures

Hooded Vultures were seen at (at least some of) the nests in every month of the year (Table 5). The numbers of days that individual Hooded Vultures were present at nests during the study period ranged from zero (at the unused Pidwa nest, which was last used in 2015; KS Walker pers. comm.) to 216 (at the Baluleni nest). Six of the nests that were occupied in 2015 were also monitored in 2016, and three of these six nests were occupied again in 2016. For the three nests that were occupied in 2015 but not in 2016, Hooded Vultures were at their nests very little during the

Table 1: Hooded Vulture nest locations, and the earliest and latest dates for which camera trap data were available, together with the number of days during this period that camera traps were active. NP = National Park, PNR = Private Nature Reserve

Nest	Nest code	Nest location	Monitoring period			Percentage of days	
			Earliest	Latest	Days	Nest occupied	Nest unoccupied
1	HVn01	Cleveland Game Reserve	15 Aug 2015	2 Dec 2016	390	0.3	99.7
2	HVn04	UniFattoria Farm	10 Aug 2015	16 Aug 2016	239	23.1	76.9
3	HVn05	Tulloh Farm	9 Aug 2015	18 Apr 2016	134	91.9	8.1
4	HVn22	Pidwa Game Reserve	29 Aug 2015	18 Sep 2015	21	0.0	100.0
5	HVn24	Baluleni Safari Lodge	19 Aug 2015	2 Dec 2016	356	55.8	44.2
6	HVn48	Wild Rivers PNR, stand 25	12 Aug 2015	12 Dec 2016	327	0.6	99.4
7	HVn52	Wild Rivers PNR, stand 14	19 Sep 2015	13 Dec 2016	313	56.9	43.1
8	HVn59	Middlesex Farm 205KT	28 Jun 2016	28 Sep 2016	93	1.1	98.9
9	HVn63	Bly Olifant Reserve (Derby Farm)	29 Jun 2016	5 Oct 2016	63	54.0	46.0
10	HVn65	Kruger NP, Nhlalalumi River	22 Jul 2016	24 Aug 2016	34	0.0	100.0
11	HV16b	Kruger NP, Sand River	5 Jul 2016	25 Aug 2016	51	100.0	0.0
12	HV16e	Kruger NP, Sabie River	9 Jul 2016	21 Sep 2016	74	100.0	0.0
Total					2 095	34.1	65.9

Table 2: Number of days per month during which camera traps monitored Hooded Vulture nests. Zeroes indicate any of the following: (1) failed camera batteries, (2) camera malfunction or (3) the camera was removed. NP = National Park, PNR = Private Nature Reserve

Nest	Nest code	Nest location	2015		2016												Total			
			Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep		Oct	Nov	Dec
1	HVn01	Cleveland Game Reserve	17	30	7	0	0	31	29	31	30	31	30	31	31	29	31	30	2	390
2	HVn04	UniFattoria Farm	22	30	12	0	0	12	6	31	30	21	28	31	16	0	0	0	0	239
3	HVn05	Tulloh Farm	23	30	31	13	0	0	0	19	18	0	0	0	0	0	0	0	134	
4	HVn22	Pidwa Game Reserve	3	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	
5	HVn24	Baluleni Safari Lodge	13	30	31	3	25	31	29	18	0	0	21	31	31	30	31	2	356	
6	HVn48	Wild Rivers PNR, stand 25	19	1	31	30	31	25	0	0	0	0	25	31	31	30	31	12	327	
7	HVn52	Wild Rivers PNR, stand 14	0	12	17	13	0	0	26	31	30	20	25	31	31	3	31	13	313	
8	HVn59	Middlesex Farm 205KT	0	0	0	0	0	0	0	0	0	0	3	31	31	28	0	0	93	
9	HVn63	Bly Olifant Reserve (Derby Farm)	0	0	0	0	0	0	0	0	0	0	2	3	22	31	5	0	63	
10	HVn65	Kruger NP, Nhlalarumi River	0	0	0	0	0	0	0	0	0	0	0	10	24	0	0	0	34	
11	HV16b	Kruger NP, Sand River	0	0	0	0	0	0	0	0	0	0	0	26	25	0	0	0	51	
12	HV16e	Kruger NP, Sabie River	0	0	0	0	0	0	0	0	0	0	22	31	21	0	0	0	74	
Total			97	151	129	59	56	99	90	130	108	72	134	247	273	172	129	120	29	2095

