Opinion Article

Towards understanding large mammal population declines in Africa's protected areas: A West-Central African perspective

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Abstract

A raft of recent studies has highlighted a major decline in large mammal populations in many of Africa's protected areas. A recent continent-wide assessment represented a major step forward also in terms of quantifying the decline on a regional basis, but fell short in its sampling and analysis. In this paper, a way out of the "black box" of large mammal declines in Africa's protected areas is formulated, with the aim of assisting in the preparation of further assessments in the future. First, large mammal assessments are categorized, highlighting the importance of using and sometimes juxtaposing peer-reviewed sources. The importance of the length of time series of large mammal counts is stressed, allowing one to distinguish between natural variation (especially rainfall) and human-induced changes. Setting reference dates, such as 1970, often gives biased results, showing the need to interpret large mammal population assessments in a historic context as well. This holds true particularly for West-Central Africa, which has experienced a considerable decline in rainfall since 1970. Building on a framework that connects herbivore physiology and behavior with environmental gradients, examples are given to explain some striking observed changes. The declines in Africa's protected areas are not limited to large mammals, but have also been observed for large birds of prey. Assessments of large mammal populations should be accompanied by the identification of proximate drivers of change, for which a framework is suggested in this paper. To conclude, some suggestions for countering the declines in large mammal populations are presented.

Keywords: large mammals; Africa; population assessments; time series; drivers of change.

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Introduction

Whereas most indicators show a decline in biodiversity, among the few successful responses to the biodiversity crisis has been an increased coverage of protected areas (PAs) over recent decades [1]. However, this global success seems, from an African perspective, to have had a limited impact in terms of countering the decline in biodiversity. In 2007, Caro and Scholte [2] argued that “a raft of studies is showing that we are losing species from many of Africa’s national parks –bastion of biodiversity conservation.” Over the last three years, countrywide assessments from Kenya [3] and the Central African Republic [4], in addition to surveys of individual PAs, including the famous Mara-Serengeti [5], have further demonstrated the decline of large mammals in Africa’s PAs.

Craigie et al. [6] recently provided a first continent-wide assessment, suggesting a 59% decline in large mammal population abundance in Africa’s PAs between 1970 and 2005, with declines in eastern Africa (52%), a collapse in western Africa (85%), and a surprising 24% increase in southern Africa. Their study also represents a major step forward in quantifying the decline on a regional basis, but falls short in its sampling and analysis. This hinders its ability to help with our understanding of to what extent the observed decline can be attributed to natural fluctuations or human influence, as well as a breakdown of the latter. It does not help that the authors decided to analyze their findings separately, drawing on parallel datasets. In this article, a reaction to Craigie et al. [6] is presented, and a way out of the “black box” of large mammal declines in Africa’s PAs is formulated, with particular attention paid to the generally neglected regions of West and Central Africa. The aim is to provide a useful point of reference for a more comprehensive review of large mammal assessments in Africa’s PAs.

Fig. 1. Left: Large mammals symbolize the wealth of Africa’s PAs. The reasons for their rapid decline are still not well understood, and should therefore be an issue of major concern and subsequent action. Kob antelope at a waterhole in Waza NP (Cameroon). Right: Dead Kob: Following upstream dam construction, the Kob antelope population in Waza NP crashed from 20,000 to 5,000. Subsequent poaching and competition with livestock has led to further declines. PHOTO CREDIT Paul Scholte

Overview of large mammal population assessments

Review of Survey and Assessment Methodologies

Large mammals are defined as having a body weight of > 2 kg [7]. However, most ungulates detectable in extensive multi-species ground surveys have a weight of > 20 kg, and for aerial surveys detectability lies at > 50 kg [8]. Ungulates generally dominate these larger large mammal population assemblages.

