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# Nesting distribution of vultures in relation to land use in Swaziland

ARA MONADJEM[1,*] and DAVID K. GARCELON[2]
[1]*Department of Biological Sciences, University of Swaziland, Private Bag 4, Kwaluseni, Swaziland;* [2]*Institute for Wildlife Studies, P.O. Box 1104, Arcata, CA 95518, USA; *Author for correspondence (e-mail: ara@uniswacc.uniswa.sz)*

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**Abstract.** Three species of vulture (African White-backed, White-headed and Lappet-faced) breed in Swaziland, all of which are threatened within the country. Vulture nests were surveyed using a fix-winged aircraft in low-lying savannas of Swaziland. Nesting was observed in three land use categories: (1) unprotected government cattle ranches, (2) protected cattle ranches, and (3) conservation areas. A total of 248 nests was recorded, of which 240 belonged to the African White-backed Vulture. Nesting densities were highest in conservation areas, an order of magnitude lower on protected cattle ranches and negligible on government ranches. Nests of White-headed Vultures and Lappet-faced Vultures were exclusively located in conservation areas. Nesting densities of African White-backed Vultures in some conservation areas exceeded 260 nests/100 km$^2$, which are the highest known densities of this species anywhere in Africa. Nests were almost exclusively located in riparian vegetation, but at Hlane National Park a large proportion of nests were placed in open woodland, possibly as a result of an influx of vultures from adjoining agricultural lands that have only been transformed in recent decades. Where elephants were present in conservation areas, vultures did not nest within their enclosures. The location and density of vulture nests may possibly be used as an indicator of pressure on biological resources in low-lying savannas of Swaziland.

## Introduction

The African White-backed Vulture *Gyps africanus* is widely distributed in sub-Saharan Africa and its population is estimated at about 270 000 individuals (Mundy et al. 1992). The Lappet-faced Vulture *Torgos tracheliotus* and White-headed Vulture *Trigonoceps occipitalis* are also widespread, but occur at far lower densities (Mundy et al. 1992). Distributions and/or numbers of all 3 species have declined markedly in southern Africa (Boshoff et al. 1983; Tarboton and Allan 1984; Mundy 1997) due to habitat loss, decline in food availability, poisoning and electrocution (Anderson 1994, 1995; Simmons 1995; van Rooyen 2000), and all are currently listed as 'vulnerable' in South Africa (Anderson 2000a, b, c).

The African White-backed Vulture is the most abundant vulture in Swaziland with an estimated 160–200 breeding pairs (Parker 1994, 1997; Monadjem 2003a). National estimates of White-headed Vulture and Lappet-faced Vulture are far lower at 6 and 3 pairs, respectively (Parker 1997; Monadjem 2003a). While the White-headed and Lappet-faced Vultures are listed as endangered in

Swaziland, the African White-backed Vulture is considered near-threatened (Monadjem et al. 2003). Of these, only the Lappet-faced Vulture is considered globally threatened and is listed as 'Vulnerable' by the IUCN.

A number of surveys have observed associations between the distribution of raptors and land use. Sightings of vultures are frequently positively correlated with conservation areas (Brandl et al. 1985; Sorley and Andersen 1994), although Herremans and Herremans-Tonnoeyr (2000) reported a greater abundance of vultures at the edge of protected areas than either within or beyond these areas. Results from such studies, however, cannot be interpreted without knowledge of the breeding habitats of the raptors. Vultures can move large distances in search of food (Boshoff et al. 1984). However, during the breeding season, which may span well over half a year (Mundy et al. 1992), these birds must necessarily concentrate their activities around nesting sites. Investigating the relationship between distribution of vulture nests and land use is therefore vitally important, but has not yet been conducted. All 3 vulture species considered here build their nests in tall trees and, in the case of the African White-backed Vulture, often in riparian habitats (Kemp and Kemp 1975; Mundy et al. 1992; Monadjem 2003b).

A previous survey of Swaziland's vultures was conducted from the ground and effort was focused on protected areas (Monadjem 2003a). Given the survey techniques, that effort was not comprehensive and may have missed many nesting pairs. Furthermore, since only protected areas were surveyed, the impact of land use on vulture distributions could not be determined. The main objectives of the present study were to: (1) determine the distribution and number of vulture nests in Swaziland based on aerial surveys; and (2) determine the influence of land use on the distribution of nests.