Table 3: Mammal species observed in photographs taken by camera traps at Hooded Vulture nests from August 2015 to December 2016. All listed species are classified both globally and regionally as Least Concern (Gaubert et al. 2015; Child et al. 2016; Hoffmann and Hilton-Taylor 2016; IUCN 2016). 'Total nests visited' indicates the total number of Hooded Vulture nests (of the 12 that were monitored) at which a particular species was seen

Mammal species	Percentage of days with visits			Total nests visited
	Occupied nests	Unoccupied nests	Total	
Chacma Baboon <i>Papio ursinus</i>	3.2	3.0	3.0	7
Rodent species (unidentified)	0.0	2.0	1.3	2
Smith's Bush Squirrel <i>Paraxerus cepapi</i>	0.0	1.5	1.0	2
Greater Galago <i>Otolemur crassicaudatus</i>	0.0	0.4	0.3	4
Vervet Monkey <i>Chlorocebus pygerythrus</i>	0.1	0.2	0.2	3
South African Small-spotted Genet <i>Genetta genetta</i>	0.0	0.2	0.1	1
Southern Lesser Galago <i>Galago moholi</i>	0.0	0.1	0.1	2
South African Large-spotted Genet <i>Genetta tigrina</i>	0.0	0.1	0.0	1
Woodland Dormouse <i>Graphiurus murinus</i>	0.0	0.1	0.0	1

Table 4: Bird species observed in photographs taken by camera traps at Hooded Vulture nests from August 2015 to December 2016. Global conservation status is given, where LC = Least Concern, VU = Vulnerable, EN = Endangered, CR = Critically Endangered (BirdLife International 2016; IUCN 2016). Note that Hooded Vultures and Pel's Fishing Owls are regionally listed as Critically Endangered (Allan 2015) and Endangered (Botha 2015), respectively. 'Total nests' indicates the number of Hooded Vulture nests (of the 10 that were monitored) at which a particular species was seen. na = not applicable

Bird species	Status	Percentage of days with visits			No. of nests visited
		Occupied nests	Unoccupied nests	Total nests	
Hooded Vulture <i>Necrosyrtes monachus</i>	CR	100.0	2.9	30.0	11
Egyptian Goose <i>Alopochen aegyptiaca</i>	LC	0.7	1.4	1.2	3
Little Sparrowhawk <i>Accipiter minullus</i>	LC	0.0	1.2	0.8	2
Wahlberg's Eagle <i>Hieraetus wahlbergi</i>	LC	0.0	0.7	0.4	1
Pel's Fishing Owl <i>Scotopelia peli</i>	LC	0.0	0.6	0.4	2
Starling species <i>Lamprolornis</i> sp.	na	0.0	0.3	0.4	3
African Hawk Eagle <i>Aquila spilogaster</i>	LC	0.0	0.2	0.1	3
Purple-crested Turaco <i>Tauraco porphyreolophus</i>	LC	0.0	0.2	0.1	2
Black-backed Puffback <i>Dryoscopus cubla</i>	LC	0.0	0.2	0.1	1
Ashy Flycatcher <i>Muscicapa caerulea</i>	LC	0.0	0.1	0.1	2
Black Sparrowhawk <i>Accipiter melanoleucus</i>	LC	0.0	0.2	0.1	1
Yellow-billed Kite <i>Milvus aegyptius</i>	LC	0.0	0.2	0.1	2
Martial Eagle <i>Polemaetus bellicosus</i>	VU	0.3	0.0	0.1	1
Red-headed Weaver <i>Anaplectes melanotis</i>	LC	0.0	0.1	0.1	1
African Fish-eagle <i>Haliaeetus vocifer</i>	LC	0.0	0.1	0.0	1
Verreaux's Eagle-owl <i>Bubo lacteus</i>	LC	0.0	0.1	0.0	1
African Harrier-hawk <i>Polyboroides typus</i>	LC	0.0	0.1	0.0	1
African Wood Owl <i>Strix woodfordii</i>	LC	0.0	0.1	0.0	1
Trumpeter Hornbill <i>Bycanistes bucinator</i>	LC	0.0	0.1	0.0	1
Hadedda Ibis <i>Bostrychia hagedash</i>	LC	0.0	0.1	0.0	1
Grey-headed Bushshrike <i>Malaconotus blanchoti</i>	LC	0.0	0.1	0.0	1
Fork-tailed Drongo <i>Dicrurus adsimilis</i>	LC	0.0	0.1	0.0	1
Dark-capped Bulbul <i>Pycnonotus tricolor</i>	LC	0.1	0.1	0.1	2
Long-billed Crombec <i>Sylvietta rufescens</i>	LC	0.0	0.1	0.0	1

