OSTRICH 2010, 81(3): 205–209
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OSTRICH
ISSN 0030–6525 EISSN 1727–947X
doi: 10.2989/00306525.2010.519894

Nesting status of African White-backed Vultures *Gyps africanus* in the Masai Mara National Reserve, Kenya

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Vulture populations have declined globally as well as regionally within Africa. Little is known about the status of the African White-backed Vulture *Gyps africanus* in Kenya, but ongoing studies indicate that its population has declined over the last two decades. A total of 32 African White-backed Vulture nests were monitored in the Masai Mara National Reserve over a five-year period between 2003 and 2007. Mean nesting success was 59%, which is comparable to that of populations from southern Africa. Nearest neighbour distances were significantly closer in wooded habitats (‘trees and shrubs savanna’) than in more open grassland habitats (‘open low shrubs’). Based on nearest neighbour distances, the estimated total breeding population within the Masai Mara National Reserve is 1 106 pairs, a figure that may be an overestimate and requires ground-truthing. Collecting baseline data on numbers of breeding pairs and regular nest monitoring are essential in order to assess the impact of various threats to vultures in Kenya, which include growing threats (elephant-mediated habitat disturbance and fire) as well as emerging threats (such as poisoning with the carbamate-based pesticide Furadan™).

Introduction

Although the African White-backed Vulture *Gyps africanus* is still quite numerous across its range (Mundy et al. 1992), it has suffered regional declines in recent years (Anderson 2000, Thiollay 2006a, 2006b) resulting in its global conservation status being upgraded from Least Concern to Near Threatened (BirdLife International 2007). The status of this species is poorly known in East Africa, and its numbers have not been reported for any protected area in Kenya. It was previously widespread in Kenya, occurring throughout most of the country with breeding populations predominating in the south and central regions (Lewis and Pomeroy 1989), and it was not listed on the East African regional Red Data List (Bennun and Njoroge 1996). The species appears to have declined in parts of Kenya over the past decade e.g. in the Laikipia area in north-central Kenya (Ogada and Keesing 2010).

African White-backed Vultures are tree nesters that breed in loose colonies (Mundy et al. 1992). The nest is relatively small in size, for such a large bird, and is usually located in the canopy of a tall large-crowned tree, often along rivers and drainage lines (Houston 1976, Monadjem and Garcelon 2005, Bamford et al. 2009a, 2009b). The female lays a single egg, which is incubated for around 56 d, with the chick fledging about four months after hatching. The peak laying date for African White-backed Vultures in the Serengeti National Park (Tanzania) was mid-April, and the birds apparently time their breeding to ensure that chicks fledge when food (in the form of carcasses of large ungulates) is most readily available (Houston 1976).

Concern about the dramatic decline of vulture populations in south Asia (Gilbert et al. 2002, Prakash et al. 2003) and parts of Africa (Thiollay 2006a), has stimulated the survey and monitoring of vultures in eastern and southern Africa (Murn et al. 2002, Virani and Muchai 2004, Monadjem and Garcelon 2005, Boshoff et al. 2009). The Mara–Serengeti ecosystem supports breeding populations of at least five vulture species. The Masai Mara National Reserve is an important foraging ground for avian scavengers primarily due to the large ungulate populations that cross into it from the Serengeti National Park between July and September annually (Houston 1976). The main aim of this paper is to report on the nesting status of the African White-backed Vulture within the Masai Mara National Reserve.