## Methods

### *Study area*

Parker's (1994) comprehensive atlas of bird distributions only recorded vultures in the 'lowveld' of Swaziland, which lies to the east of the Drakensberg escarpment (referred to as 'highveld' and 'middleveld'), and is separated from the Mozambique coastal plains by the Lubombo mountain range (Goudie and Price Williams 1983) (Figure 1). Altitude in the lowveld ranges from 150 to 500 m above sea level. Mean monthly temperature in January is 26 °C and in July is 18 °C, while mean annual rainfall ranges from 550 to 725 mm. The vegetation has been classified as Lowveld Savanna (Acocks 1988) with broadleaved woodland predominating in the west, microphyllous (*Acacia*) savanna in the east and riverine forest along rivers and major drainage lines (Hess et al. 1990; Sweet and Khumalo 1994). Riverine forest in Swaziland typically supports large, evergreen trees that often contrast sharply with shorter, deciduous trees in adjacent savannas.

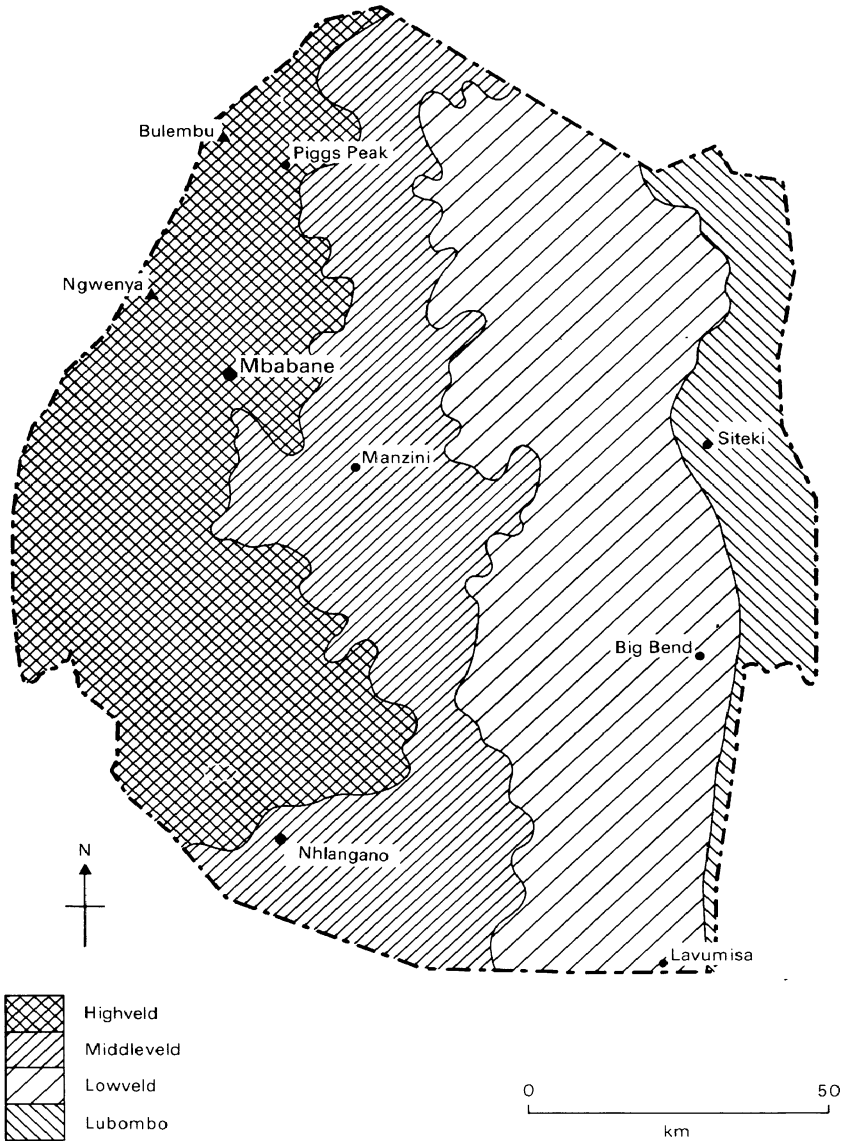


*Figure 1.* Map of Swaziland showing the four major geographical zones (based on Goudie and Price Williams 1983). The survey was conducted in the 'lowveld' region.