non-breeding season, whereas for the three nests that were occupied in both 2015 and 2016, the birds were seen frequently at their nests during the non-breeding season (Figure 2).

Egyptian Geese

Egyptian Geese were present in three Hooded Vulture nests (Table 4) for a mean (\pm SD) of 22 ± 39 min visit⁻¹ ($n = 24$). All sightings occurred from 05:39 to 09:28.

Raptors

Sightings of Pel’s Fishing Owls *Scotopelia peli* (Table 4) at Hooded Vulture nests were usually crepuscular. Owls were seen between 05:03 and 07:05 in the morning, and between 17:53 and 19:27 in the evening, with a single nocturnal sighting at 22:12. The Pel’s Fishing Owls spent a mean (\pm SD) of 29 ± 36 min at the nests ($n = 8$), and photographs always showed single owls.

Little Sparrowhawks *Accipiter minullus* were observed at two Hooded Vultures nests (Table 4). One was seen at the Cleveland nest for 15 (discontinuous) days in September and October 2015, presumably using the nest as a hunting perch. A juvenile African Fish Eagle *Haliaeetus vocifer* was seen once in the Middlesex Farm 205KT nest, mandibulating a twig. A Black Sparrowhawk *Accipiter melanoleucus*, African Harrier-Hawk *Polyboroides typus* and African Wood Owl *Strix woodfordii* also were each seen once, at unoccupied nests. A Verreaux’s Eagle-Owl *Bubo lacteus* was seen at a lined nest on 18 June 2016 (Table 4). On 20 August 2016, a subadult Martial Eagle *Polemaetus*

bellicosus was seen at the Hooded Vulture nest at Bly Olifant Reserve (Derby Farm) from 09:14 to 11:42, during which it preyed upon a five-day-old vulture nestling. At 11:48 on the same day, a Hooded Vulture returned to the empty nest.

Primates

Vervet Monkeys *Chlorocebus pygerythrus* were seen in the morning, after sunrise, at the nests at Cleveland Game Reserve (in May and November 2016), Tulloh Farm (in April 2016) and Baluleni Safari Lodge (January 2016). Chacma Baboons were seen in every month except May, mostly at occupied nests (Table 3). One instance of a baboon taking a 35-day-old Hooded Vulture egg was recorded at 08:55 on 14 July 2016. The preceding camera-trap photograph showed the single Hooded Vulture (that had been incubating the egg) leaving the nest.

Small mammals

A South African Small-spotted Genet *Genetta felina* was seen at the Cleveland nest in September and October 2016 (Table 3). On one of the sightings, the genet seemed to be holding a small mammal, possibly a Southern Lesser Galago *Galago moholi*, and on the other two nights it was travelling past the nest. A South African Large-spotted Genet *Genetta tigrina* was seen in February 2016 at night, in the Baluleni nest, and a species of dormouse, likely to be a Woodland Dormouse *Graphiurus murinus* based on the presence of this species in riverine forest (Baxter 2008), was seen at the unoccupied Baluleni nest in February 2016 (Table 3).

A Southern Lesser Galago *Galago moholi* was recorded at the unoccupied UniFattoria Farm and Baluleni nests in January 2016, and a Greater Galago *Otolemur crassicaudatus* was seen in January, March, June and August 2016 (Table 3). Smith’s Bush Squirrels *Paraxerus cepapi* were seen at the Cleveland and Baluleni nests (Table 3), always during the day.

Snakes and monitor lizards

Our cameras photographed one Spotted Bush Snake *Philothamnus sermivariatus* in November 2016 and one Southern Rock Monitor *Varanus albigularis* in December 2016, both at the unoccupied Wild Rivers PNR (stand 14) nest.