Methods

The nests of African White-backed Vultures were surveyed annually between 2003 and 2007 in the Masai Mara National Reserve (Figure 1). Nest searches were concentrated in the centre of the Masai Mara where the Mara and Talek Rivers join with several smaller tributaries, providing sufficient riparian vegetation for nesting vultures (Figure 1). The focal study area was demarcated based on logistical ease, accessibility and previous knowledge of likely breeding sites for this species in this area. The two general sites within the focal study area were coded as: Zone A (to the north) – along the Talek river and plains to the north and along the Olare Orok river; and Zone B (to the south)

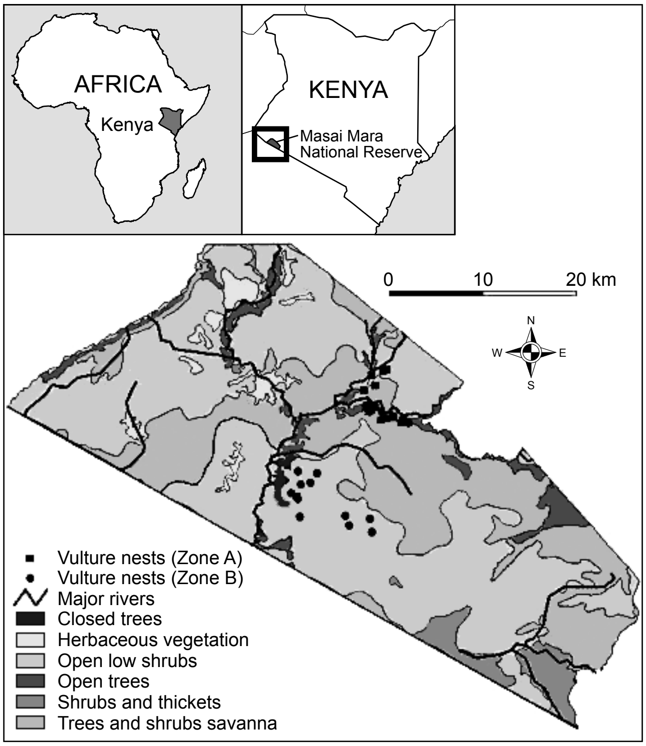

Figure 1: Map of the Masai Mara National Reserve, showing the distribution of 32 African White-backed Vulture nests in relation to the vegetation and rivers within the park

– the plains south of the Talek River up to Lookout Hill. Zone A was largely within the 'trees and shrubs savanna' category (with some 'open trees'; FAO 2000), where the main layer consists of woodland with a crown cover of 20–70% and height of 3 to >30 m, and a second layer consisting of shrubs. Zone B was predominantly within the 'open low shrubs' category, where the main layer consists of shrubland with a height range of 0.3–5 m. It has additional layers consisting of herbaceous vegetation and emergent trees higher than the main stratum (FAO 2000) (Figure 1). These two vegetation categories are the dominant habitat types in the Mara covering 84% of the reserve (Table 1).

All nests that were located within this focal area were monitored; a hand-held GPS was used to obtain the coordinates of each nest. Nests were observed during three 'observation sessions' per year. An observation session involved a period of time within which each nest was checked at least once for breeding activity. These were in March, May, and September. The breeding season of African White-backed Vultures in the Masai Mara is similar to that of the Serengeti, immediately to the south of the Mara, where nesting commences in March/April (Houston 1976). Nests that remained unoccupied all year and at which no vultures were seen during this study were designated E (empty). Various nesting and breeding behaviours were recorded during each observation, including A (active) (a pair flying and calling on and around the nest), B (nest building), M (mating), I (incubating) and C (chick present). On the final visit, each nest was assigned either F (failed) or S (successful) depending on whether a large chick ready to fledge was seen or not. 'No nest' referred to situations where previously active nests had completely collapsed or the nesting tree had fallen down. Mapping of the nests was done in ArcMap 9.0 (ESRI, New York), after which the nearest neighbour distances were calculated for each nest. These nearest neighbour distances were used to provide an estimate of nesting density within each vegetation category based on distance (plotless) methods (Cottam 1957, Greig-Smith 1964).

