

**Hooded Vultures (*Necrosyrtes monachus*) nearly extirpated from Edo State, Nigeria:
A report on the avian scavenger community**

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ABSTRACT:

Avian scavengers, by feeding on carrion and other organic matter, provide critical ecosystem services. Vultures, the only obligate avian scavengers, have reportedly experienced massive population declines in Africa yet current knowledge regarding their status in most West African countries is unknown. This study set out to ascertain the status of the avian scavenger community in Edo State, southern Nigeria. We made total counts of all scavenging birds at foraging and roosting sites in 13 urban areas. We recorded three species of avian scavenger which were, in order of decreasing relative abundance: Pied Crow (*Corvus albus*), Yellow-billed Kite (*Milvus migrans*), and Hooded Vulture (*Necrosyrtes monachus*). There was a positive correlation between relative abundance of the avian scavenger and human population size, such that more populous urban centres had larger populations of scavengers. We counted more scavenging birds at roosting sites than at foraging sites. While the Pied Crow and Yellow-billed Kite appear to be thriving in Edo State, the Hooded Vulture appears to have experienced a massive population decline. Our results suggest that without immediate conservation effort such as protection, education and advocacy, the Hooded Vulture will be extirpated from this region in the near future. We suggest that these conservation efforts be focused on the largest urban areas. Furthermore, we recommend that other states in southern Nigeria be urgently surveyed in order for more general conclusions to be drawn about the fate of avian scavengers in this region.

Keywords: Scavengers, Hooded Vulture, *Necrosyrtes monachus*, population decline, Nigeria

Introduction

Due to their mode of foraging, vertebrate scavengers play a key role in cleaning up rotting organic matter (Pomeroy 1975; Sekerçioğlu 2006). This is a particularly important ecosystem service in urban areas because by reducing the amount of exposed rotting matter, the risk of transmission of infectious diseases to humans is reduced (Gangoso et al. 2012; Inger et al. 2016a). Because of their keen eyesight and great mobility, birds are highly efficient at locating and removing carcasses (DeVault et al. 2016; Inger et al. 2016b), yet avian scavengers rank amongst the most threatened group of vertebrates (Buechley and Sekerçioğlu 2016). Scavenging birds can be divided into facultative and obligate scavengers (Buechley and Sekerçioğlu 2016; DeVault et al. 2016). Facultative scavengers include several species of raptors (such as kites), storks, gulls and crows. Vultures are the only known obligate vertebrate scavengers, with a very large proportion of species listed as globally threatened (Ogada et al. 2012; Ogada et al. 2016).

Vultures have declined drastically across the African continent (Ogada et al. 2016). The largest declines are thought to be in Nigeria (Ogada et al. 2011), the most important factor being the trade in vulture parts for traditional medicine which is prevalent in several parts of the country (Awoyemi 2014; Williams et al. 2014; Buij et al. 2015). One such species that has declined across Africa is the Hooded Vulture *Necrosyrtes monachus* (Ogada and Buij 2011). It occurs in close proximity to humans in tropical Africa, and in many urban areas within its range, Hooded Vultures are the only obligate scavengers (Odino et al. 2014). In the southern regions of Nigeria, Hooded Vultures occur in a commensal association with humans (Brown 1970, Mundy et al. 1992, Ogada and Buij 2011).

Many factors may affect the relative abundance and distribution of scavenging birds in urban areas. One such factor is the amount of food available to them (Orros and Fellowes 2015), which is determined by the size of the human population and the way waste products (especially at abattoirs) are disposed of (Pomeroy 1975; Campbell 2009; Ssemmanda and Pomeroy 2010; Jallow et al. 2016). In addition, many scavenging birds congregate at communal roosting sites, which form an important part of their habitat requirements (Ssemmanda and Pomeroy 2010). Furthermore, the Hooded Vulture in Uganda and the Black Vulture *Coragyps atratus* in Brazil have been found to roost close to foraging sites thus reducing costs associated with movement (Ssemmanda 2005; Novaes and Cintra 2013). Hence the location of, and level of protection at, these roosting sites is likely to affect the number of birds occurring within urban areas.