Craigie et al. [6] drew upon time series of a multitude of published and unpublished surveys, including smaller (< 20 kg) and larger large mammals from different guilds, and thereby neglected a wide range of peer-reviewed literature on the dynamics of large mammal populations, which in many cases have provided explanations for the observed declines [e.g. 5, 9, 10, 11]; see also below. Quantitative assessments of multi-species large mammal communities in Africa's PAs, published in peer-reviewed journals, can be broadly divided into two groups. The first is analyses of long-term datasets using statistical methods to control for confounding variables. These include a 40-year dataset of monthly transects conducted by park guards in Ghanaian PAs [9], and decades-long collections of aerial censuses over huge wildlife areas in the Central African Republic [4], Kenya [3, 12], and Tanzania [13]. The second group includes assessments that combine and juxtapose different survey methods to depict population changes, often within single and/or a complex of reserves, across considerable time frames [5, 10, 12, 14]. Other authors have also hesitated to consider different methodologies, even if they have been peer-reviewed; for example, Poilecot et al. [15] with Dejace et al. [16]. This leaves users of the research to draw conclusions based upon limited area-specific knowledge only. Obviously, survey methods should not be mixed; aerial surveys, for example, underestimate by at least 50% all but the largest mammals (compared to terrestrial counts [8]). It is worrying that Craigie et al. [6] stated for the time series they applied that "data were only included if the same data collection was used throughout," as at least one of their sources [10] juxtaposed aerial and terrestrial transects, as well as total counts.

One should add a third category of sub-continental semi-quantitative assessments of large mammal species: reviewing the available literature and drawing extensively on expert opinion on their status and evolution. Examples include the status papers published by the IUCN's Species Survival Commission, e.g., antelopes [17], elephants [18], and carnivores [19, and see also 20].

How many protected areas have been surveyed?

Craigie et al. [6] compiled time series from 35 southern, 43 eastern, and 11 western African PAs, the latter being too limited a number for the broad conclusions made by the authors regarding the collapse of its large mammal populations. Moreover, their selection was biased towards the west of West-Central Africa, thereby accentuating the decline, see below. The only PA from Central Africa included, Waza National Park (NP) in Cameroon, is exceptional because of the construction of an upstream dam [10]. Repeated counts have been conducted in Central Africa over the last 20 years, contrary to the claims of Craigie et al. [6]. In Zakouma NP (Chad), large mammal populations, with the exception of elephants, have remained stable [15, 16], whereas in five PAs in the northern Central African Republic, populations have declined by 65% [4]. Counts in the Benoué and Boubandjidah NPs (Cameroon), reported internally by the WWF and individual researchers, suggest relatively slight declines.

Length of time series

Interannual natural variation in large mammal population numbers has been observed for many PAs in West-Central, eastern and southern Africa, leading some authors to consider time series of more than 10 [13], 15 [14], or up to 40 years [10]. In contrast, the time series used by Craigie et al. [6] seem to have a much lower minimum of two years only, making it unlikely that climatic variations and their impact on population numbers can be ruled out in their assessment.

Bias of reference dates

West-Central Africa highlights a misunderstanding in Craigie et al. [6] that "1970 was not a time of unusually high mammal abundance." The authors' evidence for this came from the Serengeti, which has little relevance to southern and West-Central Africa, with their different rainfall patterns and histories of human pressure [21]. Rainfall is the main abiotic factor determining ungulate grazer populations across Africa [14, 22]. In West-Central Africa, rainfall was high throughout the 1950s and early–mid 1960s, whereas from 1970 to the late 1980s in Central Africa, and up until now in West Africa, rainfall was below average [23]. In West-Central Africa, 1970 was a turning point in terms of natural conditions for most large mammal populations, with their subsequent decline having been triggered by a prolonged decline in rainfall, coinciding with increased human pressure. When rainfall improved, human pressure lifted only partially [10]. In West-Central Africa, large mammal populations were likely to have been "higher than long-term equilibrium levels around 1970" [6], explaining part, but certainly not all, of the reported 85% decline.

In addition, the 1990-2000s increasing recovery in rainfall when going from west to east in West-Central Africa [23] may have contributed to the more limited declines in large mammal populations in Central Africa compared to West Africa, mentioned above.

