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Bird diversity in the savanna habitats of Akagera National Park, Rwanda, in the post-war recovery period

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The biodiversity of Akagera National Park (ANP), Rwanda, has reportedly been declining since 1990 due to conflict and war in the country between 1990 and 1994. In this paper, we describe bird diversity in the post-war recovery period. We used systematic plots, point counts and presence–absence surveys to estimate bird species richness and diversity in acacia savanna habitats of the park between 2009 and 2011. We recorded a total number of 301 species, of which 75% were resident and 22% migrant, including a large number of Palearctic visitors and Afrotropical migrants. Particularly notable were four endemic species of the Lake Victoria region, four globally threatened and nine near-threatened species as well as species that had not previously been recorded in the park and those overlooked by past records. Estimated species richness and diversity at the landscape level were 346 and 0.98, respectively, mean estimates per plot were 42 and 0.86 for species richness and diversity, respectively. Our results highlight regional and international importance of ANP in protecting important bird diversity. We also emphasise that ANP is the only savanna habitat in Rwanda where typical savanna birds occur. Our findings provide new insights for further strengthening of efforts to conserve the park's biodiversity.

Keywords: biodiversity, birds, East Africa, endemic species, species richness

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Introduction

Effective conservation of biodiversity is essential for the maintenance of ecosystem services and requires certain baseline data (Bowker et al. 2010; Rands et al. 2010). Savanna is the most important type of biome in Africa and continent-wide boasts many bird species (Vande weghe and Vande weghe 2011). Savanna ecosystems play important roles in conservation and tourism (Gottschalk et al. 2007; Shorrocks 2007). However, there has been a general concern over the potential loss of biodiversity in some of the protected areas or lack of data for others (Homewood and Brockington 1999). Conflicts and wars in different parts of the world, and especially in Africa, are among important threats not only to human lives and livelihoods but also biodiversity (Kanyamibwa 1998; Plumptre et al. 2001). In Rwanda, for instance, the four-year period of war (1990–1994), which culminated in the 1994 genocide, had serious consequences for biodiversity (Kanyamibwa 1998; Plumptre et al. 2001; MINITERE 2003).

Akagera National Park (ANP), which is located in the eastern part of Rwanda along the Tanzanian border, was established by decrees dating from 1934 and 1957, respectively, with an original size of 280 000 ha that included the Umutara hunting area of 30 000 ha (Vande weghe 1990; Kanyamibwa 1998). Before the 1990–1994 war, ANP was regarded as a complex savanna ecosystem in eastern Africa, combining wetland and savanna habitats (Vande

weghe 1990; Kanyamibwa 1998). It was characterised by a large number of mammals typical of eastern African savannas and an exceptionally rich diversity of birds. There are 525 bird species known from the park (Vande weghe 1990; Kanyamibwa 2001).

Between the time of generating these previous species lists and the time of our study, there have been large changes in both the savanna habitat inside and outside the park as well as in the avifauna. First, since the beginning of the war in 1990, there has been intrusion of combatants inside the park and the killing of many animals and birds (mainly birds of prey) by the soldiers, conservation activities were perturbed, poaching increased and many habitats were destroyed (Kanyamibwa 1998; Plumptre et al. 2001). Second, during the post-conflict period after 1994, ANP has been temporarily occupied by thousands of pastoralists (Kanyamibwa 1998). Third, there have also been important changes in the land use by humans outside the park (but in the former park's area) mainly through the conversion of tall grasses into short grasses and/or bare ground. Fourth, in 1997, the park was reduced in size from more than 2 500 km² to its current extent of 1 122 km² (African Parks 2012) to meet the urgent need for population resettlement. In fact, more than two-thirds of its surface area was given away for the resettlement of former refugees (MINITERE 2003). Following this important park size reduction and loss of

habitat, biodiversity losses were estimated at 13% for birds and 50–80% for mammals (Kanyamibwa 1998; Plumptre et al. 2001; Lamprey 2002; MINITERE 2003; Kock 2004). Overall, because of human activities and destruction of their habitats, many bird species, especially specialists, may no longer occur in ANP.

Lack of quantitative data on the status of biodiversity in ANP is a serious hinderance for effective conservation efforts. The challenge today is to know the status of habitat and individual species and to understand the processes affecting biological diversity in order to develop specific conservation and management programmes (Kanyamibwa 1998; Hellmann and Fowler 1999; Beever et al. 2006; Lepczyk et al. 2008). Our research aims were to understand the distribution and diversity of birds within the present park. The objectives of this study were to (1) measure and describe bird species richness and diversity within the park, and (2) develop a checklist of bird species recorded in the study area. Here we focused on species-level diversity.