Four main types of land use are practiced in the lowveld of Swaziland: (1) subsistence farming (maize and cattle), (2) commercial crop farming (mostly sugar cane and cotton), (3) commercial cattle ranching (private and government), and (4) conservation (e.g. protected areas and ecotourism reserves). Vultures do not breed in either of the first two land use categories (Esterhuizen 1995; Monadjem 2003a; personal observations). Commercial sugar cane fields

are devoid of all trees and thus do not offer appropriate nesting sites, while land under subsistence agriculture is generally heavily settled leading to disturbance of nesting raptors (Monadjem 2000). The objective of our study was to compare nesting densities in conservation areas with those in cattle ranches. Conservation areas were defined as those whose primary function was conservation. Some of the commercial cattle ranches support high biodiversity and actively manage these resources; but their primary function is not conservation, and hence they were not classified as such. Cattle ranches were categorized into those that actively provided protection to biodiversity resources (through policing of the ranches) and those that did not, hereafter referred to as protected cattle ranches and government ranches, respectively. The protected cattle ranches, although primarily in the beef production business, also utilize indigenous antelope (mostly for sustainable hunting purposes). Wildlife (especially larger mammals) on government ranches, in contrast, has not directly been valued in the past and hence has been largely reduced or eliminated by over-harvesting. The distribution of vulture nests was assessed in relation to three broad land use categories: conservation areas, protected cattle ranches and unprotected government ranches.

Previous studies have recorded high densities of vulture nests in the Hlane-Mlawula-Mbuluzi reserve network (hereafter referred to as Hlane-Mlawula) (Esterhuizen 1995; Monadjem 2003a). These three protected areas are contiguous and are situated in the north-eastern region of Swaziland (Figure 2). To the east lie the Lubombo mountains which do not support any breeding African White-backed Vultures, while the northern boundary is sharply demarcated by commercial sugar cane plantations. Two government ranches are situated to the south and west of Hlane-Mlawula, beyond which lie vast tracts of heavily populated Swazi Nation Land (SNL) on which subsistence agriculture is practiced. As a starting point this entire 50 000 ha area, including the Hlane-Mlawula area and adjoining cattle ranching areas, was surveyed.

Prior surveys (Esterhuizen 1995; Monadjem 2003a) also recorded vultures nesting in Mkhaya Game Reserve and the adjoining Big Bend Conservancy (hereafter referred to as Mkhaya-Big Bend), as well as from IYSIS Cattle Ranch (hereafter referred to as IYSIS). These areas were included in the survey, as was Panata Ranch and several government ranches (Figure 2). Panata Ranch comprises several neighbouring land owners and the main land use here at the time of the study was commercial cattle ranching. The habitat in intervening areas between these ranches and conservation areas has been either transformed (to irrigation or subsistence agriculture) or heavily settled. Since vultures do not nest under such conditions (Monadjem 2000; A. Monadjem, personal observation), these areas were not surveyed.

A number of government and private ranches to the south of the Big Bend Conservancy were also partially surveyed, but agricultural land and heavily populated areas were once again avoided. Surveyed areas are shown in Figure 2.

At the time of the study, elephants were present within special elephant-proof enclosures in Hlane National Park and Mkhaya Game Reserve. The