The relationship between the abundances of facultative and obligate avian scavengers has received only limited attention by researchers in Africa (Ssemmanda and Pomeroy 2010; Annorbah and Holbech 2012). However, it has been predicted that a decrease in the numbers of obligate (and specialized) scavengers may result in an increase in facultative (and opportunistic) scavengers, due to an increased food supply for the latter (Ogada et al. 2011; Buechley and Sekerçioğlu 2016; Ogada et al. 2016).

In light of the ongoing declines observed in vulture populations across Africa, quantifying their status has become of prime importance. This study set out to assess the status of the avian scavenger community in Edo State, Nigeria, in terms of the distribution and abundance of scavenging avian species in urban environments. Our main objective was to ascertain the abundance of each avian scavenger species at feeding and roosting sites at 13 urban areas, and seek correlations with factors that may affect this.

Materials and methods

Study area and design

The study was carried out in Edo State located in southern Nigeria (Figure 1), which comprises 18 local government areas (LGAs). Although the settlements in these LGAs are mostly rural, a few urban ones exist as well; for example, each LGA typically has one urban area which serves as the LGA headquarters. Thirteen urban areas were selected to represent the general region, and surveyed for scavenging birds. This survey was done using both transect counts and total counts at feeding and roosting sites.

Although the total number of suitable (feeding and roosting) sites is unknown, at least one such site was surveyed in each urban area. Each urban area typically had one government-owned (and registered) abattoir. However, other private abattoirs exist which were not surveyed. Also, although there are only two government approved landfills in the entire state, other dumpsites occurred randomly in terms of both spatial and temporal location. Both of these landfills were surveyed in addition to one randomly located dumpsite. All the roosts that were located in the course of the study were surveyed. It is of course possible that some roosts had been overlooked, but we feel that this is unlikely due to our extensive coverage of the area and discussion with locals.

Based on figures from the latest human population census (conducted in 2006), urban settlements in Edo State have been categorized into three population classes: high, medium, and low (Magnus and Esegbe 2012). Urban areas in the high category have a human



Figure 1: Map of Edo State, Nigeria showing the 13 urban areas (see Table 1) at which scavenger birds were counted at sites of interest and along transects. The location of Edo State within Nigeria is shown in the inset

Table 1: Sites of interest visited in each Local Government Area (LGA) and urban area. Also presented is the human population size class

| Region | LGA | Urban area | Sites of interest | Population size class |
|-------------|-----------------|--------------------------------------|---|-----------------------|
| Edo-South | Egor | Benin-City (Ugbowo) | Campus (open spaces/roost) | High |
| | Ikpoba-Okha | Benin-City (Ikpoba-slope, Ikhueniro) | Abattoir, roost, dumpsite | High |
| | Oredo | Benin-City (Ogogugbo, Ogba) | Airport (open spaces/roost) | High |
| | Ovia North-east | Okada, Oluku | Abattoir, dumpsite | Low |
| Edo-Central | Esan West | Ekpoma, Iruiekpen (sub-urban) | Abattoir (x2), campus (open spaces/roost) | Medium |
| | Esan Central | Irrua | Abattoir | Low |
| | Esan North-east | Uromi | Abattoir, dumpsite, roost | Low |
| | Igueben | Igueben | Abattoir | Low |
| Edo-North | Etsako-West | Auchi | Abattoir | Medium |
| | Akoko-Edo | Igarra | Abattoir | Low |
| | Etsako-East | Okpella | Abattoir | Low |
| | Owan-East | Afuze | Abattoir | Low |

population greater than 151,000, while those in the medium and low categories have populations of 51,000 – 150,000, and 20,000 – 50,000, respectively. We surveyed 13 urban areas that included three in the “high”, two in the “medium”, and eight in the “low” class. These 13 urban areas included 10 abattoirs, five avian roost sites, and three human waste disposal sites (hereafter dumpsites) (Table 1).

Each urban area was selected based on the availability of sites of interest (places which harbour resources for scavengers in urban areas) such as abattoirs, roosts and dumpsites. This was established using published lists of dumpsites and abattoirs in Edo State found online (<http://data.edostate.gov.ng>), which were confirmed by visits to the places listed. Roosts were determined by inquiry from the locals (in each area) and our observations as we traveled through the area (Table 1).