Table 5: Months in which certain observations were made for at least one Hooded Vulture nest. ‘Bringing nesting material’ refers to Hooded Vultures bringing twigs and/or dry grass and/or green leaves. Y = an observation was made in the corresponding month

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mating	Y			Y	Y		Y	Y	Y			
Bringing nesting material		Y	Y	Y		Y	Y	Y	Y			Y
Egg							Y	Y	Y	Y		
Chick								Y	Y	Y	Y	

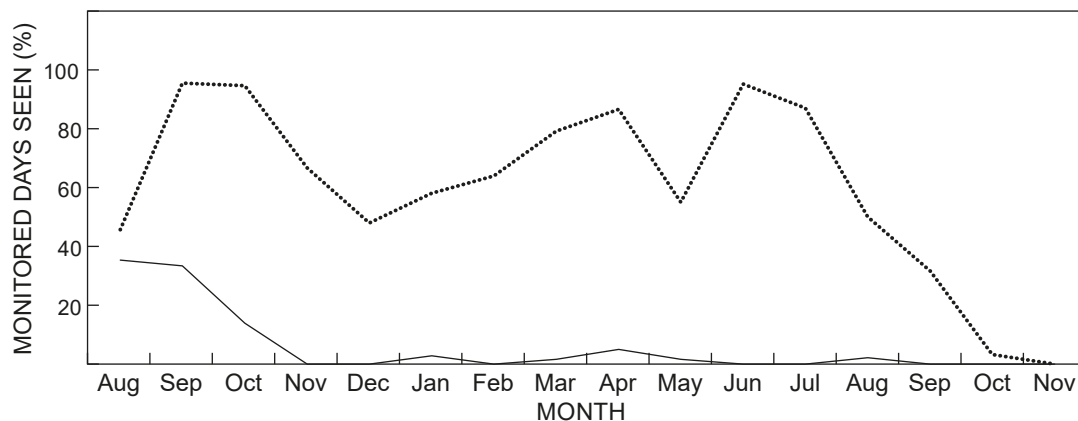


Figure 2: Mean percentage of days each month that Hooded Vultures were observed at nests. The dotted line is the mean of three nests that were occupied in both 2015 and 2016. The solid line is the mean of three nests that were occupied in 2015, but not in 2016

Discussion

Hooded Vulture nests are visited by a range of mammalian and avian species, and most visits are to unoccupied nests. The only species to visit occupied Hooded Vulture nests were Chacma Baboon, Vervet Monkey, Egyptian Goose, Martial Eagle and Dark-capped Bulbul. Mundy et al. (1992) listed the Sykes' Monkey *Cercopithecus mitis* as a predator of Hooded Vulture eggs, and here we note additional nest predators: Martial Eagle and Chacma Baboon. Five pairs of Hooded Vultures were seen at their nests throughout the non-breeding season, suggesting that some individuals visit their nest(s) year-round. Our results suggest that more frequent visits by Hooded Vultures to their nests during the non-breeding season might indicate that the nest will be used in the following breeding season, although we recognise that our sample size of just six nests was small.

The densely foliated crowns of Hooded Vulture nesting trees may help to protect nestlings from predation by avian predators (Mundy et al. 1992) as well as from the weather. In this study, the only instance of predation on a vulture nestling was by a subadult Martial Eagle, a species known to eat birds (Tarboton and Allan 1984).

Our sample of 12 Hooded Vulture nests comprises 12–24% of the region's (South Africa, Lesotho and Swaziland) currently estimated breeding population of 50–100 pairs (Allan 2015). Whilst the current IUCN Red Data Book suggests that the region's breeding pairs of Hooded Vultures are restricted to the Kruger National Park and the Associated Private Nature Reserves (Allan 2015), five of the 12 nests that we monitored were outside of these areas, indicating that the current breeding range of Hooded Vultures in South Africa extends further west than previously thought. Nest surveys in 2015 revealed Hooded Vulture nests still further west along the Olifants River at Ndlovumzi Nature Reserve (LJT unpublished data).