Plotless density estimators (PDE) were developed in order to overcome the limitations of fixed plot sampling strategies as well as reduce the amount of man-hours necessary for sampling. Instead of estimating the number of organisms per unit area, PDEs attempt to estimate the mean area per sessile organism (in our case, nests), the inverse of density. For our study, this allowed for the use of spacing between nests to be used in determining mean area per nest. Consequently, density could be calculated given the mean distance between nests (Cottam 1957). In using the mean distance to nearest neighbour as a proxy measure of nest density, an important assumption is that all nests were known. It was likely that this assumption was met because, as indicated earlier, African White-backed Vulture nests are placed atop large trees and are unlikely to be missed when present. Besides, the open nature of the vegetation meant that few nests would have escaped detection. It has been demonstrated that, in a randomly distributed population, the distance between nearest neighbours is equal to one-half the square root of the mean area (Clark and Evans 1954). However, it has also been shown that for a set of individuals chosen in a paired manner that is not completely random, their nearest neighbour distances involves multiplication of observed distances by a correction factor of 1.67 instead of the theoretical 2.0, to obtain the correct square root of mean area (Cottam 1957). We calculated nest densities using the correction factor because there were paired nearest-neighbour nests in our sample.

Results

A total of 32 African White-backed Vulture nests were located and monitored within the study area between 2003 and 2007, 20 in Zone A and 12 in Zone B (Figure 1, Table 2). The number of nests observed yearly ranged from a minimum of five to a maximum of 32. Most of the tree species used for nesting by African White-backed Vulture in Zone A were *Ficus* sp., whereas in Zone B they were *Balanites* sp. Other uncommonly used trees were *Diospyros*, *Drypetes*, *Warburgia* and *Boscia* spp. (Table 2).

Nest WB08 remained intact and unoccupied during the entire study period (Table 2). All other failed (F) nests were those where the nesting tree fell down, except nest WB06 where only the nest fell down. Mean nesting success over the five years was 59% and ranged between 40% and 78% (Figure 2).

The mean distance between nearest neighbour nests was significantly different between the two zones (*t*-test: $t = 3.8$, df = 30, $p = 0.00071$). The mean distance (±SE) in the northern Zone A was 511 ± 83 m, while in the southern

Table 1: Area covered by various vegetation categories in the Masai Mara National Reserve following the Land Cover Classification System from Africover (FAO 2000)

Landcover	Area (km²)	Percentage of total area
Open low shrubs (65–40% crown cover)	925.2	53.2
Trees and shrubs savanna	542.9	31.2
Very open trees (40–15% crown cover)	81.4	4.7
Shrub savanna	39.3	2.3
Open trees (65–40% crown cover)	39.1	2.2
Closed to open woody vegetation (thicket)	31.5	1.8
Open to closed herbaceous vegetation	31.8	1.8
Open to closed herbaceous vegetation on temporarily flooded	21.8	1.3
Isolated rainfed herbaceous crop	20.1	1.2
Closed trees	4.6	0.3
Rainfed herbaceous crop	1.6	0.1
Closed trees on temporarily flooded land	0.5	0.0
Grand total	1 739.8	100.0

Table 2: Summary results of African White-backed Vulture nest locations and tree species, together with status/outcome of each nest as per the final visit between 2003 and 2007 in the Masai Mara National Reserve, Kenya. NN = Nearest neighbour distance in metres

