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## **A literature review of mammalian research respective to the Akagera ecosystem in Rwanda**

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**Abstract** *The Akagera NP (and the Mutara GR) in north-eastern Rwanda are considered part of the most complex and biodiversity rich savannah ecosystem in eastern Africa. Following the violent past of Rwanda, the park has recovered from civil war, poaching and overgrazing, counting today more than 12,000 large mammals. Since proclamation in 1934, a wealth of ecological research was carried in these protected areas. This literature review summarizes the available literature and puts it into a historical context, compiling more than 90 books, book chapters, and journal articles but also unpublished theses and reports respective to the ecology and conservation of mammals.*

**Key words:** *literature review, Akagera ecosystem, conservation history, mammals*

**Résumé** *Le Parc National de l'Akagera (et le Domaine de Chasse du Mutara) au Rwanda du nord-est sont considérés une partie de l'écosystème plus complexe et riche en biodiversités de la savane en Afrique orientale. Après le passé violent du Rwanda, le parc a récupéré de la guerre civile, chasse illégale et surpâturage, comptant aujourd'hui plus de 12.000 grands mammifères. Depuis la proclamation en 1934, une quantité de recherche écologique a été portée dedans ces zones protégées. Cette revue de littérature récapitule la littérature disponible et la met dans un contexte historique, rassemblant plus de 90 livres, chapitres de livre, et articles de journal mais également thèses non publiées et rapports respectifs à l'écologie et à la conservation des mammifères.*

**Mot clés:** *revue de littérature, écosystème de l'Akagera, histoire de la conservation, mammifère*

## 1. Introduction

Since Henry Morton Stanley came to find the source of the River Nile in 1876, the area between the Albertine Rift Valley (reaching as far east as the Byumba Escarpment) and the Lake Victoria forest belt is known as the Akagera ecosystem (*sensu* Kindt et al., 2014). Already Stanley remarked the extraordinary richness of wildlife in this area (Stanley, 1891; Akeley, 1950) and as early as 1934 the Belgian colonial government of Ruanda-Urundi declared the area west of the Akagera River a protected area – the Akagera National Park (NP). The Akagera NP (2,500 km<sup>2</sup>) and the adjacent former Mutara Game Reserve (GR; 300 km<sup>2</sup>) in north-eastern Rwanda, are considered part of the most complex savannah ecosystem in eastern Africa, combining wetlands and several savannah habitats (Kanyamibwa, 1998). The Mutara GR (formerly also called Mutara Hunting Reserve) was annexed by the local pastoralist community in 1971, and subsequently reduced from 855 km<sup>2</sup> to 612 km<sup>2</sup>. In 1991, the Mutara GR was further reduced to its final size till it was eventually degazetted—together with the western parts of the Akagera NP—in 1997 (de Leyn, 1960). Until today about 50 mammal species have been reported for this area, and since the protected areas were proclaimed, a wealth of research has been carried out on the mammalian wildlife in this unique landscape. Until to date numerous books, book chapters and journal articles were published, but also several unpublished theses and reports are available. In recent years, after the country had recovered from civil war, ecological research in and around the modern Akagera NP has gained momentum again. Here we provide an overview on what literature on mammals is available, which will assist future researchers to easier access it.

## 2. Methodology

This review article intends to gather most (if not all) published and unpublished literature respective to mammalian species in the Akagera ecosystem of Rwanda and puts it into a historical context. To achieve this goal, we applied several search strategies such as computer based search in ‘Google Scholar’, applying a selection of key words relating to the Akagera ecosystem and the National Park. More important, we checked the reference sections of known publications and compilations to obtain further

citations. These were searched again for unknown references, and so on. Last but not least, Jonathan Kingdon's Mammals of Africa (Kingdon et al., 2013) was systematically searched for any reference relating to Rwanda or the Akagera National Park. The review period extended over six months from November 2016 to April 2017.