Egyptian Geese numbers are increasing by >10% annually in southern Africa (Banks et al. 2008). They are highly territorial, and may usurp the nests of some raptors (e.g. Rutz et al. 2006; Curtis et al. 2007; Sumasgutner et al. 2016). Despite the presence of Egyptian Geese at some Hooded Vulture nests, we observed no instances of nest usurpation, and those seen at Hooded Vulture nests may have been simply roosting, as they are known to perch in trees and to roost on high structures (Davies and Allan 2007).

A recent isotope study indicated that certain individual Pel's Fishing Owls exploit an exclusively non-piscivorous diet (CT Symes *in litt.*). The photographed Pel's Fishing Owls may have been hunting small mammals in the Hooded Vulture nests, or simply resting.

Chacma Baboons were seen at six Hooded Vulture nests. Some of the troops seem to have slept in nest trees, with baboons entering the tree at night, and departing the following morning. Other signs of the use of nest trees as Chacma Baboon sleeping trees include the accumulation of dung below and in these trees. A baboon preyed on at least one Hooded Vulture egg during the course of this study. Chacma Baboons have also been recorded eating medium-sized birds (Moolman 1976), and animal matter is the preferred food of some Chacma Baboon populations (Hamilton et al. 1978). On 22 August 2016, baboons were observed entering a Hooded Vulture nest tree on Grietjie

Nature Reserve where a breeding pair had been repeatedly mating earlier that morning, approaching the nest, grabbing at one of the adult birds, and then eating the newly laid, nest-lining material after the pair had flown from the tree (LJT and F Fern pers. obs.). In this instance, the flushed pair of Hooded Vultures did not return to the nest that day. There may have been a bias towards detecting Chacma Baboons at Hooded Vulture nests, due to their gregarious nature, and this bias may be affected by troop size and composition (Treves et al. 2010).

Vervet Monkeys feed on the fruits of the jackalberry tree (Skinner and Chimimba 2005), the species in which all of the monkey sightings were recorded. On one of the four days on which monkeys were photographed, the nest tree was in fruit and, given the timing of the sightings, it is possible that the photographed monkeys slept in or near the Hooded Vulture nest trees, as Vervet Monkeys typically begin the day by feeding within their sleeping trees (Isbell and Jaffe 2013).

The South African Small-spotted and Large-spotted Genets prefer wooded habitats and are often associated with rivers (Gaubert and Do Linh San 2015; Gaubert et al. 2015). Both species are known to eat birds (Gaubert et al. 2015; Widdows and Downs 2015), but we found no evidence of them disturbing breeding Hooded Vultures. Instead, they were either using the nest as a feeding platform (the South African Small-spotted Genet) or traversing the tree (both genet species). Similarly, there was no evidence that the other mammal species seen at the nests were a threat to Hooded Vulture breeding success.

Southern Rock Monitors and Spotted Bush Snakes were both photographed by our cameras, and both are known to climb trees well (Alexander 2014; Marais 2014). The relative scarcity of snakes and monitors photographed in this study may be because, as in most camera trapping studies (Rovero et al. 2013), our camera traps had PIR sensors. These sensors rely on a temperature differential between the subject and the background, and the body temperatures of poikilothermic species may be too similar to ambient temperatures to trigger the PIR sensors and so they may elude detection (Rovero et al. 2010; Meek et al. 2012). Southern Rock Monitors are known to eat birds (Dalhuijsen et al. 2014), but feeding occurs only during the wet season (Kaufman et al. 1996), when Hooded Vulture chicks have fledged.

This study links breeding failure in Hooded Vultures to two species: the Martial Eagle and the Chacma Baboon. Nest depredation probably affects Hooded Vulture populations to a lesser extent than mass-poisoning events, when numerous birds may be killed (Ogada et al. 2016). Furthermore, whilst nest predation reduces numbers of Hooded Vulture eggs or nestlings, poisoning kills breeding adults as well, and for long-lived species with slow maturation rates such as Hooded Vultures, the loss of breeding adults may have more serious impacts on population trends than the loss of eggs or nestlings. We do not expect the results of this study to be representative of Hooded Vultures in other regions, where they may be more commensal with humans. We suggest that observational studies (e.g. from a well-concealed hide) be conducted to complement data gathered from nest cameras, as some animals (including the vultures themselves) may enter nest trees without being photographed by nest cameras, and because individuals

of certain species may disturb Hooded Vultures without necessarily being at the nest.

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