Materials and methods

Study area and period

This study was carried out from August 2009 to August 2011 in ANP (1°45'00" S, 30°38'00" E, 1 300–1 825 m above sea level; Figure 1). The mean annual rainfall is <700 mm and the mean temperature ranges between 20 and 22 °C (Vande weghe and Vande weghe 2011). ANP lies in the Lake Victoria Basin. Habitats are mainly acacia savanna, with open grasslands and flooded plains in the valley bottoms. These have been extensively described in previous studies (Vande weghe 1990; Lamprey 2002; Averbek et al. 2009; Vande weghe and Vande weghe 2011). Akagera savanna together with savanna in southern Uganda, north-western Tanzania and northern Burundi make up the 'interlacustrine' savannas, which are similar in species composition (Vande weghe 1990; Kanyamibwa 2001). The Akagera River runs through the park forming vast papyrus wetlands and many lakes, offering diverse habitats for birds. ANP has been classified as an Important Bird Area (IBA) with IBA code RW003 (Kanyamibwa 2001; BirdLife International 2015). African Parks Network, a private park management institution in Africa, took over the management of the park in early 2010, in public-private partnership with the Rwandan government. Given the recent reduction in size of the park, the number of bird species in the park was reduced to 482 species, but the park still holds 99 species, not found in any other protected area in Rwanda (Vande weghe and Vande weghe 2011). Key bird species include the Shoebill *Balaeniceps rex*, listed as Vulnerable in the current version of the IUCN Red List of Threatened Species (version 2015.2; <http://www.iucnredlist.org>), the Red-faced Barbet *Lybius rubrifacies* (endemic to the 'interlacustrine' region) and the Pallid Harrier *Circus macrourus*, both considered as Near Threatened (Birdlife International 2015).

Survey design

We used a systematic design of equally spaced 1 km² plots with a random starting-point, distributed across the whole area using ArcMap 9.2 (Buckland et al. 2000,

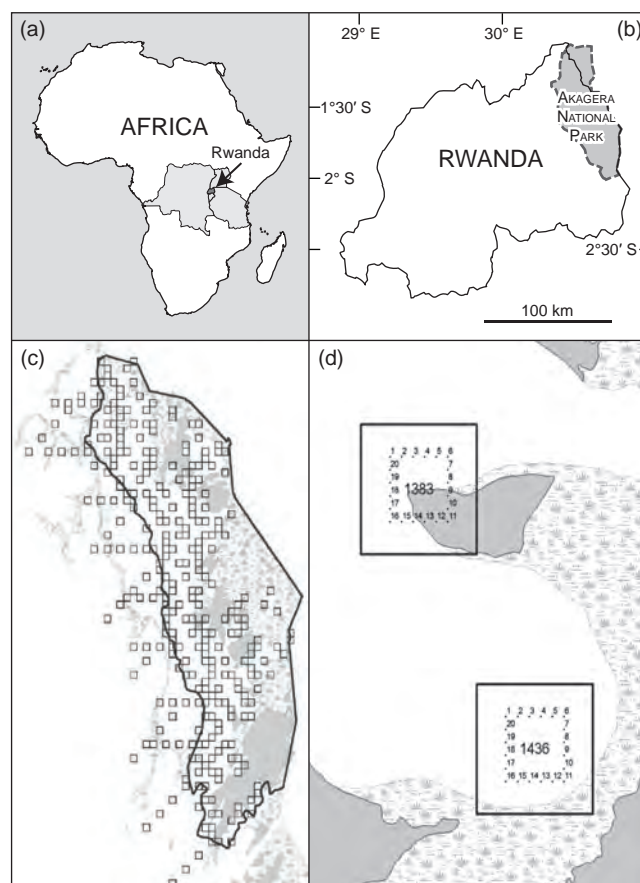


Figure 1: Map of the study area showing: locality of country of study (Rwanda) within the African continent (top left); locality of study site (Akagera National Park) within the country (top right); systematic design of sampling plots (bottom left) and subsampling of the points in each plot with numbering of both plot and points (bottom right)

2001, 2006; Jurasinski and Beierkuhnlein 2006; Figure 1). We obtained shapefiles of the study area from the National University of Rwanda Centre for Geographical Information System (NUR-CGIS). We first divided the whole area into 1 662 plots (including areas adjacent to the park). From this, we selected a sample size of 148 plots within the park surveyed during 2009–2010, and 118 plots surveyed during 2010–2011. These plots were numbered and selected such that all different parts of the park were evenly covered. Within each plot we subsampled 20 predefined locations or points (Figure 1). The four corner points of each plot were used for main bird counts (numbered 1, 6, 11 and 16 in Figure 1). The distance between two main adjacent points was 500 m. All sampled plots were associated with specific IDs, area and global positioning system (GPS) coordinates, and permanently marked using ArcPad 7.0.1 so that they could be surveyed repeatedly over time during the study period to detect long-term trends. Sampled plots were mainly located in grassland habitats with their associated trees and shrubs. We excluded papyrus swamps, lakes and dry forests in our sampling. The total area sampled was 1 085 km².