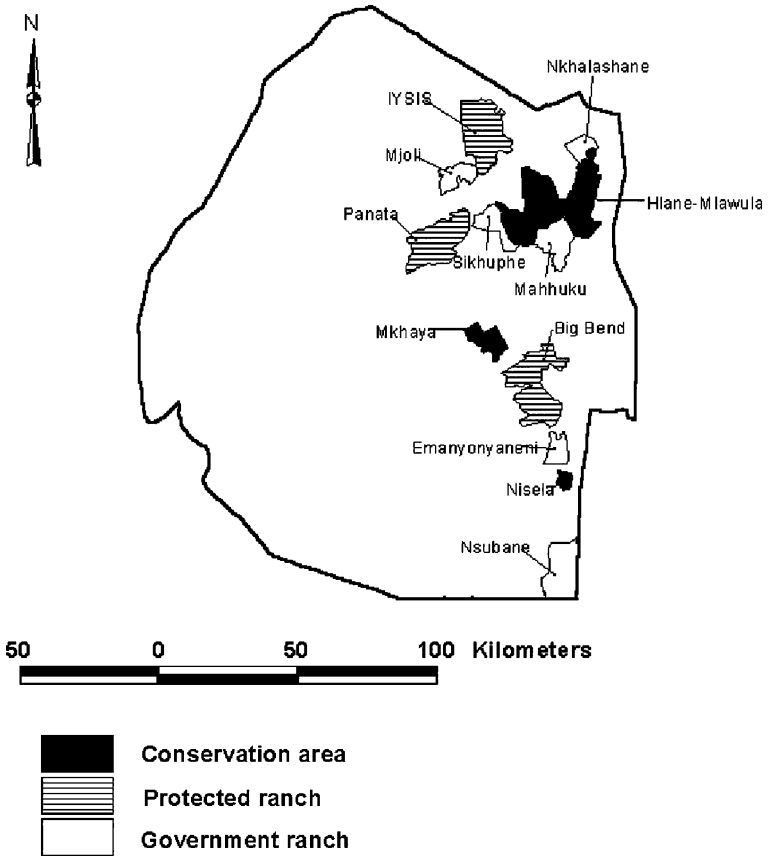


*Figure 2.* Location of survey areas, and predominant land use of each area.

impact of these elephant enclosures on vulture nests was also assessed. The exact areas of these enclosures are not known, but the two at Hlane were about 300 ha in extent. The enclosure at Mkhaya was of similar size.

### *Aerial census*

The aircraft used in the survey was a two-seater, fixed-wing Kitfox. Cruising speed was generally maintained at between 60 and 100 km/h, depending on direction and speed of the wind. For most of the survey the aircraft was flown 5–15 m above the tree line.

As most vulture nests in Swaziland are located along rivers or drainage lines (Monadjem 2001), all major riparian zones were surveyed first. These riparian zones were identified from 1/50 000 maps, and were flown in both directions i.e. upstream and downstream. The pilot maintained the plane over the river

causeway and an observer (A. Monadjem) counted the number of active nests on one side of the river or drainage line. At the end of the drainage line, the pilot turned the plane around and flew back along the same flight path. The same observer then counted nests on the opposite bank. Once the rivers and drainage lines had been surveyed the rest of the area was surveyed by flying parallel strips (straight lines). The Hlane-Mlawula area was divided into7 blocs, of which two had large numbers of vultures breeding beyond the riparian zone. These two blocs were flown in strips 100 m apart, and only the observer counted nests. The remaining 5 blocs supported very few vulture nests (except along drainage lines) and were flown in strips of 200 m, with both pilot and the observer counting nests. Hence, the entire Hlane-Mlawula area, including the two government cattle ranches, was completely covered.

Major drainage lines in Mkhaya-Big Bend and IYSIS were surveyed as described above. In addition, several 200 m strips were conducted at random intervals (i.e. partial coverage as opposed to complete coverage). These strips were selected from the air and ran parallel to each other. Ranches south of Mkhaya-Big Bend were surveyed in a similar manner.

The positions of all observed nests were stored, while in the air, onto a Garmin 12 Global Positioning System (GPS). However, only active nests (defined by the presence of one of the following on/in the nest: incubating adult, egg or chick) were counted. Where necessary, a nest was circled to confirm identification of the species or to check nest contents. The low-flying aircraft did not appear to disturb the incubating vultures, none of which ever left the nest as a result of the passing plane.

### *Data analysis*

All nest locations were entered into a Geographical Information System (GIS; ArcView 3.1) from which the distribution maps were plotted. The $\chi^2$-test was employed to test for differences in vulture densities in different land use categories (Zar 1984).

## Results

A total of 235 African White-backed Vulture nests were recorded during the aerial survey. An additional 5 nests were recorded from ground surveys that were missed during the aerial survey, bringing the total to 240 active nests recorded during the 2002 breeding season.