Towards understanding changes in large mammal populations

Studies on the management efficiency of protected areas

One may expect that PA managers and site experts are well-placed to explain changes in large mammal populations. These perceptions have been included in studies on management effectiveness of African PAs, but unfortunately not linked with the status of large mammal populations [e.g., 24, 25, 26]. The studies have highlighted concerns surrounding management conditions in PAs, especially regarding inputs of human and material resources, but have failed to reveal the above-mentioned extent of the decline in large mammal populations, including the large regional variation. One hypothesizes that this is because (1) management effectiveness studies generally cover a timespan of a few years only; (2) assessments have generally been made based on self-reporting, biased by "counter-psychology" [10]; and (3) perceptions often focus on charismatic species which in a number of cases have fared relatively well compared to ungulates, e.g., elephants in Waza NP (Cameroon) and mountain gorillas in Volcanoes NP (Rwanda).

Opposing views on the state and evolution of large mammal populations

Opposing explanations regarding the state of Africa's large mammal populations continue to circulate, hampering proper management responses. There has, for example, been much debate surrounding the impact of the late 19th century rinderpest, which may have inflated large mammal numbers in the 20th century. The so-called "myth of wild Africa," an argument especially used in eastern Africa for mixing wildlife conservation with other land uses, such as pastoralism [27], contradicts the recommendations of many natural scientists [e.g., 28]. This is not the forum to contribute to this debate, but it nevertheless demonstrates the need also to place the observed declines of large mammals in a historic perspective. This notion holds true for southern Africa as well, where private and community conservancies have taken flight [29], countering the declines in large mammal populations in PAs, although the 24% increase reported by Craigie et al. [6]

suggests that these declines have indeed already been countered. Such increases do not compensate for the losses in the larger PAs in the past [11], and South African private ranch stakeholders also warn of the dangers of the commercial nature of wildlife ranching, in which tourist preferences drive the industry [30].

Parallel studies with converging results

The general picture of declines in large mammal populations, dominated by ungulate population assessments, is confirmed by semi-quantitative (category 3, above) assessments, as for example of the top predators (African wild dog and lion), which show massive declines and even disappearance from the largest PA complexes [19, 20]. Large mammal population declines do not stand alone; the collapse of vulture and large eagle populations outside, and their decline inside, PAs over the last 30–35 years has been highlighted in a number of studies by Thiollay [e.g. 31] from West-Central Africa, and recently by Virani et al. [32] in Masai Mara. Whereas Thiollay [31] highlights changes in land use, Virani et al. [32] also present the possible poisoning of carcasses as a main cause of the declines. The connections between these various taxa in Africa's PAs remain to be analyzed in the light of the recent declines.

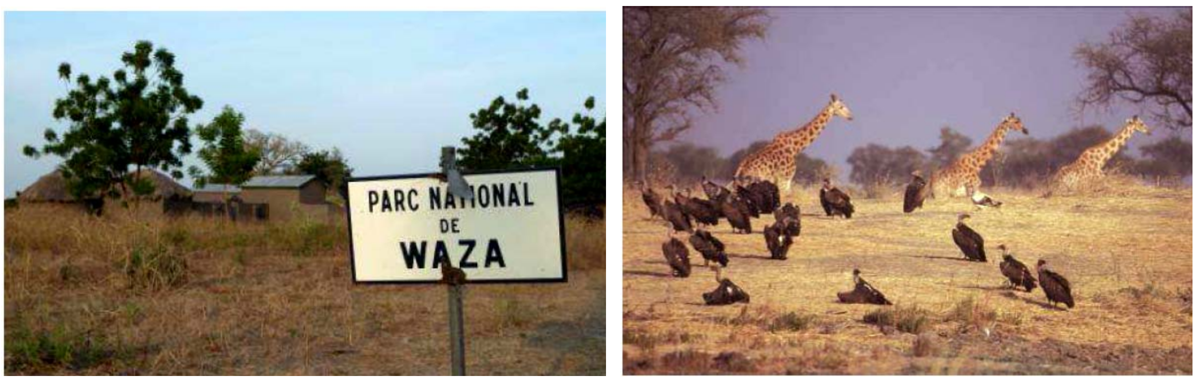

Fig. 2. Left: Village at the edge of Waza NP (Cameroon). Since the creation of many African PAs, neighboring human population densities have increased greatly, exerting increased pressure on PA resources. Right: Three species of vulture with giraffes near a waterhole in Waza NP (Cameroon). The decline of large mammal populations in West-Central Africa has occurred in parallel to a decline in numbers of vultures and large eagles. Changes in land use are common among the reasons given for these declines. PHOTO CREDIT Paul Scholte

