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ASSESSMENT OF LIVESTOCK AND HUMAN SETTLEMENT ENCROACHMENT INTO THE NORTHERN GONAREZHOU NATIONAL PARK, ZIMBABWE

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ABSTRACT

Livestock and human settlement encroachment into protected areas and associated interactions with wildlife is a global issue with implications for sustainable development particularly in developing countries. We examined the changes in the northern Gonarezhou National Park (GNP), Zimbabwe, following the livestock and human settlement encroachments into the park in 2000. The main objective of this study was to determine the history, extent of livestock and human settlement encroachment, and discuss potential impacts associated with the resultant human-livestock-wildlife interactions. Our results show that livestock encroached up to 10–20 km deep inside the park to graze and access surface water mostly in the dry season. Several wildlife species were reportedly sighted in the settlement area and adjacent livestock grazing areas. Some of the wildlife species were reported to kill livestock and damage crops. Developing approaches to minimise human-livestock-wildlife interactions would help enhance natural resources conservation.

Keywords: Africa, Conservation, Large herbivores, Protected Area

INTRODUCTION

Protected areas have long been recognized as the single most important method of conserving wildlife and preserving biological diversity (Kideghesho, Nyahongo, Hassan, Tarimo, & Mbije, 2006). Protected areas are popularly associated with large areas of 'undisturbed wilderness' (Twyman, 2001). Another view sees protected areas as *social spaces*; that is, they are socially conceived and preserved (Twyman, 2001). For instance, the national park concept involves the exclusion of people from wildlife areas apart from visitors and employees concerned with management (Eltringham, 1990). Few places have not been strongly influenced by human existence and activities at some time in the present or past (Twyman, 2001). Although protected areas conserve many of the world's habitats and species, human encroachment, especially in the tropics, is severely degrading and destroying many of these areas (Brandon & Wells, 1992). Human encroachment into wildlife areas, which has increased almost exponentially over the past few decades, has usually resulted in the elimination of the larger species, particularly the large mammals (e.g. Eltringham, 1990). Destruction of wildlife habitats has remained the leading threat to biodiversity. This destruction, taking different forms, for example degradation, fragmentation or outright loss, is a function of the growing human activities prompted mainly by such factors as poverty, demographic factors, land tenure systems, inadequate conservation status, development policies and economic incentives (Kideghesho, et al., 2006).

Livestock and wildlife share much of their respective ranges throughout semi-arid ecosystems of the world (Young, Okello, Kinyua, & Palmer, 1997). Wild, large herbivores and humans have had a long history of interaction (Gordon, 2009). Initially this interaction was based on the provision of resources to meet human needs, but with the advent of domestication of animals and plants, this interaction changed to one of pest and competitor (Gordon, 2009). Livestock-wildlife interactions in rangelands are often viewed in terms of competition because herbivores with overlapping habitat and diets have obvious potential for competition (Georgiadis, Ihwagi, Olwero, & Romanãch, 2007; Prins, 1992, 2000) but livestock and native ungulates can also benefit each other through long-term modifications of rangeland habitats (Augustine, Veblen, Goheen, Riginos, & Young, 2011). Recent studies provide evidence that multiple pathways of interaction are possible in diverse herbivore communities (e.g. Augustine, et al., 2011; Odadi, Jain, Van Wieren, Prins, & Rubenstein, 2011). When herbivore guilds or species share habitats, they can compete, facilitate or have no effect on each other, depending on the availability of forage resource and the extent to which they share those resources (Odadi, et al., 2011).