African White-backed Vultures nested in three discrete areas (Figure 3). The majority of nests were located in Hlane-Mlawula, with smaller numbers in Mkhaya-Big Bend and IYSIS. Only 4 nests were located on the unprotected government cattle ranches (Table 1). Nesting densities were highest in conservation areas, an order of magnitude lower in protected cattle ranches and

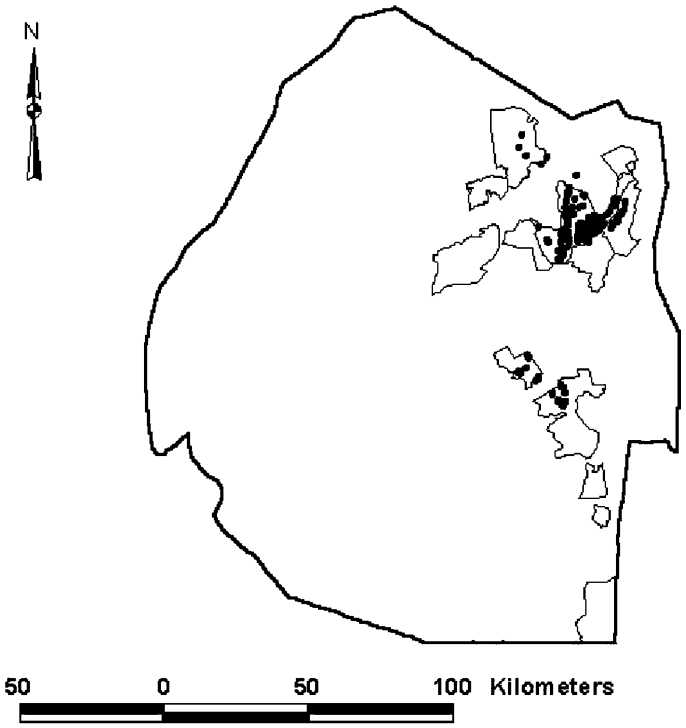


*Figure 3*. Distribution of African White-backed Vulture nests recorded during this study.

negligible on government ranches (Table 1). These differences are statistically significant ($\chi^2 = 429.457$; $p < 0.001$; degrees of freedom = 2).

Despite no obvious differences in vegetation structure between the Hlane-Mlawula reserve complex and the adjoining government ranch to the south (A. Monadjem, personal observation), the distribution of nests were very clearly confined to the conservation area (Figure 3). Vultures nested right up to the boundary of the reserve but, with the exception of a single nest, did not breed on the government ranch. A similar pattern was observed with respect to vulture nests within IYSIS and Big Bend Conservancy (both protected cattle ranches) and the neighbouring unprotected government ranches. At both protected ranches, vultures nested right up to the boundaries of the properties, but were entirely absent once one crossed into the government ranches. Again, no obvious differences were noted in vegetation structure (A. Monadjem, personal observation).

African White-backed Vultures nested almost exclusively in riparian vegetation at all sites expect at Hlane National Park (Figures 4 and 5). In the eastern half of the Park (mostly the Nzotho section), a large proportion of these birds nested in open woodland, some several kilometers away from the nearest drainage line. In the west, however, nests were almost exclusively

*Table 1.* Nesting density of African White-backed Vultures in relation to land use and level of protection afforded to wildlife.

| Location | Area ($km^2$) | Number of nests | Nesting density (nests/100 $km^2$) |
|---|---|---|---|
| *Conservation areas* | | | |
| Hlane-Mlawula | 347 | 202 | 58.2 |
| Mkhaya | 64 | 12 | 18.8 |
| Nisela | 19 | 0 | – |
| Subtotal | 430 | 214 | 49.8 |
| *Protected cattle ranches* | | | |
| Big Bend Conservancy | 214 | 19 | 8.9 |
| IYSIS | 200 | 6 | 3.0 |
| Panata Ranch | 179 | 0 | – |
| Subtotal | 593 | 25 | 4.2 |
| *Government ranches (unprotected)* | | | |
| Nsubane | 194 | 0 | – |
| Mahhuku | 103 | 1 | 1.0 |
| Sikhuphe | 69 | 0 | – |
| Mnjoli | 58 | 0 | – |
| Emanyonyaneni | 45 | 0 | – |
| Nkhalashane | 43 | 0 | – |
| Subtotal | 512 | 1 | 0.2 |
| Total | 1535 | 240 | 15.6 |

confined to riparian vegetation (Figure 5). Interestingly, at Hlane National Park, vultures avoided nesting in the two elephant enclosures (Figure 5). Not a single vulture nest was located in any of the elephant enclosures, either in Hlane National Park or in Mkhaya Game Reserve.

