Scientific Research

Population Dynamics of Large Herbivores and the Framing of Wildlife Conservation in Zimbabwe

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Abstract

This article reviews: 1) The role of natural and human-induced controls in influencing large herbivore populations; 2) how human controls (*i.e.*, policy instruments, incentives and provisions) influence human activities and wildlife conservation; and 3) media framing of wildlife conservation using Zimbabwe as a case study, in particular Gonarezhou National Park and adjacent areas. The review shows that droughts are important in influencing large herbivore populations in semi-arid ecosystems; political instability and economic collapse does not necessarily lead to increased illegal hunting in situations where policy instruments, such as laws, are enforced. A higher perceived effectiveness of Communal Areas Management Programme for Indigenous Resources was partly associated with a decline in human-wildlife conflicts and there was a spill-over effect of frames from the political domain into wildlife conservation following Zimbabwe's land reforms in 2000. It is concluded that natural bottom-up processes (e.g., droughts) influence large herbivore population dynamics whereas policy instruments, incentives, provisions and societal frames mainly have a top-down effect on wild large herbivore populations in savanna ecosystems.

1. Introduction

This article presents insights from a novel attempt to understand wildlife conservation issues in Zimbabwe

through focusing on scientific findings generated from interdisciplinary research [1] [2]. More specifically, this review primarily draws insights from a PhD research conducted in Zimbabwe, whose fieldwork covered the Gonarezhou National Park and the adjacent areas [3]. Generating information that help improve wildlife conservation and management through assessing the role of natural and human-induced top-down and bottom-up control of large herbivore populations and how policy instruments influence benefits and costs associated with community-based wildlife conservation in semi-arid savanna ecosystems is increasingly becoming important [4] [5]. Moreover, investigating the framing of wildlife conservation in the mass media following a political crisis and economic decline is essential in changing environments [6]. This article, therefore, specifically reviews the role of natural and human-induced controls, effectiveness of Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) and human-wildlife conflicts and media framing in wildlife conservation using a case study of Zimbabwe.

In natural ecosystems, animal population sizes are largely controlled by two processes, namely top-down and bottom-up controls [7] [8]. Top-down control refers to processes whose effects flow down the food chain such as the herbivore populations being controlled by direct predation, and thus, carnivores indirectly influencing plant abundance. Bottom-up control refers to processes that control animal communities from the bottom of the food chain upward to higher trophic levels since plant primary production fuels the animal biota, plants, along with nutrients and light. Moreover, humans can also alter the terrestrial ecosystem structure and composition through actions such as setting fires and livestock grazing (human-induced bottom-up control), and by acting as a generalist super predator that can top-down harvest any animal species [4]. **Figure 1** shows a model of relations of human-induced top-down and bottom-up controls of large herbivore populations in terrestrial ecosystems.