Wild large herbivores provide goods and income to rural communities, have major impacts on land use and habitats of conservation importance and in some cases, face local or global extinction (Gordon, Hester, & Festa-Bianchet, 2004). The African savanna biome carries the earth's greatest diversity of ungulates and has sustained multispecies animal production systems for millenia (Du Toit & Cumming, 1999). However, the geographical distributions of many species in Africa have been reduced due to hunting, pastoralism, encroachment into protected areas, habitat modification and disease control (Bonnington, Weaver, & Fanning, 2007; Happold, 1995; Homewood, et al., 2001; James, 2002; Kideghesho, et al., 2006; Lamprey & Reid, 2004; Mamo & Bekele, 2011; Stephens, d'Sa, Sillero-Zubiri, & Leader-Williams, 2001). The importance of each of these factors depends on the species, its location and habitat, and density of the human population (Happold, 1995). Furthermore, many African reserves are becoming isolated as a result of habitat loss, fences and roads, overhunting and disease (Newmark, 2008). These factors promote protected-area isolation by restricting animal movement and dispersal into and out of reserves and by creating sinks in the human dominated matrix that increasingly abuts most reserves (Newmark, 2008). Some of the major drivers of protected-area isolation in Africa are rapid population growth, economic expansion, social and environmental human displacement, and poverty (e.g. James, 2002). Consequently, the increasing isolation of protected areas poses a serious threat to the long-term viability of many wildlife populations and migrations in Africa (see Newmark, 2008).

The human-livestock-wildlife interface is multifaceted and has both positive and negative implications for health, the environment and economics (Kock, 2005). For example, complex interactions involving humans, domestic animals, and wildlife create environments favourable to the emergence of new diseases (Palmer, 2007). Wild animals are susceptible to infection with many of the same disease agents that afflict domestic animals and transmission between domestic animals and wildlife can occur in both directions (Palmer, 2007). Conserving African wildlife in human-occupied landscapes requires management intervention that is guided by a mechanistic understanding of how anthropogenic factors influence large-scale ecological processes (Georgiadis, et al., 2007). Therefore, there is a need for better understanding of the interactions between humans, livestock and wildlife. Human-livestock-wildlife interactions have increased in northern Gonarezhou National Park (GNP), Zimbabwe, in recent years (since 2000) following the livestock and human settlement encroachment into the park. Here we contribute to the existing body of knowledge by focusing on the encroachments in northern GNP. The main objective of this study was to determine the history, extent of livestock

and human settlement encroachment, and discuss potential impacts associated with the resultant human-livestock-wildlife interactions in northern GNP.

MATERIALS AND METHODS

Study area

This study was carried out in the north-western portion of the GNP, Zimbabwe. Established in the early 1930s as a Game Reserve, GNP was upgraded into a national park under the Parks and Wildlife Act of 1975. GNP and the surrounding wards have been part of the Great Limpopo Transfrontier Conservation Area since 2000. Tucked into Zimbabwe's south-eastern corner, between 21° 00'–22° 15' S and 30° 15'–32° 30' E and bordering Mozambique and South Africa, and covering 5053 km^2, GNP is the second largest national park in Zimbabwe (Figure 1). GNP has a hot and semi-arid climate, with highly seasonal rainfall. Long-term average annual precipitation for the GNP is 466 mm. Three seasons can be recognized: hot and wet (November to April), cool and dry (May to August) and hot and dry (September to October). Average monthly maximum temperatures are 26 °C in July and 36 °C in January. Average monthly minimum temperatures range between 9 °C in June and 24 °C in January (Gandiwa, Magwati, Zisadza, Chinuwo, & Tafangenyasha, 2011).