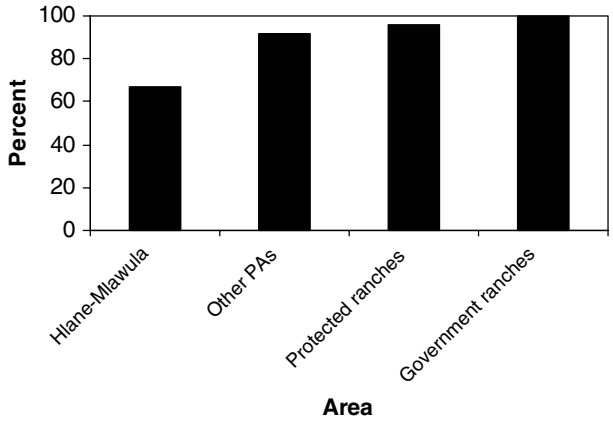


*Figure 4.* Percentage of African White-backed Vultures nesting in riparian vegetation at Hlane-Mlawula, other protected areas (PAs), protected ranches and government ranches. The remaining nests were situtated in open woodland/savanna.

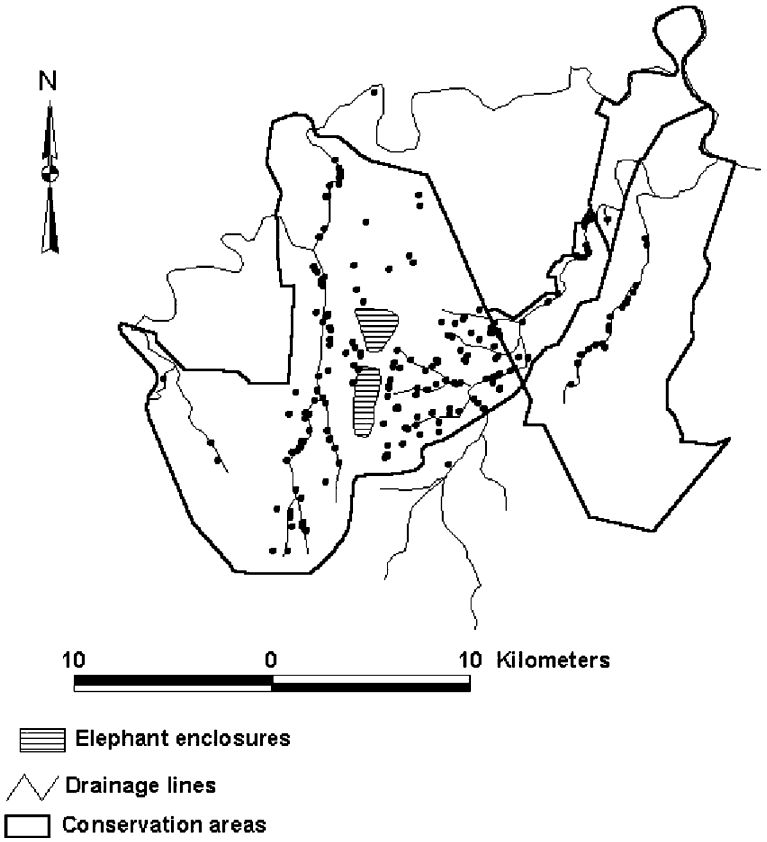


*Figure 5*. Distribution of African White-backed Vultures at Hlane National Park, showing the absence of nests within the elephant enclosures. Note the high proportion of nests not distributed in riparian vegetation. Nests in woodland, however, were restricted to the eastern part of the park (see text for explanation).

A total of 5 White-headed Vulture and 3 Lappet-faced Vulture nests were recorded during this survey. All 8 nests were found in the Hlane-Mlawula reserve complex. Unlike the African White-backed Vulture, nests of these 2 species were spaced well apart and were not situated in riparian vegetation. Nest densities recorded at Hlane-Mlawula were 1.4 nests/100 $km^2$ (White-headed Vulture) and 0.9 nests/100 $km^2$ (Lappet-faced Vulture). Mean nearest neighbour distance for White-headed Vulture nests was 4.3 km (range: 1.6–5.7 km), and for Lappet-faced Vultures was 6.5 km (range: 6.0–7.0 km).

## Discussion

African White-backed Vultures were observed to nest in three discrete areas in the lowveld: (1) Hlane-Mlawula; (2) Mkhaya-Big Bend and (3) IYSIS. These

three areas were also identified by Monadjem (2003a) as supporting breeding vultures. Despite extensive aerial searches in appropriate habitat, no new nesting areas were found. Hence, these three areas are the only areas that currently support breeding vultures in Swaziland.