Community-based natural resources programs, such as the CAMPFIRE program developed in Zimbabwe, have been implemented to allow for the sustainable use of natural resources in areas bordering protected areas [9]. CAMPFIRE is a government initiative that was implemented in 1989 specifically to stimulate long-term development, management and sustainable use of natural resources in Zimbabwe's communal farming areas ad-
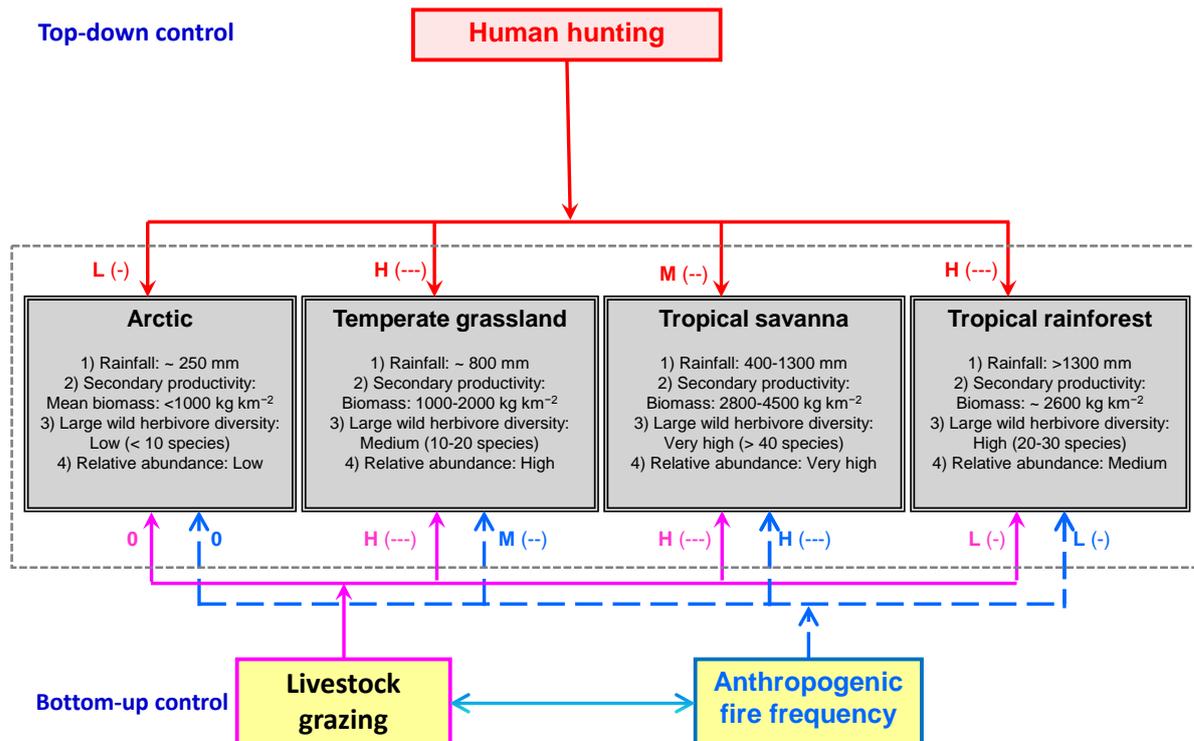

Figure 1. A schematic representation indicating the top-down and bottom-up controls of human activities (at global biome level) particularly on wild large herbivore community in the arctic, temperate grasslands, tropical savannas and tropical rainforests. Data sources: [21]-[23]. Notes: H = high negative impact, M = medium negative impact, and L = low negative impact. Impact refers to negative human influence on specifically wild large herbivore populations and composition occurring in the various biomes, if and only if the outlined respective biome characteristics are satisfied. Source: [4].

jacent to state protected areas [10]. However, the effectiveness of the CAMPFIRE programs remains largely unknown due to the differences in human communities and the recent policy changes in Zimbabwe following the land reforms that occurred since 2000 which were largely published in both the local and international media, hence the importance of further research on CAMPFIRE effectiveness and also media framing of wildlife conservation.

2. Natural Large Herbivore Population Controls

Rainfall, in particular droughts, play a major role in influencing large herbivore population dynamics in semi-arid savanna ecosystems with high rainfall variability [3]. Rainfall is a key driver of primary production in terrestrial ecosystems [11]-[13] and thus its influence on large herbivore population developments. Droughts are associated with a reduced primary production [13]-[15], which results in large animal die-offs due to forage shortages and also reduced surface water availability [16]-[18]. According to [3], evidence of a weak synchrony in the occurrence patterns of droughts and wet years was recorded in areas adjacent to the Gonarezhou National Park, Zimbabwe between 1970 and 2009. Populations of some large herbivore species declined following the 1992 drought in Gonarezhou National Park and subsequently increased after the drought. A similar trend in large herbivore population declines following the 1992 drought was also recorded in the adjacent Kruger National Park, South Africa [19] [20], suggesting a synchrony in large herbivore population development between these two adjacent protected areas [3]. Moreover, there was evidence to suggest that population growth was high when rainfall was average to above average for some consecutive period since the exceptionally wet periods did not lead to sudden increase in populations [3].