Bird point counts

We used point counts and a presence–absence approach to gather data (Boulinier et al. 1998; di Battista 2002; Monadjem 2002; Magurran 2004; Buckland et al. 2005; Begon et al. 2006). During the study period, we surveyed a total of 228 plots on foot, of which 166 were measured once and 62 repeatedly. The latter plots were chosen systematically. We sampled seven times between 2009 and 2011 taking into account seasonal variation. The number of plots that were surveyed during each sampling period was also chosen in a manner to cover different parts of the park. We conducted surveys in the early mornings (around 07:00) when birds were at their most active, as well as 2–3 h before sunset (around 18:00). Surveys were carried out using 10-minute point counts at the main points. We allowed 2–3 min for birds to resume normal behaviour before counting.

Each bird species seen or heard was recorded with an associated sighting distance (in metres) from the survey point. We also recorded plot and point numbers, date of the survey, observers' names, start and end time of the count, bird species' names and the number of individual birds within each species. We used an ArcPad 7.0.1 layer of ANP stored on a hand computer and GPS to locate different plots and points. We measured exact distances to individual birds using a laser distance meter (range finder). We also recorded birds seen or heard while travelling between main points (species and number only) without recording the sighting distance. However, only birds recorded at the main points were used for species richness and diversity estimates. Birds that fled away during point counts were recorded from the point of their first sighting; however, we paid attention to birds flying over anywhere that could bias our results. Birds that were seen flying over the survey area were also identified, recorded and the sighting distance was estimated from the ground. Birds that could not be identified were also recorded as 'unidentified' and were not included in species richness estimation. We did not sample nocturnal species.

Data analysis

Species richness and composition

All analyses were performed using R version 2.7.0. To estimate bird species richness, we used S_{Chao2} , a non-parametric estimator of species richness, which uses presence–absence data in sampling units and provides a reduction in bias relative to observed species number (Chao 1987; Gimaret-Carpentier et al. 1998; Bunge and Fitzpatrick 2003; Chiarucci et al. 2003; Magurran 2004; Chao 2005; Bolwig et al. 2006; Magurran and McGill 2011). We used a modified bias-correction of this estimator developed by Chao (2005). We also computed theoretical variance and mean square error of the estimator using a formula developed by Gimaret-Carpentier et al. (1998). Estimates of species richness were calculated at different spatial scales: per plot and at the landscape level.

A checklist of recorded species was made (only available online), based on taxonomy (order, family and species). The classification followed the IOC World Bird List version 3.1 (Gill and Donsker 2012). Additional information was provided by Vande weghe and Vande weghe (2011)

and Stevenson and Fanshawe (2009). The status of occurrence followed the IUCN Red List categories (BirdLife International 2015).

We also focused our analysis on important savanna species that have been overlooked by recent known records and those species previously known to occur in ANP but were missed by this study.

Comparative analysis of bird species richness between ANP and other savanna protected areas in East Africa

We made a comparative analysis of bird species richness found in ANP with that of other savanna protected areas in East Africa based on two parameters: number of species and park area. The natural logarithm of the number of species was plotted against the natural logarithm of the park's area. Other parks included Ruaha National Park (NP), Serengeti NP, Mkomazi Game Reserve, Mikumi NP, Maasai Mara NP, Murchison Falls NP, Meru NP, Ngorongoro Conservation Area, Ruvubu NP, Lake Mburo NP and Amboseli NP. We used data provided by Fishpool and Evans (2001) and BirdLife International (2015). Classification of each protected area as a savanna habitat was based on habitat description by Homewood and Brockington (1999), Vande weghe and Vande weghe (2011) and BirdLife International (2015).

Species diversity and spatial distribution

We measured bird diversity using the Simpson diversity index, which takes into account both the relative abundance and the species richness (Gimaret-Carpentier et al. 1998; Magurran 2004; Buckland et al. 2005; Begon et al. 2006; Gorelick 2006; Kangah-Kesse et al. 2007; Magurran and McGill 2011). The Simpson index is more effective than other non-parametric measures of species diversity because it has statistical accuracy, regardless of sample size, as its estimator is unbiased (Gimaret-Carpentier et al. 1998; Lande et al. 2000; Magurran 2004). We also calculated the theoretical variance of this index (Gimaret-Carpentier et al. 1998). As for S_{Chao2} , we computed the overall Simpson index at the landscape level and average diversity per plot. Values of Chao2 and the Simpson index were plotted into GIS using ArcMap 9.2 to display their spatial distributions across the study area.