Vultures nested in all conservation areas surveyed during this study expect the tiny Nisela reserve. As this reserve was established less than a decade ago and does not support appropriate riparian vegetation, it is not surprising that vultures did not breed there. Panata Ranch, though covering a large area with suitable nesting habitat, did not support any breeding vultures. Vultures have been regularly sighted in this area (Parker 1994), and with the recent establishment of a vulture 'restaurant' at the Ranch (A. Monadjem, personal observation), African White-backed Vultures could potentially commence nesting. A vulture 'restaurant' is a site at which supplementary food, often in the form of dead livestock, is placed at regular or frequent intervals (Mundy et al. 1992), resulting in the birds associating the site with the presence of food. Since African White-backed Vultures have been known to breed at new sites where food has suddenly become super-abundant e.g. after elephant culling operations in Zimbabwe (Mundy et al. 1992), the same may also happen at a site where food has been increased through the creation of a vulture restaurant.

In stark contrast, only a single vulture nest was recorded on any of the six government ranches surveyed and was located within 2 km of the Hlane-Mlawula reserve complex. The only other nest to be recorded outside of a conservation area or a protected ranch was located along riparian vegetation within a sugar cane field (2 km to the north of Hlane National Park). This field was only established a year before the survey and the area was previously within Hlane National Park and supported natural vegetation. The vulture pair, therefore, probably nested there as a result of nest site fidelity (personal observation).

A total of 240 active nests was recorded during this survey. This is significantly higher than the 163 pairs estimated to be nesting in Swaziland in 2001 (Monadjem 2003a), suggesting that the previous survey had under-estimated this population. Assuming that 20% of the adult population does not attempt to breed each year (Mundy et al. 1992), then the total number of breeding pairs present in Swaziland in 2002 would have been 300 pairs or 10% of the South African population (Anderson 2000a). Swaziland, therefore, supports a significant proportion of birds breeding in the region, and could play an important role in their conservation.

The density of African White-backed Vulture nests recorded in Swaziland conservation areas was 49.8 nests/100 $km^2$ (see Table 1). However, densities varied considerably between areas. The highest densities (and the highest absolute numbers) were recorded in the Hlane-Mlawula area. Approximately 150 $km^2$ (43%) of this area is mountainous and unsuitable for nesting by African White-backed Vulture. The density of nests recorded in the remaining (suitable) area was 102.5 nests/100 $km^2$ . Within this, the 41 $km^2$ Nzotho section of Hlane supported a density of 266 nests/100 $km^2$ .

By comparison with other regions of Africa, these density figures are very high. Other areas supporting 'high' nesting densities of African White-backed Vultures in South Africa include: Umfolozi-Hluhluwe 24.4 nests/100 $km^2$ (Whateley 1986), Kruger National Park 7.9 nests/100 $km^2$ (Kemp and Kemp 1975), Timbavati-Klaserie 9.8 nests/100 $km^2$ (Tarboton and Allan 1982), Kimberley 61–110 nests/100 $km^2$ (Mundy 1982; Mundy et al. 1992; Murn et al. 2002). A much lower nesting density of 4.1 nests/100 $km^2$ was recorded from Zimbabwe (Mundy et al. 1992). The nesting density in the Hlane-Mlawula reserve complex compares favourably with the highest densities previously recorded, while the Nzotho section appears to support the highest known density of African White-backed Vultures on the continent.

In many sites throughout Africa, African White-backed Vultures have been known to favour riparian vegetation for nesting (Mundy 1982; Whateley 1986; Monadjem 2001). Why then did a large proportion of birds nest in open woodland at Hlane National Park? The lack of riparian vegetation does not necessarily prevent African White-backed Vultures from nesting (Tarboton and Allan 1984; Kemp and Kemp 1975). For example, birds in the Kimberley area of South Africa nest at high densities in camelthorn savanna (Murn et al. 2002). It is possible that with the transformation of vast tracts of land for agricultural purposes during the past three decades, in the lowveld of Swaziland (Deall et al. 2000), there has been an influx of breeding vultures into Hlane National Park originating from adjoining transformed lands. These surplus birds probably entered an already saturated breeding habitat along riparian vegetation and may have had to select secondary woodland habitats in which to nest. This may also explain the extra-ordinarily high nesting density in the Nzotho section of the park. Whateley (1986) proposed a similar explanation to account for the high density of African White-backed Vultures in Hluhluwe-Umfolozi Game Reserve in South Africa.