3. Top-Down Human Control of Animal Populations

Issues of illegal hunting have received considerable attention in recent years, particularly, in the tropical rainforest and savanna ecosystems [24]-[28], therefore, advancing our understanding of the negative impacts associated with human bushmeat hunting on animal communities and how law enforcement can influence such human bushmeat hunting in times of political crisis and economic collapse is of importance. Gandiwa *et al.* [29] used data gathered from 236 local people on perceptions of illegal hunting and wildlife protection in the northern Gonarezhou National Park and adjacent areas together with data collected from law enforcement patrols covering the period from 2000 and 2010, which coincided with the land reforms, political crisis and economic collapse in Zimbabwe. Main drivers of illegal hunting included bushmeat consumption at household level and the need to raise income for family or personal use as also reported by other authors [30]-[32]. Snaring was mostly used to catch a wide range of wild animals for bushmeat whereas firearms were used for large herbivore species such as elephant (*Loxodonta africana*), primarily for ivory. However, there was no evidence of massive large herbivore declines in Gonarezhou National Park between 2000 and 2010. This suggests that the negative impacts of the land reforms were low in Gonarezhou National Park, despite the fact that a small section (about 90 km^2) of the northern part of the park had an illegal settlement since 2000 [33] [34].

Adaptation to New Situations: Changes in Law Enforcement

An increase in recorded illegal activities, *i.e.*, hunting and fishing, was associated with reduced law enforcement efforts, between 2000 and 2003, as a result of few rangers and inadequate financial resources in Gonarezhou National Park [29]. However, when law enforcement staff numbers were increased in 2004 following the transformation of the wildlife authority into a parastatal and increased funding from the Frankfurt Zoological Society in the park, increased law enforcement efforts led to a decline in the numbers of arrested illegal hunters [29]. Illegal hunters appeared to have switched to snaring methods which are difficult to detect with increases in law enforcement as also reported by other authors [35]-[37]. This suggests that paying more attention to the detection of snares and their removal in protected areas is important, especially, when law enforcement efforts are increased.

Thus, [29] have shown that the variation in the recorded illegal activities in the northern Gonarezhou National Park ecosystem corresponds with the variations in law enforcement efforts. These findings, therefore, confirms that law enforcement is an important component of wildlife conservation in protected areas [38]-[40]. The increased law enforcement efforts inside Gonarezhou National Park and existence of community-based wildlife

conservation programs in adjacent areas could also have helped in maintaining large herbivore populations inside the protected area [41] [42]. Further, there was no evidence in Gonarezhou National Park to suggest that illegal hunting had increased following the Zimbabwe's political crisis and economic collapse between 2000 and 2008. Similarly, the local people also attributed the perceived decline in illegal hunting between 2000 and 2010 to increased law enforcement by the wildlife authority [29]. This is in contrast to the media reports on general increase in illegal hunting across wildlife areas in Zimbabwe since 2000 [27].

4. Socio-Ecological Systems and Wildlife Conservation

The model shown in **Figure 1** outlined the human-induced top-down and bottom-up controls of large herbivore populations in terrestrial ecosystems. However, the model does not include two important elements: 1) human controls which influences human behaviour, and 2) decision-making and framing processes, in particular media framing, which influences societal debates. Human controls are important in understanding the impact of human activities on large herbivore populations and also wildlife conservation hence the need to include this element in the model. Moreover, societal debates and decision making related to wild large herbivore population dynamics and associated wildlife conservation are informed not only by science but also by communication in, e.g., the mass media, thus, signifying the importance of including the element of decision-making and framing processes in the research model.

4.1. Wildlife Conservation: Policy Instruments, Incentives and Provisions

The findings of [43] suggest that human-wildlife conflicts are common even in communities with integrated conservation and development projects (ICDPs) as reported by other authors [44]-[46]. ICDPs play an important role in reducing human-wildlife conflicts through enabling communities to actively participate and derive economic benefits from natural resources management [47]-[49]. Community benefits under the CAMPFIRE program include infrastructural development, employment opportunities, cash dividends and a well-informed community on wildlife management issues and practices [43].