Developing a framework of large mammal dynamics including human disturbances

An increase in our understanding of large herbivore dynamics has allowed for the development of a framework connecting environmental gradients and disturbance patterns with body size and trophic structure [33]. The present model incorporates, among others: (i) body size, (ii) digestive strategy, (iii) feeding strategy, (iv) migration ability, and (v) predator avoidance. Human-induced disturbances (see below) are to be integrated in this mechanistic model, allowing further insight into observed declines. Some of the more striking changes in large mammal populations, and their links with these five variables, are presented below.

Elephant and white rhino, hardly affected by predation because of their body size (i), have fared relatively well over the last decades especially in southern Africa [18], contrary to their recent dramatic decline in Central Africa due to poaching associated with poor security [15]. Populations of impala, an animal that can switch between browsing and grazing (iii), fares well over much of its distribution in southern Africa [34], contrasting to the West-Central African kob (grazer) (iii), whose population crashed in Waza NP because of floodplain degradation. This same degradation benefited the (uncommon) red-fronted gazelle, which has lost much of its more Sahelian habitat [10]. The increase in large mammal populations in South Africa has been accompanied by a shift in species composition, especially in PAs that have lost their connectivity and used to sustain migration, such as Kruger NP. Large herbivores, such as buffalo and white rhino, have replaced smaller ones (i), and zebra, a non-ruminant that can handle lower-quality grass (ii), now outnumber wildebeest [34]. There is a parallel here with the Mara-Serengeti, where migratory zebra also hold well, contrary to most (sedentary) ruminants (ii, iv). In contrast, buffalo (ii) are vulnerable to drought, resulting in their early extirpation in semi-arid areas of West-Central Africa, such as Waza NP [10]. In the more humid Sudanian zone of West and Central Africa, buffalo and and roan have held surprisingly well, in contrast to the overall declines in large mammal populations [4,10]. Roan have shown a dramatic decline in some parts of southern Africa because of artificial water provision [14]. However, they hold well in northern Botswana in waterless areas with very low lion densities (v) [34], not unlike their habitat in West-Central Africa, although there the permanent water they avoid may be related more to human pressure than to pressure from lions (v).

Fig. 3. The habituated mountain gorilla is at the basis of a multimillion dollar tourism industry (Volcanoes NP, Rwanda). The future of Africa's large mammals depends on such economic rationalities. Inevitably, this will "domesticate" Africa's natural environment. PHOTO CREDIT Paul Scholte

Drivers of change

Reporting on changes in large mammal populations without making reference to (large-scale) changes in land use around PAs is a hindrance to gaining insight into the possible causes of their decline. Unfortunately, most large mammal assessments are unsystematic in describing such changes. Therefore, here a classification of proximate drivers of change in and around PAs is proposed, to be addressed alongside large mammal population assessments. Proximate drivers should be distinguished from underlying drivers, not themselves causing change, but acting indirectly to contribute to change. For example, human population growth, such as through immigration (underlying driver), in itself does not harm a PA, but (illegal) activities (proximate driver) employed by the newly arrived people may cause pressure on large mammal populations. Identifying these drivers and, where possible, quantifying their impact, facilitates greatly the formulation of appropriate management responses at local as well as at larger scales.