We also conducted transects on foot along roads through each urban area. We specifically selected main roads that were at least 1 km away from the sites of interest (mentioned in the previous paragraph). At each urban area, we chose two 1 km transects that were spaced at least 1 km apart. We were not able to maintain this 1 km spacing in Igarra and Afuze because these two urban areas were too small to allow that.

Data collection

We made total counts of all avian scavenger species that we observed either feeding and/or roosting at the 13 study areas. Counts were made in all 13 study areas during two survey periods: 23 May 2017 to 13 June 2017, and 14 June to 19 July 2017.

The counts were carried out at the optimal time of the day when congregations of avian scavengers were most expected to occur. For example, at abattoirs, data was collected between 30-90 min after the slaughter of livestock and the cleaning of the slaughter slab. This varied from one urban area to the next, but usually took place between 09:00 and 17:00 hrs.

Dumpsites were visited at various times during the day; in the morning, afternoon and evening.

Roosting sites were visited in the early morning between 06:00 and 07:30 hrs before the birds had left and in the late afternoon and evening between 16:00 and 18:30 hrs when the birds had returned.

At each communal roost, the number of mature trees (which represent possible roosting sites) was estimated by recording the average number of trees counted in three randomly selected 10 m × 10 m quadrats. Furthermore, each site was classified based on the population density of the urban area in which it was located according to the classification by Magnus and Esegibe (2012) as high, medium or low.

During road transects, all scavenging bird species were identified with the aid of a pair of binoculars, and all individuals were counted. These counts were conducted between 9:00 and 15:00 hrs when the sun was out, and scavenging birds were expected to be soaring or at least away from the roost. We took approximately 20 min to complete a 1 km transect. We attempted to avoid double-counting as best as we could by, for example, not counting individuals appearing from directions that previously counted birds had recently been seen to disappear in.

Data analyses

All statistical analyses were conducted in the programme R, version 3.1.2 (R Development Core Team 2011). We first used Analysis of Variance (ANOVA) to test for differences between the abundance of the scavenger species, as well as between the combined abundance of scavengers in the different levels of each variable (human population class and type of site).

Next we employed Generalized Linear Mixed-effect Models (GLMMs) developed in the R package lme4 (Bates et al. 2015) to fit models of avian scavenger abundance with explanatory variables. We used GLMMs of the negative binomial family because count data are typically over-dispersed (Thomas et al. 2015), and to account for the non-independence of the repeat counts in the second survey period (Pomeroy et al. 2015). In the models fitted, the response variable was the abundance of avian scavengers (avian scavenger count), which was tested with the explanatory variables: “population class” (human population recorded as high, medium, or low), “species” (species of avian scavenger) and “type of site” (abattoir, dumpsite, or roost).

We also tested for interactions between “species” and “type of site”, and “species” and “population classes”. The best model was chosen using the Akaike Information Criterion (AIC), and all models within 2 AIC units were considered competing models. The relationship between the number of trees per 10 m² and avian scavenger count was tested separately using a generalized linear mixed-effect model, for only the avian scavengers recorded at roosts. The same type of model was also used to test the counts of avian scavengers obtained from transects. The response variable was the same as that used for counts at sites of interest (count of birds) but we only tested it against “population classes” and “species” as the explanatory variables since transects were conducted away from roosts and dumpsites.

A map showing the occurrence of Hooded Vultures across the sampled urban areas in Edo State was created in QGIS (Quantum GIS Development Team (2016). Quantum GIS Geographic Information System. Open Source Geospatial Foundation Project. <http://qgis.osgeo.org>).

Results

We recorded three species of avian scavengers on our surveys across the 13 urban areas in Edo State namely, Pied Crow *Corvus albus*, Yellow-billed Kite *Milvus migrans*, and Hooded Vulture.

Analysis of Variance (ANOVA)

Based on count data, the Pied Crow was the most abundant avian scavenger followed by the Yellow-billed Kite ($F_{2, 141} = 33.7$, $p < 0.01$; Figure 2). The same result was obtained from the transect data ($F_{2, 141} = 29.9$, $p < 0.01$). The Hooded Vulture was the least abundant scavenger based on both counts and transects (Appendices I & II). Avian scavengers were more abundant in urban areas with high human populations than in either the medium or low human population classes ($F_{2, 141} = 13.5$, $p < 0.01$; Figure 3), and we counted the highest numbers of birds at roosts and the lowest at dumpsites ($F_{2, 141} = 12.2$, $p < 0.01$; Figure 4). We obtained similar results from the transect data, confirming that the number of avian scavengers is dependent on the human population ($F_{2, 141} = 3.06$, $p < 0.01$).