Results

Species richness and diversity

We recorded 301 bird species (from 228 plots) belonging to 22 orders and 71 families (see Supplementary Appendix S1 for the complete list). The largest order was the Passeriformes with 32 families and 154 individual species. The most abundant families were Accipitridae with 26 species, Muscicapidae (17) and Cisticolidae (17 species). Seventy-five percent of the recorded species were resident, 22% were seasonal migrants and 3% were rare or accidental species. Of the migrant species, 35 were Palearctic visitors, 30 were Afrotropical migrants and two were vagrants (Stevenson and Fanshawe 2009; Vande weghe and Vande weghe 2011).

The most frequent species were Common Bulbul *Pycnonotus barbatus* (recorded in $n = 174$ plots), Bare-faced

Go-away-bird *Corythaixoides personatus* ($n = 138$) and Rueppell's Glossy-Starling *Lamprotornis purpuropterus* ($n = 132$). Savanna birds of prey were abundant with 30 species (10% of observed birds) recorded. The most common were the Long-crested Eagle *Lophaetus occipitalis* ($n = 10$), the Tawny Eagle *Aquila rapax* ($n = 9$) and the Lappet-faced Vulture *Torgos tracheliotos* ($n = 8$).

Savanna birds were dominant and included several species of rollers, bee-eaters, cisticolas, martins, barbets, francolins, honeguides, weavers, drongos, tchagras, chats, flycatchers, bustards, pipits, larks, wood doves, waxbills, swifts, swallows and birds of prey. They were found in all savanna habitat types of the park, such as open dry grasslands, seasonally wet grasslands (e.g. Kirara plain

in the northern part of ANP), acacia-*Combretum* bushed or wooded grassland, acacia and *Albizia* woodlands, acacia thorn bush and fringing acacia as previously described by Kanyamibwa (2001) and Vande weghe and Vande weghe (2011).

Due to the large number of species recorded from only a single plot (66 species) and those recorded from only two plots (47 species), simple counts of the observed species ($S_{obs.}$) yielded an underestimation of the true species number. Thus, at the landscape level the total species richness in the park, estimated by Chao2, was 346 ± 12 (SE) species, which should be closer to the true species richness of the study area. At the plot level, the mean species number was 16 ± 0.46 (observed) and 42 ± 3.98