Underlying drivers

I. Since many (savanna) NPs have been created, some up to 50 years ago, there has been a large increase in (rural) human population density, including around PA boundaries [35]. Many of these people live in poverty, although they are not necessarily poorer than in other rural areas [36], and depend on resources from within the PAs.
II. Poor incentives, including wildlife laws, regulations, and corruption, prohibit communities and the private sector from investing in wildlife compared to other land uses [e.g., 37].
III. African PAs are chronically underfunded, running on an estimated 10% of the necessary funds [38]. Despite an increase in development assistance for biodiversity, African PAs possibly receive less public funds than in the recent past [39], although until recently NGO funding has been increasing [40].
IV. Climate change, possibly already driving parts of the observed changes in West Africa, is likely to become a main driver of change in the near future [41].

Proximate drivers

1. **Habitat loss and degradation by changes *inside* the PA:**
   i. Encroachment (agricultural, livestock, fisheries, mining, others).
   ii. Detrimental fire regime (amplified by low wildlife densities).
   iii. Changes through artificial water provision (e.g., Kruger [14]).
   iv. Others (to be specified).
2. **Land use and land cover change *outside* the PA [42,43], in the wider ecosystem, landscape or zone of interaction [44], through the following mechanisms:**
   i. Decrease in the effective size of the larger ecosystem, often expressed only after several decades by the extirpation of populations – the so-called "extinction debt."
   ii. Change in ecological flows, e.g., blocking flooding in the Waza (Cameroon) and Kafue NPs (Zambia) [10].
   iii. Loss of crucial habitat and/or corridors to those habitats, e.g., Kruger NP [11].
   iv. Increased human population and exposure to human impacts (only to be used when not overlapping with other categories).
3. **Overexploitation for:**
   i. Bushmeat.
   ii. Poaching for other animal products (ivory, trade, etc.).
   iii. Trophy hunting.
4. **Diseases:**
   i. Indigenous (e.g., Ebola among gorillas [45]).
   ii. Indirect (transmission through livestock, feral dogs).
5. **Natural causes, e.g., droughts that explain fluctuations (especially with time series <15 yr), difficult to filter out [5].**

Towards a response

Presenting declines in large mammals without offering possible solutions, as Caro and Scholte [2] did, leads to frustration for the reader. Some suggestions are proposed here based on one underlying driver: the lack of funding, which stands out as an opportunity to a rapid and general response, especially in the context of West-Central Africa.

The few quantitative studies available [38, 39] suggest that a 3- to 10-fold increase in the operational budget of African PAs is required. In addition to up-scaling the funding, a dramatic increase in the (institutional, human, and local) capacity to handle such up-scaled support would be necessary. More modestly, one could concentrate on the few functional conservation areas [11], which possess viable wildlife assemblages, including the savanna PAs of northern Cameroon and the CAR, the Boma complex (southern Sudan), the western Congo Basin, i.e., the complexes of TRIDOM (Cameroon, Gabon, and Congo) and TriSangha (CAR, Cameroon, and Congo), the Mara-Serengeti (Kenya and Tanzania), Selous-Niassa (Tanzania and Mozambique), and the northern Botswana-Zimbabwe complexes [11]. Such initiatives should assure that all PA management costs are covered. This raises the question of what to do regarding the largely depleted PAs in West Africa: Niokolo (Senegal), Comoe NP (Ivory Coast), and WAP (Niger, Benin, and Burkina Faso). For other areas, where the rehabilitation of large mammal communities is at present unlikely, there should be an appreciation of smaller wildlife, such as waterbirds, and intact vegetation, e.g., in Waza NP (Cameroon) and Dinder NP (Sudan).

Apart from this handful of last “functional conservation areas,” domesticated nature [46] will ultimately remain. Its viability is illustrated by the increasing large mammal populations in southern Africa, largely thanks to the 9,000 profit-driven private wildlife ranches in South Africa, covering 17% of the land surface [30]. Other symbols of domesticated nature – habituated gorillas and chimpanzees in the tiny protected areas of Volcanoes NP (1600 ha) and the Cyamadongo section of Nyungwe NP (400 ha) – sustain a tourism industry of some 100 million USD yr^{-1}. Large mammal assemblages are doomed to disappear under these “domesticated” conditions. With only a few exceptions (e.g., Mara-Serengeti), for the average western tourist, upon whom the funding for conservation in Africa overwhelmingly depends [30], little will change.

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