Generalized Linear Mixed Models (GLMMs)

The best model based on the total count data was the one that included all the explanatory variables without any interaction terms (Table 2). In this best model, all the variables (population class, species and type of site) were significant. Therefore, the number of avian scavengers recorded is best explained by the human population class of the area in question, the type of site (whether it is a roost, abattoir or dumpsite) and the species being counted. The number of avian scavengers recorded at communal roost sites however, was not influenced by the number of trees present ($p = 0.8$).

The best model based on the transect data was the one in which the both variables (population class and species) were included (Table 3). Hence, both these variables were found to be important whether based on total counts or transects.

Pied Crows and Yellow-billed Kites were recorded in all 13 urban areas surveyed during this study. Hooded Vultures on the other hand, were only recorded in seven of 13 urban areas. The numbers presented on the map are the highest counts recorded (Figure 5).

Discussion

Relative abundance of avian scavengers in urban areas of Edo State

Of the three species, Pied Crow, Yellow-billed Kite and Hooded Vulture, which made up the avian scavenger community in Edo State, Nigeria, the Pied Crow was found to be the most abundant. Like other members of the family Corvidae, the Pied Crow is an omnivorous generalist predator, and a facultative scavenger (Barrow et al. 2014; Cunningham et al. 2015). It is known to be opportunistic, highly adaptable and may readily fill a vacant niche created by reduced numbers of other avian scavengers. This appears to have been the case in Edo State where the Hooded Vulture has declined significantly. To the best of our knowledge, there are no published counts of the Hooded Vulture in this region prior to our study. Despite this, there is ample anecdotal evidence suggesting that this species was widespread and abundant in southern Nigeria and elsewhere in tropical West Africa (Mundy et al. 1992). Therefore, our study is strongly suggestive of a massive population decline in Hooded Vulture populations in Edo State. The status of this species in other parts of southern Nigeria requires urgent assessment. The Yellow-billed Kite (family Accipitridae), is known to occur in large numbers in tropical African towns (Brown et al. 1982). Although this species may occasionally kill live prey, it is primarily a scavenger in urban areas, and takes advantage of food resources provided by humans through waste disposal. This species is an intra-African migrant, moving northward in Nigeria during the rainy season (Cresswell et al. 2009). Our counts may therefore have been affected by this migration, as the beginning of our data collection coincided with the onset of the rains. We suggest repeating these counts in the dry season when the Yellow-billed Kite is present in southern Nigeria in the highest numbers. The Hooded Vulture was previously known to be abundant in towns of West Africa (Thiollay 2006; Ogada et al. 2016), but during this study, it was found to be the least abundant of all the avian scavengers. We suggest that this low abundance may be attributed to human exploitation particularly for vulture parts in traditional medicine (Sodeinde and Soewo 1999; Saidu and Buij 2013; Awoyemi 2014; Buij et al 2015; E. Nosazeogie personal observation). This may be supported by the fact that in urban areas in West Africa (such as the Gambia) where vultures face little or no exploitation pressure, they have been known to thrive and attain high numbers (Jallow et al. 2016).

Distribution of avian scavengers in urban areas of Edo State

Among the avian scavenger species, only the Hooded Vulture was not observed in all the surveyed towns. This might have been caused by predation-risk facing Hooded Vultures from

humans. Although this was not measured, vultures appeared to be more wary of humans than the other avian scavengers in the study area (E. Nosazeogie personal observation). Behavioural plasticity as a result of exploitation pressure may result in the avoidance of areas of high persecution by the birds (Mulli   et al. 2017). Thus, vultures might prefer to roost in compounds where they are not likely to be attacked or disturbed, and this might affect the distribution of this species in Edo State, Nigeria, as has been previously observed in Kenya (Odino et al. 2014).