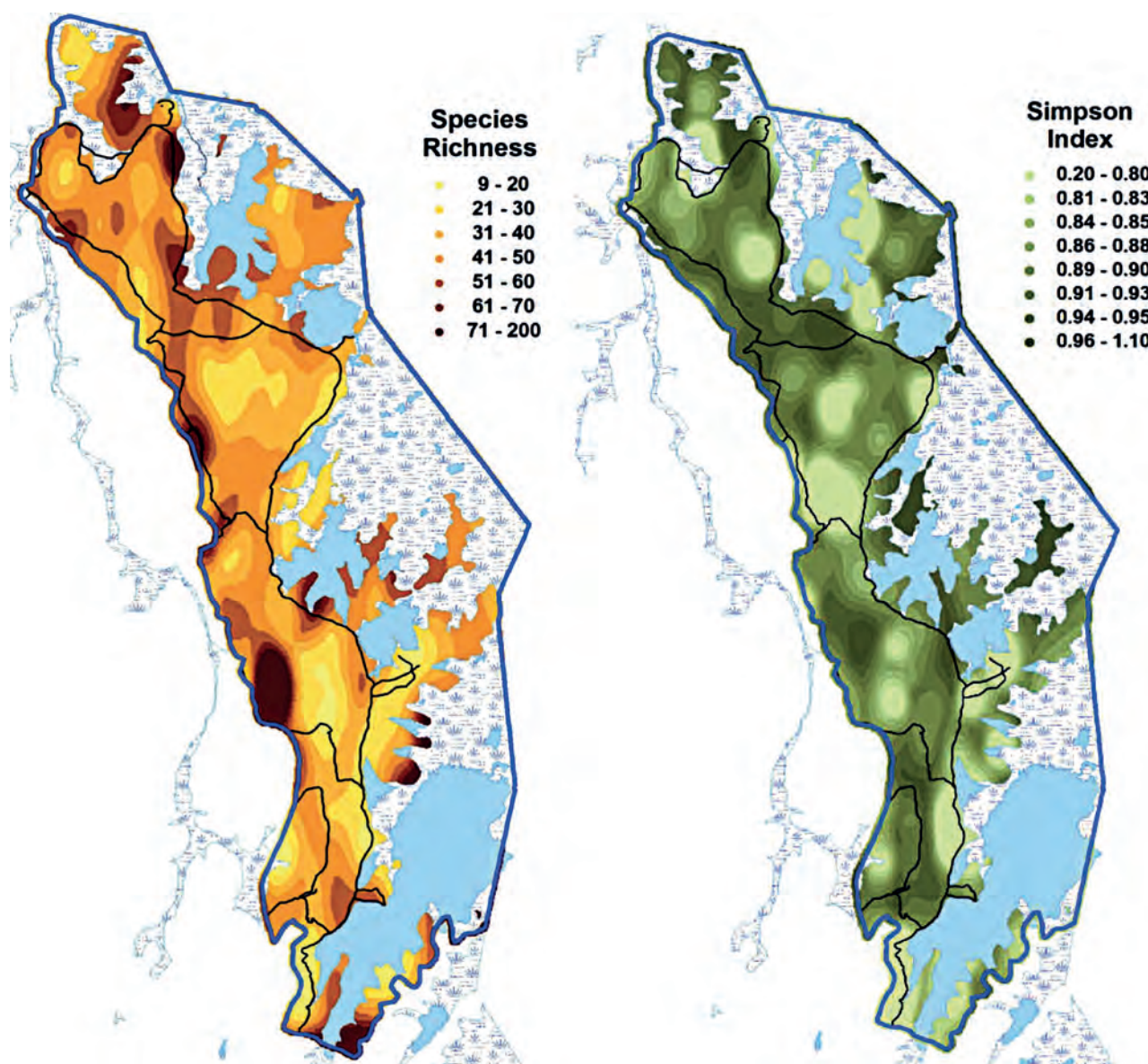


Figure 2: Spatial distribution of bird species richness indicating estimated number of species by computing Chao2 estimator (2a) and bird diversity indicating values estimated by computing the Simpson index (2b) in Akagera National Park. Values of Chao2 and the Simpson index are plotted into GIS

(Chao2 estimate). Figure 2a summarises spatial distribution of the species richness (Chao2 estimates) across the study area, plotted into GIS. There was considerable variation in the number of bird species at different plots (Figure 2a). Overall, the number of species seen in a plot varied between 3 and 44.

The Simpson index at the landscape level, which can be considered to be the total diversity (γ), was estimated to be 0.980 ± 0.0185 (SE), whereas mean diversity per plot, which can be thought as α -diversity, was 0.860 ± 0.010 . Considering the diversity levels or parts of the total diversity as additive, β -diversity was calculated as 0.120 ± 0.085 . The Simpson diversity index was in general well distributed across the study area with few exceptions (Figure 2b).

Endemic species of the Lake Victoria region and Zambesian elements

A notable feature of this study was the detection of four endemic and one near-endemic species of the Lake Victoria region. These included the Red-faced Barbet ($n = 31$), a typical savanna species and common breeding resident in ANP, Fischer's Lovebird *Agapornis fischeri* ($n = 1$), which has been introduced to Rwanda and is also an endemic of East Africa, the Northern Brown-throated Weaver *Ploceus castanops* ($n = 1$) and the Red-chested Sunbird *Nectarinia erythrocerca* ($n = 2$). The Black-lored Babbler *Turdoides sharpei* ($n = 24$) is considered as a near-endemic species of the Lake Victoria region according to Vande weghe and Vande weghe (2011). In addition, this study recorded different elements of the Zambesian biogeographic region such as the Long-tailed Cisticola *Cisticola angusticauda*, Crested Barbet *Trachyphonus vaillantii*, Broad-tailed Paradise Whydah *Vidua obtusa*, which is mainly a migrant, and Miombo Wren-Warbler *Calamonastes undosus* (Kanyamibwa 2001; Vande weghe and Vande weghe 2011).

Globally threatened species

The majority of recorded species (96%) are classified as of least concern, whereas the remainder (4%) is considered

threatened according to the IUCN Red List categories (BirdLife International 2015). Four of the 13 threatened bird species recorded in this study are globally threatened (Table 1). These comprised the Grey Crowned Crane *Balearica regulorum*, the White-backed Vulture *Gyps africanus*, both regarded as Endangered, and the Lappet-faced Vulture *Torgos tracheliotos* and the White-headed Vulture *Trigonoceps occipitalis*, which are Vulnerable (BirdLife International 2015).

Bird species not previously recorded in ANP

This study also recorded a number of species, known from neighbouring countries (Uganda, Tanzania and Burundi), that were not on the country's checklist or were on the Rwanda's list by mistake according to a recent atlas of birds in Rwanda by Vande weghe and Vande weghe (2011). The latter included the Little Weaver *Ploceus luteolus* ($n = 3$), Nubian Woodpecker *Campethera nubica* ($n = 4$; Figure 3), which are both residents of Tanzania and Uganda, and Variable Indigobird *Vidua funerea* ($n = 1$), which is resident of Tanzania. Other species were the Black-billed Barbet *Lybius guifsobalito* ($n = 2$), which is widespread at low densities mostly in Uganda and Tanzania, Black-billed Wood-Dove *Turtur abyssinicus* ($n = 1$), which is locally common in north-western Uganda and a migrant, Yellow-throated Cuckoo *Chrysococcyx flavigularis* ($n = 1$), a solitary and uncommon resident of south-western Uganda, Whistling Cisticola *Cisticola lateralis* ($n = 2$), which is resident of Uganda and Burundi, and Yellow-throated Tinkerbird *Pogoniulus subsulphureus* ($n = 2$), a resident of southern Uganda. We characterised these new species as accidental (a species that rarely or accidentally occurs in Rwanda) for the study area. Another species, the Velvet-mantled Drongo *Dicrurus modestus* ($n = 14$), which is very similar to the Fork-tailed Drongo *Dicrurus adsimilis*, was previously recorded in other parts of Rwanda (e.g. Nyungwe National Park) but never occurred in ANP before (Vande weghe and Vande weghe 2011). Figure 4 shows in which plots these new species occurred (including observations made in the former park area).