Of particular importance was the perceived increase in human-wildlife conflicts as a result of increasing wildlife populations in communities adjacent to the northern Gonarezhou National Park, e.g., elephant [3]. Similar, perceived increases in human-wildlife conflicts associated with increasing wildlife populations have been reported in northern Zimbabwe [50]. However, a high involvement of local people in the day-to-day running of CAMPFIRE was associated with lower perceived increase in human-wildlife conflicts since the local people were involved in decision making on aspects such as how to manage wildlife, income and human-wildlife conflicts [43].

Contextual factors, such as size (area) of the community, human population density and previous success of the CAMPFIRE programs across the local communities appeared to influence the perceived effectiveness of CAMPFIRE programs and attitudes towards problematic wildlife species in communities bordering the northern Gonarezhou National Park [43]. Moreover, the reduced benefits from CAMPFIRE programs associated with the hands-off reaction through the withdrawal of financial support by international donors following the recent land reforms in Zimbabwe appeared to have influenced perceptions of effectiveness of CAMPFIRE programs. This was also compounded by the high inflationary environment which led to the economic collapse in Zimbabwe, resulting in low response by safari operators or the local authorities to reported human-wildlife conflict cases, together with low benefits from CAMPFIRE in the local communities adjacent to the park [51] [52]. Low response rate incidences to human-wildlife conflicts to some extent led to the poisoning or hunting of problem animals [43] [53]. Carnivores, e.g., leopard (*Panthera pardus*), lion (*Panthera leo*) and spotted hyena (*Crocuta crocuta*), were more likely to be poisoned after livestock losses to large carnivores. Poisoning has also been reported in retaliation of human-wildlife conflicts across different ecosystems [53]-[55].

More favourable attitudes towards wildlife appeared to be associated with success of CAMPFIRE programs [43]. It can be hypothesised that the involvement of local people in decision making related to wildlife management issues and associated benefits accrued by the community from natural resources management programs plays an important role in influencing local people's attitude towards problem animal species. For instance, benefits and costs associated with wildlife-related conservation programs have been reported to influence attitudes towards animal species in some ecosystems [56]-[58].

4.2. Decision-Making and Framing Processes

Gandiwa *et al*. [6] concluded that images that exist in society are not necessarily congruent with reality on the ground, and that these images are influenced by other issues. In particular, findings by [42] [59] were at odds with the image of Zimbabwe mostly in the international media, thus it was valuable to better understand the role of mass media in framing wildlife conservation in Zimbabwe. This is important since societal decisions about wildlife conservation and management are not only taken on the basis of scientific information but also on what the mass media publishes. Using newspapers from countries with different relations to Zimbabwe, *i.e.*, political, historical and conservation relations, [6] demonstrated that framing of wildlife conservation in the international media (United Kingdom and United States of America) was positive between 1989 and 1999 and then changed between 2000 and 2010, to being more negative. This change in framing was related to the land reforms that started in 2000 and legalized by the Zimbabwean Government in 2002. Thus, [6] concluded that a spill-over effect from a political-related phenomenon, *i.e.*, land reforms, to a less political related issue, wildlife conservation, occurred. Between 2000 and 2010, newspaper articles in the international media blamed the Zimbabwean Government for the demise of wildlife and also challenges related to wildlife conservation in the country. However, the local Zimbabwean newspaper did not show any change in media frames before and after 2000.

Moreover, large herbivore population studies in Zimbabwe have showed that wildlife populations in state protected areas have either increased or remained stable [41] [59], whereas major wildlife declines were reported to have occurred in private-owned wildlife ranches or conservancies since the land reforms in year 2000 [60]-[62]. However, in the international newspaper articles, little attempt was made to distinguish this pattern of wildlife population decline with respect to land ownership following the land reforms in Zimbabwe. Hence, this type of misrepresentation of wildlife conservation in Zimbabwe in the international media is likely to have an influence on societal debates and decision making related to wildlife conservation issues and large herbivore population dynamics as shown in Figure 2.