Nest ID	Zone	Tree genus	NN	2003	Status	2004	Status	2005	Status	2006	Status	2007	Status
WB01	A	*Diospyros*	270	No nest	F	No nest	F	No nest	F	No nest	F	No nest	F
WB02	A	*Ficus*	630	C	S	C	S	C	S	C	S	C	S
WB03	A	*Ficus*	350	No nest	F	No nest	F	No nest	F	No nest	F	No nest	F
WB04	A	*Ficus*	385	No nest	F	No nest	F	No nest	F	No nest	F	No nest	F
WB05	A	*Ficus*	240	C	S	C	S	C	S	C	S	C	S
WB06	A	*Ficus*	80			E	F	E	F	No nest	F	No nest	F
WB07	A	*Ficus*	400			No nest	F	No nest	F	No nest	F	No nest	F
WB08	A	*Ficus*	1 230			E	F	E	F	E	F	E	F
WB09	A	*Balanites*	1 230			C	S	C	S	C	S	C	S
WB10	A	*Ficus*	690			C	S	C	S	C	S	No nest	F
WB11	A	*Ficus*	450			C	S	C	S	C	S	C	S
WB12	A	*Ficus*	80			C	S	C	S	C	S	C	S
WB13	A	*Ficus*	400					C	S	C	S	No nest	F
WB14	A	*Ficus*	1 335					C	S	C	S	C	S
WB15	A	*Ficus*	505					C	S	C	S	C	S
WB16	A	*Ficus*	505					C	S	C	S	No nest	F
WB17	A	*Ficus*	240					C	S	C	S	C	S
WB18	A	*Ficus*	110					C	S	C	S	C	S
WB19	B	*Drypetes*	745					No nest	F	No nest	F	No nest	F
WB20	B	*Boscia*	1 175					C	S	C	S	C	S
WB21	B	*Balanites*	1 030					C	S	C	S	C	S
WB22	B	*Balanites*	1 030					No nest	F	C	S	No nest	F
WB23	B	*Balanites*	360							C	S	C	S
WB24	B	*Balanites*	625							C	S	C	S
WB25	A	*Balanites*	350							C	S	C	S
WB26	B	*Boscia*	1 450							C	S	No nest	F
WB27	B	*Balanites*	360							C	S	C	S
WB28	B	*Balanites*	1 360							C	S	C	S
WB29	B	*Balanites*	1 360							C	S	C	S
WB30	B	*Warburgia*	1 075							C	S	C	S
WB31	B	*Balanites*	1 950							C	S	C	S
WB32	B	*Balanites*	1 075							C	S	C	S

Zone B it was 1071 ± 132 m. Applying the correction factor, this produced a density of approximately one nest (breeding pair) per 0.7 km² in Zone A, and one nest per 2.8 km² in Zone B. Extrapolating for the whole Masai Mara, the estimated number of nests (breeding pairs) would be 776 in Zone A (542.9 km²) and 330 nests in Zone B (925.2 km²), with a total of 1 106 for the entire reserve.

Discussion

Our results indicate that the African White-backed Vulture breeds at relatively high densities in the areas of the Masai Mara that we studied. However, the density estimates we obtained were lower than those reported by Monadjem and Garcelon (2005) for this species within some conservation

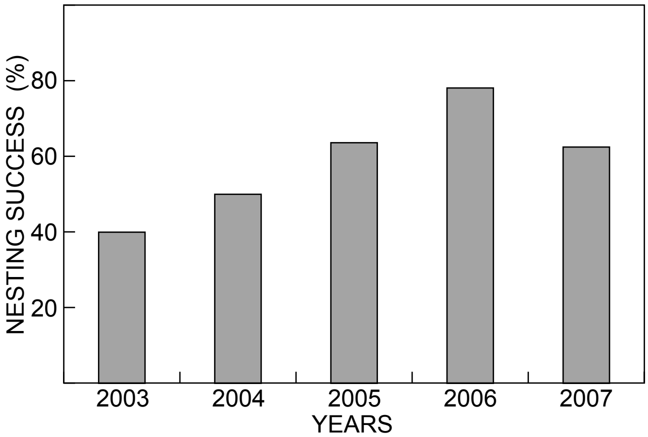

Figure 2: Nesting success of African White-backed Vultures in the Masai Mara National Reserve between 2003 and 2007