Table 1: Globally threatened and near-threatened bird species recorded in Akagera National Park. Four species are globally threatened. IUCN Red List categories follow BirdLife International (2015): EN = Endangered, VU = Vulnerable, NT = Near-threatened. Occurrence (Vande weghe and Vande weghe 2011; Stevenson and Fanshawe 2009): CR = common resident, BW = Palearctic migrant and winter visitor, V = vagrant

Common name (English)	Scientific name	No. of plots in which species were observed	Occurrence	IUCN Red List category
Grey Crowned Crane	<i>Balearica regulorum</i>	3	CR	EN
White-backed Vulture	<i>Gyps africanus</i>	3	CR	EN
Lappet-faced Vulture	<i>Torgos tracheliotos</i>	8	CR	VU
White-headed Vulture	<i>Trigonoceps occipitalis</i>	1	CR	VU
Bateleur	<i>Terathopius ecaudatus</i>	56	CR	NT
Martial Eagle	<i>Polemaetus bellicosus</i>	3	CR	NT
Red-faced Barbet	<i>Lybius rubrifacies</i>	31	CR	NT
European Roller	<i>Coracias garrulus</i>	2	BW	NT
Semi-collared Flycatcher	<i>Ficedula semitorquata</i>	2	BW	NT
Red-footed Falcon	<i>Falco vespertinus</i>	1	BW	NT
Sooty Falcon	<i>Falco concolor</i>	1	BW	NT
Pallid Harrier	<i>Circus macrourus</i>	1	BW	NT
Fischer's Lovebird	<i>Agapornis fischeri</i>	1	V	NT



Figure 3: Nubian Woodpecker *Campethera nubica* photographed in Akagera National Park in August 2011 during our survey. The species was previously not recorded in Rwanda according to Vande weghe and Vande weghe (2011) but is resident of the neighbouring countries Tanzania and Uganda (photograph by Kjell Wallin)

Species overlooked by previous records and those missed by our study

This study recorded a number of ‘interesting’ savanna species, not accidental, that have probably been overlooked by past studies. These included Singing Cisticola *Cisticola cantans* ($n = 11$ plots within the park), an uncommon resident previously recorded in the former park’s area, African Firefinch *Lagonostica rubricata* ($n = 22$), Black-and-white Mannikin *Spermestes bicolor* ($n = 18$), Brown-necked Parrot *Poicephalus robustus* ($n = 9$) and Chubb’s Cisticola *Cisticola chubbi* ($n = 51$), all considered by previous studies (e.g. Vande weghe and Vande weghe 2011) as absent from the semi-arid savannas of ANP. However, these species, except the Chubb’s Cisticola, are listed by BirdLife International (2015) as occurring in eastern savannas (e.g. ANP) of Rwanda. Other overlooked species, but with fewer records in our study, were African Dusky Flycatcher *Muscicapa adusta* ($n = 7$), Bronze Sunbird *Nectarinia kilimensis* ($n = 3$) and Brown-backed Scrub Robin *Cercotrichas hartlaubi* ($n = 4$). Figure 5 summarises in which plots these species were recorded (including records in the former park area).