### **3. Chronological literature review**

In the early 1940s, a first mammal list for Rwanda (incl. Akagera NP) was published by Schouteden (1943, 1947). At that time herds of African buffalo (*Syncerus caffer*), bohor reedbuck (*Redunca redunca wardi*) and lions (*Panthera leo*) were observed as far west as Lake Muhazi near the Kayonza-Kagitumba road (Van den Berghe, 1942; Vienne et al., 1980; Vande weghe, 1990). First scientific studies on the mammalian community and the population structure of large ungulates in relation to vegetation and main predators were carried out in the 1940/50s by the Institut des Parcs Nationaux du Congo et du Rwanda-Urundi (Frechkop and Verheyen, 1944; Curry-Lindahl, 1961; Bourliere, 1965; Verschuren et al., 1965). At that time, large parts of the park were encroached by pastoralists and their cattle, until around 1960, when political instability affected Rwanda and many Rwandans were forced to exile (de Leyn, 1960).

In the 1970s and early 1980s, wildlife recovered and Akagera NP advanced to one of the most renowned protected areas in sub-Saharan Africa. First community conservation approaches were discussed (Ruwet, 1974), and first systematic ecological research was conducted inside the park, e.g., Spinage and Guinness (1971) studied the survival of trees in the absence of elephants (*Loxodonta africana*). From 1960 to 1975, Akagera NP had no elephant population, until about 50 elephants were translocated from Bugesera District in southern Rwanda (Monfort A. and Monfort N., 1977, 1979a; Haigh et al. 1979). Prior to their introduction into Akagera NP, Monfort A. and Monfort N. (1979b) studied the food intake and the energy balance of two young elephants inside a pre-release enclosure. Moreover, Monfort A. (1972) provided a preliminary record on the density, biomass and structure of wild ungulate populations, while Spinage (1969) and Spinage et al. (1973) carried out first wildlife counts and provided population estimates for the larger mammals in the park. Numerous studies were carried out on the ecology and social organisation of ungulates in the park (Monfort A., 1973; Monfort et

al., 1973). Monfort A. (1974) studied the ecology of warthogs, Monfort A. and Monfort N. (1974) focused on the ecology of oribi (*Ourebia ourebi*), Monfort N. (1974a) worked on the social structure of impalas and Monfort N. (1974b, 1975), Froment (1980) and Monfort-Braham (1985) studied the social and spatial organisation of topi (*Damaliscus korrigum jimela*). Furthermore, Monfort A. and Monfort N. (1978) provided insights in the social structure and habitat utilisation of the park's zebra (*Equus quagga*) population, and Monfort N. (1979, 1980) conducted two detailed studies on the social organisation and the adaptations of African buffalo to the semi-arid environment in the Akagera ecosystem. Other ecological studies focused on the effects of fire and salinity on the ungulate community in Akagera NP and the Mutara GR (Spinage and Guinness, 1972; Minani, 1986). In the 1980s Akagera was one of the most visited national parks in Africa (Monfort A. and Monfort N., 1982), but also faced management problems and increased poaching (Monfort N., 1981). In contrast to what was known about elephants in the Akagera region, giraffes never occurred in the savannahs of eastern Rwanda (although they occurred in the Burigi region of north-western Tanzania; Rogers et al., 1977). In January 1986, six Masai giraffes (*Giraffa camelopardalis tippelskirchi*) were translocated from Lake Magadi in Kenya and released in the park (Vande weghe, 1990). During that period of relative political stability, more comprehensive species lists of mammals occurring in Rwanda were published by Monfort N. (1985), Verschuren (1987) and later up-dated by Monfort A. (1992), also including new records from Akagera NP.

In the late 1980s, research concentrated on the conservation status of the protected area and on changes in the vegetation structure due to increasing human impact (Verschuren, 1986, 1988). Resulting from those surveys Monfort N. (1988) published a first account on the conservation status of antelopes in the park. Subsequently, two internationally funded conservation projects were initiated in Akagera NP, attempting to establish the status of wildlife and to implement distinct conservation measures (Vande weghe and Dejace, 1991; Fourniret and De Schrevel, 1993; Fourniret, 1994; Chardonnet and East, 1995; Williams and Ntayombya, 1999).