areas in Swaziland where they exceeded 260 nests per 100 km², among the highest known densities of this species anywhere in Africa. Comparative estimates from our study were 100 and 25 nests per 100 km² in Zone A and B, respectively. Besides, it was likely that the areas included in our study were not representative of the entire Masai Mara ecosystem because they were not selected randomly, since we chose sites close to riverine habitats. These riparian areas probably provided optimal conditions for the vultures in terms of tree availability, meaning that our extrapolation for the total number of breeding pairs for the Masai Mara is the maximum possible and likely to be an overestimate. Similarly, African White-backed Vulture nests in Swaziland are almost exclusively located in riparian vegetation (Monadjem and Garcelon 2005, Bamford et al. 2009a), and trees selected by African White-backed Vultures for nesting are at least 11 m tall (Houston 1976, Monadjem 2003a, Herholdt and Anderson 2006). Hence, moving away from riverine vegetation (where the tallest trees occur) reduces the probability of finding appropriate trees for nesting, leading to a decline in the density of nests. Clearly, the fact that the nest density in Zone B (predominantly open low shrubs with few emergent trees) was about a quarter of that in Zone A (predominantly wooded riverine habitats) is indicative of the importance of large trees for nesting African White-backed Vultures. It was, however, not clear if the breeding individuals were selecting these tree species or whether they were opportunistically using available trees. The wide range of tree species used in this study suggests the latter, with the variation only indicative of the underlying abundance and distribution of the trees in these habitats. Similarly, Wedge-tailed Eagles *Aquila audax* in Australia displayed no preference for particular tree species and built their nests in the most abundant tall trees available (Sharp et al. 2001). In contrast, Kemp and Kemp (1975) and Monadjem (2003a) suggested that African White-backed Vultures were selecting specific tree species for nesting in.

Mean nesting success in the Masai Mara over the five years was 59%, which compares favourably with previous studies conducted in southern Africa (Monadjem 2003b, Herholdt and Anderson 2006), but was lower than that recorded in the Serengeti (Houston 1976). Breeding failures in the African White-backed Vulture have been attributed to death of the chick or death of the adult birds through poisoning, drowning or predation (Herholdt and Anderson 2006). No deaths of adults were reported during the period of our study in the Masai Mara, implying that breeding success largely hinged on the survival of chicks, mediated through the availability of food and favourable climatic conditions. A growing elephant population coupled with fire pressure in the Masai Mara (Walpole et al. 2004) poses additional threats to breeding vultures due to the associated disturbance and destruction of trees. Indeed, Monadjem and Garcelon (2005) reported that where elephants were present in Swaziland, vultures did not nest in those areas.

Across its range, the African White-backed Vulture has suffered myriad threats such as *inter alia* indirect poisoning, habitat loss, collisions, drowning and electrocution by power lines (Anderson 2000, Herholdt and Anderson 2006). Throughout Kenya, there is a growing threat from the misuse of the highly toxic Carbamate-based pesticide Furadan™ which has already caused large-scale vulture mortalities (Maina 2007, Mijele 2009, Otieno et al. 2010, ST pers. obs.). Poisoning could have a catastrophic impact on vulture populations in Kenya and neighbouring countries and requires urgent investigation to evaluate the extent of its use, and its impacts on breeding populations of all vulture species.

The location and density of vulture nests has been suggested as a possible indicator for pressure on biological resources in low-lying savannas of Swaziland (Monadjem and Garcelon 2005). Monitoring of vulture nests over longer periods of time in the Masai Mara is necessary in order to determine the impacts of elephants, fire and poisoning. Additionally, increasing the number of nests monitored and following the success of these nests and fledglings would provide better estimates of breeding success, which is a crucial demographic parameter for assessing the conservation of the African White-backed Vulture in the Masai Mara National Reserve.

Acknowledgements — This study is part of The Peregrine Fund's Pan African Raptor Conservation Program and was funded by grants from The Peregrine Fund. We are indebted to the Narok County Council and the staff of the Masai Mara National Reserve, in particular the wardens Mr Sindiyo and Mr Minis, for their assistance and permission to conduct vulture research in the reserve. We also thank Mr Koikai and Mr Lenjir for their help. We also thank Keith Bildstein for his invaluable assistance. We are grateful for the support accorded by the Mara Conservancy and neighbouring group ranches—Koiyaki, Lemek, Siana and Olaro Orok—plus logistical help accorded by Heritage Hotels, Mada Hotels and Africa Eco-camps. We are thankful to Kenya Wildlife Service and the National Museums of Kenya.

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Received August 2009, accepted July 2010
Editor: MA Anderson