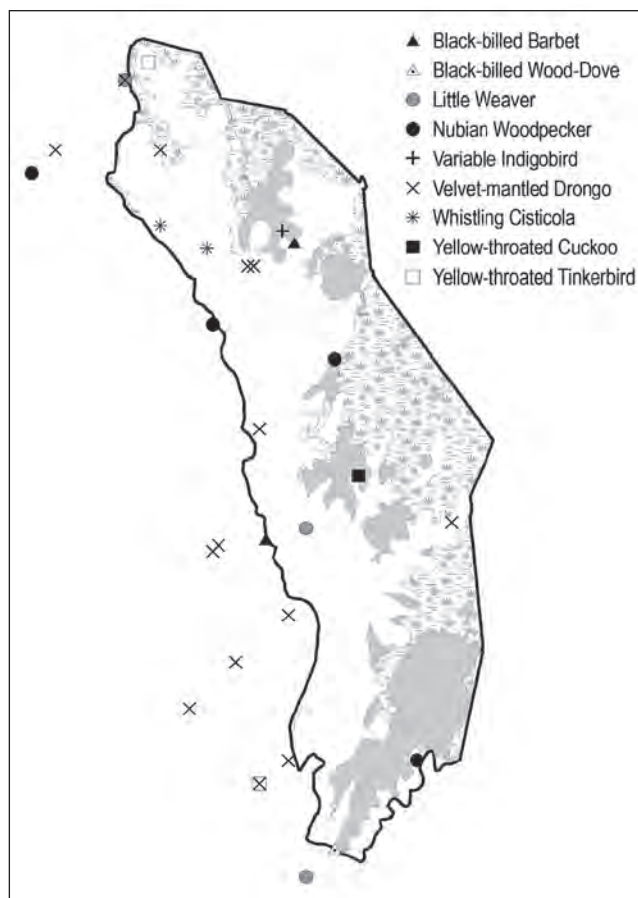


Figure 4: Spatial distribution of bird species not previously recorded in Akagera National Park (ANP). Only the Velvet-mantled Drongo was recorded in other parts of the country but was absent from ANP (Vande weghe and Vande weghe 2011). Records also include observations made outside the park in the former park area. All these species are resident of the neighbouring countries of Burundi, Tanzania and Uganda

However, several species, previously known to occur in ANP, which are easy to detect, were missed by our survey. These included five species that are endemic to the Lake Victoria Basin biome, such as Ring-necked Francolin *Francolinus streptophorus*, Papyrus Gonolek *Laniarius mufumbiri*, which is restricted to papyrus swamps and is of global conservation concern, White-winged Warbler *Bradypterus carpalis*, Carruthers’s Cisticola *Cisticola carruthersi* and White-collared Oliveback *Nesocharis ansorgei* (Kanyamibwa 2001; Vande weghe and Vande weghe 2011). Other species included the Wing-snapping Cisticola *Cisticola ayresii*, currently common in ANP, Brown-chested Lapwing *Vanellus superciliosus*, a Sudanian near-endemic inhabiting different habitat types in ANP, Ruaha Chat *Myrmecocichla collaris*, a common resident occurring mainly in *Acacia* and *Albizia* woodlands and wooded grasslands of ANP, and Denham’s Bustard *Neotis denhami*, which occurred in the former limits of the park but has been a victim of hunting and land-use change according to Vande weghe and Vande weghe (2011). We also missed two globally threatened species, namely the



Figure 5: Distribution map of bird species inhabiting the savanna of Akagera National Park that have been overlooked by past known records (e.g. Vande weghe and Vande weghe 2011), emphasising possible changes in avifauna over time

Hooded Vulture *Necrosyrtes monachus*, considered as Endangered, and the Southern Ground-hornbill *Bucorvus leadbeateri*, which is Vulnerable according to BirdLife International (2015). The former became less abundant in ANP due to repeated poisoning of carcasses by local people, whereas the latter has not been recorded recently in ANP since the 1960s according to Vande weghe and Vande weghe (2011).

Our survey also failed to detect three pipits that were previously considered easy to spot in ANP. These were the Short-tailed Pipit *Anthus brachyurus*, which is found on short grasses and bare soil, Striped Pipit *Anthus lineiventris*, inhabiting acacia and *Combretum* woodland, and Red-throated Pipit *Anthus cervinus*, a Palearctic

migrant occurring on short grass in ANP. Other undetected species were the Long-billed Pipit *Anthus similis*, which was abundant throughout the country but now restricted to ANP, Black-winged Kite *Elanus caeruleus*, a common breeding resident, Fan-tailed Grassbird *Schoenicola brevirostris*, another common breeding resident restricted to ANP, and Little Greenbul *Eurillas virens*, which was common in ANP but seems locally extinct since the early 1990s according to Vande weghe and Vande weghe (2011).

Even though we did not sample the swamps, we expected to detect along the lake shores the rare Shoebill *Balaeniceps rex*, which is restricted to undisturbed swamps. Finally, we missed two more species currently restricted to the park: Souza's Shrike *Lanius souzae*, a Zambesian

near-endemic inhabiting *Combretum* wooded grassland, and Shelley's Francolin *Francolinus shelleyi*.

Bird species richness of ANP compared with that of other savanna parks in East Africa

The number of bird species in ANP was relatively large compared with that of other savanna parks in East Africa (Figure 6). However, the number of species was not strongly dependent on the park's area and the correlation was not significant ($r = 0.46$, $p = 0.17$).