Factors affecting relative abundance of avian scavengers

In this study, the Pied Crow and the Yellow-billed Kite were found to be relatively more abundant than the Hooded Vulture. In the past, Hooded Vultures have been found in large numbers around abattoirs, which provided their preferred food –soft animal parts (Pomeroy 1975). In contrast, Pied Crows and Yellow-billed Kites, being more catholic in their diet, have been located opportunistically across a wider spectrum of environments. However, this was not the case in this study. Exploitation pressure, and other related factors such as a fear of humans, might be having a strong effect on the numbers of the Hooded Vultures (Mulli   et al. 2017).

Pied Crows were more abundant than Yellow-billed Kites in this study. Apart from interference competition which results from the mere sharing of resources which are in short supply, competition (physical conflict) for roosting spaces was observed especially between the Pied Crows and Yellow-billed Kites. The Yellow-billed Kite appeared to be superior to the Pied Crow in this regard because in the counts made at one roost (at Ikpoba Slope) in the first survey period (before migration), greater numbers of the Yellow-billed kite were recorded. However, Pied Crows which are known to be opportunistic may benefit from reduced competition pressure resulting from the declining numbers of the vultures due to exploitation pressure, as well as the seasonal migration of the Yellow-billed Kites. In Uganda, the number of Pied Crows appeared to reach a peak at the time of the year when the numbers of Yellow-billed Kites and Marabou Storks (*Leptoptilos crumeniferus*) were reduced due to migration while the number of Hooded Vultures did not show any marked change throughout the year (Pomeroy, 1975). This suggests that a reduction in the numbers of other avian scavengers, whether through migration or exploitation, might favour the population of the Pied Crows.

Factors affecting avian scavenger abundance

We show that the abundance of avian scavengers was positively correlated with human population size. Scavengers are known to benefit from the ongoing increase in human population and its associated activities that generate food for this group of birds (Pomeroy 1975;

Campbell 2009; Kibuule 2016). We counted larger numbers of avian scavengers at roosts than at foraging sites, a trend observed by other studies (Pomeroy 1975; Ssemmanda and Pomeroy 2010; Kibuule 2016), and may be related to the fact that these birds congregate in large numbers to roost but feed in widely dispersed areas (Ssemmanda and Pomeroy 2010). At foraging sites, avian scavengers were recorded in higher numbers at abattoirs than dumpsites. This has been attributed to the high supply of food resources present at abattoirs (Kibuule 2016). Also, abattoirs are thought to provide more palatable and preferred food resources (such as soft animal parts) for avian scavengers than dumpsites (Pomeroy 1975; Kibuule 2016). However, at one of the abattoirs visited in this study, in which all the waste produced was burnt at the end of each day, no scavenging bird was observed. As a result of changing sanitary practices in Kampala, Uganda, more avian scavengers were recorded at dumpsites than at abattoirs (Ssemmanda and Pomeroy 2010). In Kenya, abattoirs at which the vultures were observed practiced the “open-air” system, in which wastes and effluents are disposed on open ground rather than in underground storage tanks (Odino et al. 2014). Changing sanitary practices in urban abattoirs are likely to pose a threat to the survival of obligate avian scavengers by reducing the amount of food available to them (Mullié et al. 2017). In this study, the number of avian scavengers recorded at a communal roost was not affected by the number of trees present at the roost site.

One explanation for this might be the varying composition of trees at the different roost sites. This ranged from a sacred grove (containing a variety of native tree species) to plantations of introduced species such as *Tectona grandis* and *Pinus sp.* The native tree species had wider girths, and an individual tree could hold more birds than the introduced tree species. Our study has provided evidence suggestive of a dramatic decline in the population of Hooded Vultures from Edo State in southern Nigeria. This species has historically been known to occur in large numbers in West African towns “in a happy symbiotic relationship with people” (Mundy 1976). Unfortunately, our results clearly demonstrate that this is not the case in the urban areas of Edo State. Should conditions remain the same, we predict the extirpation of the Hooded Vulture from Edo State in the near future. It is noteworthy that the highest number of vultures (18 individuals) was recorded in an urban area with a high human population, and these were roosting in a protected urban forest. This might suggest that such safe roosting sites are essential, although perhaps not sufficient, for the Hooded Vulture to persist in Edo State.

Urgent conservation efforts such as education, protection and advocacy are required for this species in Edo State, and probably throughout southern Nigeria. We suggest continued

monitoring of populations in Edo State to determine the efficacy of any conservation interventions.

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