Since 1990, Akagera NP has suffered from the successive effects of civil war, genocide and the invasion of returning refugees and their cattle. In the mid-1990s, when peace

had returned, large areas of Akagera NP and the Mutara GR were occupied by pastoralists and their livestock with the consequence of a severe reduction of wildlife numbers (Chardonnet and East, 1995; East, 1999). In 1997, the Mutara GR (300 km<sup>2</sup>) and the northern and western sections of Akagera NP (1,680 km<sup>2</sup>) were degazetted. The total protected area was reduced from 2,800 km<sup>2</sup> to only 1,120 km<sup>2</sup>. To determine the ecological viability of the new Akagera NP, the biodiversity of the reduced park and the degazetted area of the former park were assessed by Williams and Ntayombya (1999, 2001) as part of the Akagera Biodiversity Project. The reduction of protected area by 60% (one of the largest size reductions in modern African conservation history; Kanyamibwa, 1998; Bizoza and Madina, 2013) eliminated three important habitat types, i.e., the sub-humid savannah in the west, the *Acacia kirkii* gallery forest along the Akagera River in the north and the flood plains in the centre of the former National Park. This habitat loss had adverse effects on species using these habitats either for feeding (eland, *Taurotragus oryx*, warthog, *Phacochoerus africanus*; waterbuck, *Kobus defassa* and plains zebra), or for breeding (topi). By contrast, some vegetation communities such as the lakes and adjoining swamp systems are still well represented in the new park and provide important habitat for species such as sitatunga (*Tragelaphus spekii*; Beudels-Jamar et al., 1997) or hippos (*Hippo potamus amphibius*; Williams and Ntayombya, 1999). Wildlife populations in the degazetted parts of the former park were rapidly decimated due to vegetation changes caused by overgrazing with cattle, and uncontrolled hunting for meat and entertainment (mainly by military personal between 1990 and 1997). As a result of these adverse factors, a significant decline in the numbers of larger mammal species was observed, reducing the abundance of impala, buffalo, warthog, waterbuck, topi and oribi by about 75-80% (Kanyamibwa, 1998; Plumptre et al., 2001; Schoene, 2003). Three species have undergone even more severe population declines, i.e. the bohor reedbuck, the roan antelope (*Hippotragus equinus*) and the black rhinoceros (*Diceros bicornis*). Before the political unrest of the 1990s, about 145 roan were reported from the former Akagera NP (Beudels et al., 1992), but declined to only 31 individuals in 1998 (Vande weghe and Dejace, 1991; Williams and Ntayombya, 1999, 2001). By 2013, the roan population had recovered to 83 individuals occupying an area of favourable habitat in the west-central part of the new Akagera NP (Macpherson, 2013). Today, the roan is considered the most threatened antelope species

in the park and its conservation must have priority since the Akagera population is the last in a corridor once connecting the southern populations to those of East and West Africa (Vaz Pinto et al., 2016). Originally, the black rhinoceros did not occur inside the protected area but was introduced in 1957 (Haezaert, 1969). After a significant population increase to more than 50 individuals, the political turmoil of the 1990s resulted in a sharp decline of the population until it was reported extinct in Akagera NP in 1994 (Vande weghe, 1990). The last rhino in Rwanda was encountered south of the new Akagera NP in 2007 (Mwai, 2017). Between February and March 2017, a founder population of Eastern black rhinos were captured on the Thaba Tholo Game Ranch in South Africa and translocated to Rwanda where they were reintroduced into Akagera NP in May 2017 (African Parks, 2017).

The political instability during (and after) the civil war had also implications on the law enforcement in the new Akagera NP, leading to a lack of protection activities, and hence to further loss of wildlife (Kanyamibwa, 1998; Plumptre et al., 2001). After stability had resumed, some studies monitored the persistence and/or recovery of ungulates in the modern Akagera NP and adjacent areas (i.e., the former Mutara GR and degazetted parts of the former Akagera NP). While Lamprey (2002), conducting an aerial survey, reported on depleted numbers of larger ungulates, Apio and Wronski (2011) carried out a road strip count revealing a recovery, at least for impala and topi. Even for the degazetted parts, outside the yet unfence modern Akagera NP, Gatere (2011) reported good numbers of impala, zebra, waterbuck and oribi. These promising results were supported by aerial surveys of Viljoen (2010) and Macpherson (2013). In the same year, Gatali (2013) estimated the population size of larger mammals in Akagera NP and reported on positive effects of the recovering vegetation on the ungulate fauna. Recently, Apio et al. (2015b) estimated the abundance of bushbuck (*Tragelaphus sylvaticus*) and common duiker (*Sylvicapra grimmia*) in the degraded parts of the former protected areas, using local ecological knowledge. Simultaneously, Hirwa and Nsengimana (2015) estimated the persistence of other wildlife species (including small carnivores and lagomorphs) in the same area applying the same technic. Wronski et al. (2015) investigated an isolated, surviving population of impalas in the Kazaza Sector, a part of the Mutara GR that was lost for conservation as early as 1970.