Discussion

The total number of bird species in our study is relatively low compared with the number of species previously known from the park. However, the species lists are still incomplete and will increase as more research is undertaken, especially with the sampling of papyrus swamps, open water, dry forests and for birds with nocturnal habits. According to historical changes that have affected the park's biodiversity following the 1990–1994 Rwandan conflict, there might be a reduction of bird species from 525 to 482 due to the loss of part of the park's area and destruction of habitats (Vande weghe and Vande weghe 2011). However, we lack actual figures considering which species have been affected, as Vande weghe and Vande weghe did not specify which species have disappeared from the park. The work by Kanyamibwa (1998) on the consequences of the Rwandan war on wildlife also does not provide any statistics or figures; however, a reduction of species number is suspected. Our results present the current situation but there is still a weak understanding of which individual species were most affected during that specific period of Rwandan history.

Our data demonstrate that a number of species typical of savanna habitat have been overlooked by recent studies. These species are not accidental in the study area as

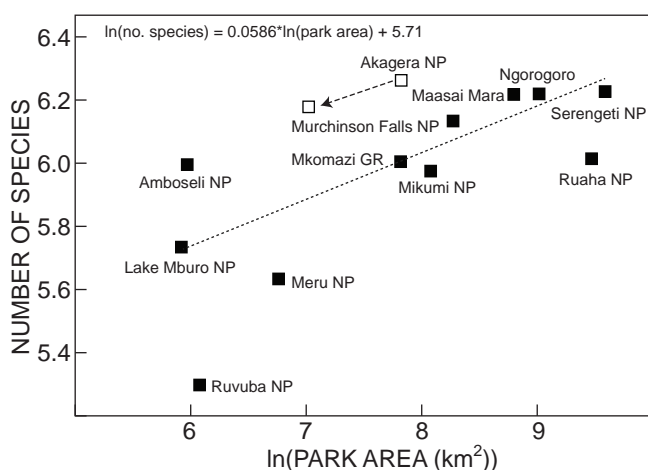


Figure 6: Comparison of the number of bird species of Akagera National Park (ANP) with that of other savanna parks in East Africa. The arrow shows a reduction in the number of species of ANP following the reduction of the park area (Homewood and Brockington 1999; Fishpool and Evans 2001; Vande weghe and Vande weghe 2011; BirdLife International 2015)

they have been recorded before. For example, our results confirmed the presence of some species that were not accepted on Rwanda's bird checklist previously, such as the Nubian Woodpecker, Variable Indigobird and Little Weaver according to Vande weghe and Vande weghe (2011).

However, this study failed to detect 'interesting' species such as the Shoebill, Carruthers's Cisticola and Papyrus Gonolek because we did not sample their habitats. Nonetheless, some species, previously known to occur in ANP, might no longer appear within the park because of the destruction of habitat and possibly local extinctions or emigration (Kanyamibwa 2001; Vande weghe and Vande weghe 2011). These species are of great conservation importance for the park as they include biome-restricted species, globally threatened species, and species now restricted to ANP.

Despite important changes in the park's habitats and avifauna already mentioned, our results underline that ANP has still maintained an important bird species richness and diversity. For instance, the number of species recorded in this study represents 43% of Rwanda's checklist of birds, which has a total of 697 species (Vande weghe and Vande weghe 2011). We emphasise the importance of savanna habitats in supporting the overall avian diversity in this species-rich part of Africa. ANP is also the only place in Rwanda where typical savanna species occur. Some groups of species, such as cisticolas, chats, robin-chats, thrushes, sunbirds, savanna frugivores, pigeons, doves, finches, canaries and buntings, can even breed in the park throughout the year (Vande weghe and Vande weghe 2011).

Our findings also show the regional and international conservation importance of ANP and its role for the protection of important bird diversity. Apart from its diversity of species endemic to the Lake Victoria region, the chief importance of ANP as an IBA is the occurrence of globally threatened and near-threatened species as well as several species known to be endemic to sub-Saharan Africa. The latter include, for example, the Helmeted Guineafowl *Numida meleagris*, turacos, woodhoopoes, bush shrikes, helmetshrikes and oxpeckers (Shorrocks 2007). The savanna habitat in ANP also supports a large number of raptor species, including eagles, buzzards, vultures, hawks, kestrels, falcons, sparrowhawks and ospreys. Even though ANP has been reduced in size and witnessed a civil war and hosts many former refugees, our results show that Akagera still maintains many of its original ornithological features (Kanyamibwa 2001; Plumptre et al. 2007).

Conclusions

The results of this study have highlighted the importance of Akagera National Park in protecting important bird diversity. Though more research is still to be undertaken, long-term protection and concrete management priorities are needed. All management actions must rest on comprehensive information of the bird diversity, both temporally and spatially. We have suggested and implemented such a system for the Akagera National Park. Our findings might be useful for further assessment of the relationships between species diversity/richness and community

stability as well as ecosystem function (Hamilton 2005; Begon et al. 2006). Hopefully, bird watching, as a newly launched ecotourism product in Akagera, might significantly contribute to its sustainability.

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