5. Practical Implications

5.1. Science-Society Interaction

Gandiwa's [3] study inferred that there may be clear differences between dominant perspectives in society and the reality on the ground from a scientific investigation about wildlife conservation. The relationship between science and society is important in shaping people's views and also scientific research. Mass media is one way in which information from science is brought to the society and/or vice versa. Thus, [3] deduced that state protected areas were less negatively affected by the land reforms, political crisis and economic collapse between 2000 and 2010 than were private-owned wildlife areas. Therefore, the published international newspaper articles may not be accurate on the facts relating to wildlife conservation in Zimbabwe after the year 2000, due to the spill-over effect of a highly political related issue into a less political related issue of wildlife conservation [3] [6].

The media often neglect certain angles or frames of stories or neglect to provide evaluations of related events or issues [63]. Hence, the way that issues are framed can have a profound effect on the practical business of conservation because it defines agendas and limits the range of potential strategies that can be used to address problems [64]. There is need to address the negative image of wildlife conservation in Zimbabwe through: 1) ensuring that appropriate information is given in the international media so as to allow for support to conservation efforts by the international donors; 2) increased scientific research and dissemination of results in both scholarly and public media in order to really show the failure or success of conservation efforts in different land categories; and 3) hiring professional advertisement companies to counter publish representative wildlife conservation information about Zimbabwe into the opposing media.

Moreover, knowledge on large herbivore population trends, role of law enforcement and the need for local people involvement in decision making processes regarding problem animals generated by [3] is important in the societal arenas particularly in negotiations relating to natural resource use [2] and resource protection under the CAMPFIRE programs.

5.2. Wildlife Management

Management of wildlife in savanna ecosystems requires information on the factors controlling large herbivore populations, human interactions with ecosystems and how to control illegal activities. Gandiwa [3] recorded that
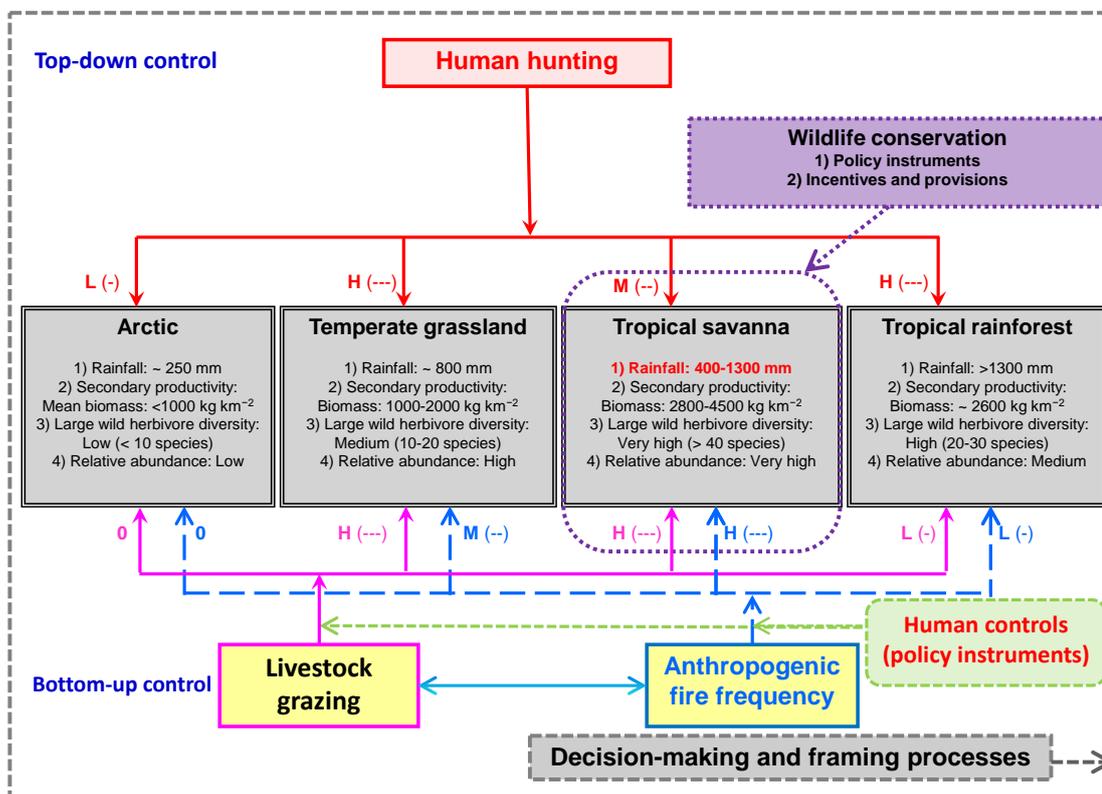
Figure 2. An adapted schematic representation indicating the natural and human-induced top-down and bottom-up controls (at global biome level) particularly on wild large herbivore communities in the arctic, temperate grasslands, tropical savannas and tropical rainforests. Improvements to the model in **Figure 1**: 1) rainfall acts as a natural control in the tropical savanna (highlighted in red and bold); 2) policy instruments, e.g., law enforcement, help in reducing human hunting (top-down human control), livestock grazing in protected areas and anthropogenic fires whereas incentives and provisions help in dealing with problem animals; and 3) decision-making and framing processes about terrestrial ecosystems and wildlife conservation influences societal debates and wildlife management systems. Data sources: [21]-[23]. Notes: H = high negative impact, M = medium negative impact, and L = low negative impact. Impact refers to negative natural and human process influence on specifically wild large herbivore populations and composition occurring in the various biomes, if and only if the outlined respective biome characteristics are satisfied. Source:[3].