From 2010 to 2015, Apio et al. (2017) conducted further road strip counts to evaluate the population development of ungulates in the new Akagera NP. The study provided surprising results: numbers of impala, zebra and waterbuck seem to have reached the carrying capacity of the new Akagera NP (Goodman, 2003), and are in decline again. Resulting from road strip counts, Apio et al. (2015a) also provided a detailed up-date on the positive population development of African buffalo in the park. Given this and the small size of the modern Akagera NP—especially after the park was electro-fenced in 2013 (RDB, 2013)—the necessity for continuous monitoring of ungulate populations inside and outside the park is imperative. Most recently, Bariyanga et al. (2016) published a study on the population development of larger ungulates in the Uruhita Valley (in the centre of the former Akagera NP) before and after the new fence was closed. The authors report on the effectiveness of fencing and the helicopter based game drive, herding wildlife into the new park. Fencing national parks has become a widespread practice to reduce human-wildlife conflicts but fences also prevent the dispersal of wildlife, leading to overstocking especially if predatory species have gone extinct. African wild dogs (*Lycaon pictus*) are considered extinct in Akagera NP (de Leyn, 1962), lions (*Panthera leo*) have not been reported for at least 15 years (Lamprey, 2002) but were recently reintroduced to the new park (Hall, 2015; Toovey, 2015), while spotted hyenas (*Crocuta crocuta*) and leopards (*Panthera pardus*) persisted inside the new park (Macpherson, 2013), but also outside (e.g. Muvumba riverine; Bariyanga, unpubl. data).

Compared to what is known about the larger game species and their predators, surprisingly few studies have focused on primates or small carnivores. Lejeune (1981, 1984, 1985, 1986) studied the ecology and social organisation of olive baboon (*Papio anubis*) in Akagera NP, and Lejeune, (1989a, b, 1990) and Lejeune and Frank (1990) reported on the ecology and behaviour of spotted-necked otter (*Lutra maculicollis*) and its impact on commercial fishing in Lake Muhazi. For rodents (Missone, 1965) and bats (Verschuren, 1965; Baeten et al., 1984) some information is available from Akagera NP, while for insectivores barely a species list was compiled (Hutterer et al., 1987). Only recently, the persistence of southern tree hyrax (*Dendrohyrax arboreus*) was confirmed for the Muvumba riverine forest (de Jong and Butynski, 2016), a strip of natural riparian *Acacia kirkii* woodland that marked once the border of the Mutara GR



to the West. This still intact woodland continues to harbour some wildlife but is under severe pressure from an ever growing human population (ACNR, 2011; Tuyizere, 2015).

#### **4. Discussion and conclusion**

This literature review attempts to provide a comprehensive collection of published and unpublished literature respective to the Akagera ecosystem in Rwanda. However, while the published record is considered complete, there might be the chance that some unpublished reports and thesis remain undetected by our literature search. This may particularly apply to studies that were carried out by the National University of Rwanda (NUR; Butare) before 1994. It would be therefore beneficial to search the archives and libraries of NUR in order to further complete this bibliography. Nevertheless, this literature review provides an overview on what literature on mammalian wildlife is known from the region, which will assist future researchers to easier access it and to consider those studies in their future works. The extraordinary habitat diversity including forest fringed lakes, papyrus swamps, savannah plains and rolling highlands combine to make Akagera one of the most scenic protected areas in Africa. Akagera still has exceptional levels of biodiversity and forms the largest protected wetland in central Africa. The considerable improvement in the management and law enforcement of the new Akagera NP makes it an important role model for successful conservation and wildlife regeneration. This literature review is therefore also addressed to encourage future research to study the positive and adverse effects of modern conservation management in and around Akagera NP.

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