In contrast, nests in the west of the park were almost exclusively located in riparian vegetation. This may be related to the change in vegetation that occurs here. The woodland in the east of the park is dominated by tall knobthorn (*Acacia nigrescens*) savanna while in the west, the scrubby *Spirostachys-Euclea* bushveld (Gertenbach and Potgieter 1978) is probably too short to support vulture nests. Nests of African White-backed Vultures at Mlawula Nature Reserve were all located above 12 m (Monadjem 2003b), but trees in the *Spirostachys-Euclea* bushveld rarely reach this height.

The absence of nests in the elephant enclosures at Hlane National Park cannot be explained by differences in vegetation. The entire area is dominated by tall *Acacia nigrescens* trees (Gertenbach and Potgieter 1978), in which all the nests outside of riparian vegetation were situated (A. Monadjem, personal observation). The only observable difference was that practically all the trees in the elephant enclosures had been debarked and killed by elephants. It would appear that vultures were avoiding nesting in the elephant enclosures on account of the dead trees. Supporting this observation is the fact that no vultures nested within the elephant enclosure at Mkhaya Game Reserve, although

several nests were located just outside it. This has implications for the conservation of vultures in confined areas into which elephants are introduced, and may account for the low nest densities in the Kruger National Park (Kemp and Kemp 1975; Tarboton and Allan 1984).

Lappet-faced Vulture densities vary considerably across the continent, but 'high' figures of 2–7 nests/100 $km^2$ have been reported from Kenya and Zimbabwe (Pennycuick 1976; Hustler and Howells 1988; Mundy et al. 1992). Somewhat lower nesting densities, averaged across 10 years, were recorded from several sites within the Namib desert in Namibia (Bridgeford and Bridgeford 2003). However, maximum densities in the Namib lie within the density figures quoted above. The Swaziland density is lower than this, but is similar to that quoted for KwaZulu-Natal (1.5 nests/100 $km^2$, Mundy et al. 1992), and higher than densities in the Kruger National Park (Tarboton and Allan 1984).

White-headed vultures nest at low densities throughout Africa, and the density recorded in Swaziland is similar to those quoted for Zimbabwe and Zambia (Mundy et al. 1992), but higher than densities quoted for Kruger National Park and neighbouring private reserves (Kemp and Kemp 1975; Tarboton and Allan 1984) and the Serengeti, Kenya (Pennycuick 1976). This species appears to be particularly sensitive to disturbance (including poisoning) and even sightings of this species are mostly confined to large conservation areas (Mundy 1997; Herremans and Herremans-Tonnoeyr 2000).

Why vultures did not breed on the (unprotected) government ranches is unclear. It is unlikely that vultures are currently poisoned here or anywhere else in Swaziland (Monadjem 2003a). In any case, poisoning would not likely result in the observed nesting distributions, where nests occurred right up to the boundary of conservation areas but not beyond in government ranches. It is also unlikely to be food-related, as vultures can cover large areas in search of food (Boshoff et al. 1984); they do not need to breed adjacent to feeding areas. The lack of nests in government ranches is most likely due to active avoidance of these areas by vultures. Nesting vultures are sensitive to disturbance and even increased activity along a road may lead to nest site desertion (Bridgeford and Bridgeford 2003). Body parts of vultures are highly sought after by traditional healers (Cunningham 1990) and many vultures have been killed in South Africa directly for this trade. This may also be the reason for the observed vulture nesting distributions in Swaziland.

The virtual absence of vulture nests on government ranches may be symptomatic of widespread over-harvesting of biological resources on these properties. Although vegetation surveys were not conducted in this study, vegetation structure of government ranches did not appear to differ from that of adjoining protected areas (A. Monadjem, personal observation). Species richness of birds, however, is lower on these ranches than in protected areas (Monadjem 2000), and mammalian diversity is even further reduced (Monadjem et al. 1998; Monadjem and Mahlaba 2000). The distribution of vulture nests, therefore may be a reliable indicator of the pressure on the biological resources of Swaziland's savannas.

Our data suggest that Swaziland harbours perhaps the highest density of breeding African White-backed Vultures known in southern Africa, and indicates the great importance of protected areas for the continued conservation of vultures in Swaziland.

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