wet and drought occurrence patterns can vary in areas relatively close to each other (*i.e.*, areas in the same climatic region). By identifying animal movement patterns and routes across different land-uses, managers could effectively remove or establish fences so as to allow free animal movements in wildlife areas during periods of resource scarcity. Currently, CAMPFIRE communities in Zimbabwe act as sinks for animals whereas the protected areas act as the sources, thereby expanding the habitat ranges of wildlife. Moreover, an understanding of animal movements is useful for managing cases of human-wildlife conflicts in CAMPFIRE communities [43] [65]. In addition, transboundary management of large herbivores [66] would also allow animals to move to less affected areas during droughts.

Research in Gonarezhou National Park shows that snaring becomes a major illegal hunting method with increasing law enforcement efforts [27] [29]. Thus, specifically having rangers trained in snare detection and removal would help reduce the negative impacts of snaring on wildlife. Further, management need to reduce the use of poisons in illegal hunting and retaliatory killing of wildlife through influencing policy to include stiffer penalties on use of pesticide and herbicides in wildlife killings since some of the illegally killed animals falls within the Near Threatened, Vulnerable and Lower Risk categories of the International Union for Conservation of Nature Red List of Threatened Species.

A high involvement of local people in decision making is important for the overall perceived effectiveness of CAMPFIRE programs [43]. Therefore, by ensuring that local people genuinely participate in community-based

conservation programs, policy makers and wildlife managers may, thus, need to develop structures and policy instruments that enable local people to fully participate in conservation programs [67]. An investigation of local people involvement in decision making in wildlife conservation is needed for CAMPFIRE programs as this will allow for drawing lessons from both successful and unsuccessful CAMPFIRE communities which would help strengthen CAMPFIRE programs.

6. Conclusion

This review has provided valuable insights on understanding the influence of rainfall, particularly droughts, on large herbivore populations in savanna ecosystems. Wet and drought occurrence patterns somehow varied within the same climatic region with the 1992 severe drought having a negative impact on some large herbivore populations within a semi-arid savanna ecosystem [3]. Political crisis and economic collapse does not necessarily lead to increased illegal hunting in situations where law enforcement is strengthened [29]; and local people involvement in decision-making in natural resources conservation was highlighted as important in the perceived success of community-based natural resources programs [43]. Moreover, framing of wildlife conservation in changing environments, *i.e.*, from a stable political and economic situation to political crisis and economic decline, was associated with the misrepresentation of wildlife issues due to a spill-over of political related issues to less politically related issues [6]. Thus, interdisciplinary research is valuable in understanding wildlife conservation issues in African savanna ecosystems which are dominated by human activities. To conclude, it is therefore suggested that natural controls (rainfall) influence large herbivore population dynamics whereas policy instruments, incentives, provisions and societal frames influence the human activities that affect wild large herbivore populations in savanna ecosystems.

Acknowledgements

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