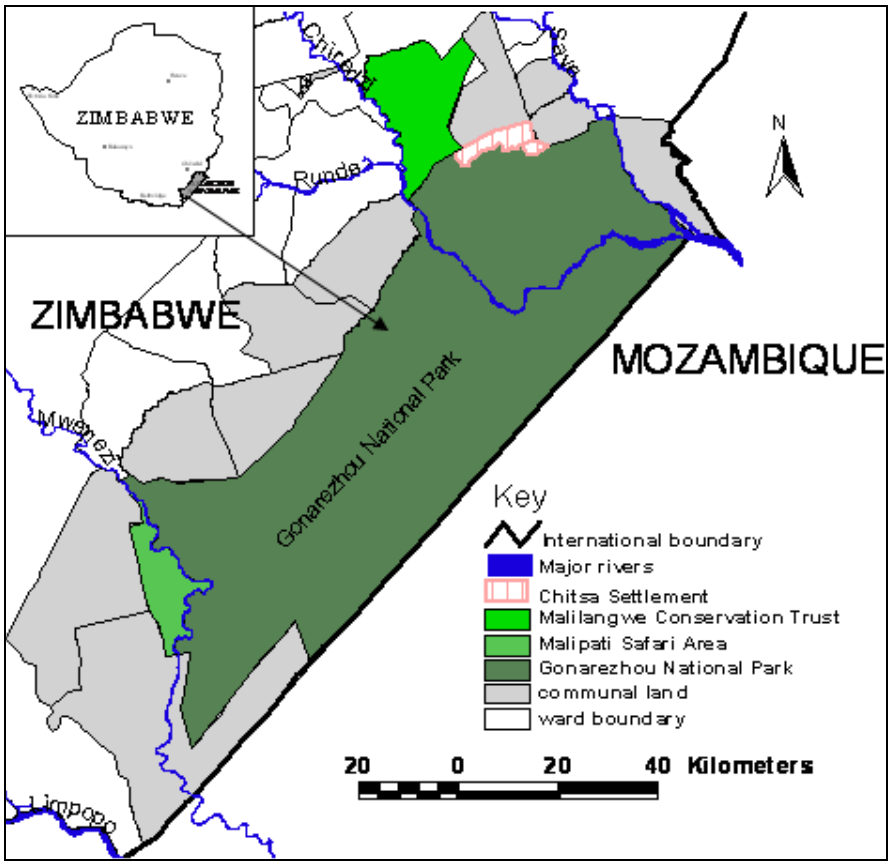

Figure 1: Location of the Gonarezhou National Park and adjacent areas in southeastern Zimbabwe. Source: Gandiwa & Zisadza (2010).

The vegetation of south-eastern lowveld of Zimbabwe is typical of semi-arid *Colophospermum mopane* zone, and is predominantly dry deciduous savanna woodland of varying types (Zimbabwe Parks and Wildlife Management Authority, 2011). The dominant vegetation in the GNP is *C. mopane* which covers almost 40% of the park (Gandiwa & Kativu, 2009). There is a wide variety of large herbivore species in the GNP and these include African buffalo (*Syncerus caffer*), African elephant (*Loxodonta africana*), blue wildebeest (*Connochaetes taurinus*), eland (*Taurotragus oryx*), giraffe (*Giraffa camelopardalis*), hippopotamus (*Hippopotamus amphibius*), impala (*Aepyceros melampus*), kudu (*Tragelaphus strepsiceros*), plains zebra (*Equus quagga*), roan antelope (*Hippotragus equinus*), sable antelope (*Hippotragus niger*) and waterbuck (*Kobus ellipsiprymnus*). The park has a variety of large carnivores such as cheetah (*Acinonyx jubatus*), lion (*Panthera leo*) and spotted hyena (*Crocuta crocuta*) (Zisadza, Gandiwa, Van Der Westhuizen, Van Der Westhuizen, & Bodzo, 2010).

Data collection and analysis

Encroachments into the northern GNP

We gathered information on the history of the Chitsa settlement and associated encroachments into the northern GNP through two ways. First, we held discussions with key informants who included those staying in the northern GNP and adjacent areas. Second we reviewed literature from published and unpublished sources on the land-use changes in northern GNP. We summarized the key points that drove the livestock and human settlement encroachment into the GNP, history of land-use and characteristics of the settlement.

Livestock grazing spatial extent

Data on livestock grazing area extent were retrieved from the GNP ranger's patrol sighting reports stored in the park's law enforcement database for the period between 2000 and 2010. Areas where cattle were commonly seen inside the park were marked with GPS coordinates on ranger patrol forms and then entered in a law enforcement database. In addition, verification of the spatial extent of livestock grazing areas was also gathered from occasional park monitoring aerial flights in the northern GNP. Data on the spatial grazing range use by livestock was used to produce a cattle grazing spatial distribution map using Geographic Information System (GIS) ArcView 3.2 software for Windows (ESRI, Redlands, CA).

Human-livestock-wildlife interactions in northern GNP

We carried out a simple questionnaire survey in five of the ten villages in northern GNP to gather data on wild animal species commonly sighted in the settled and livestock grazing areas. The survey was conducted in August and September 2010. Since we were interested in wild animal species, we did not gather data on the demography of respondents nor their socio-economic status. Another factor that prompted us not to gather data on demography and socio-economic status from respondents was the fact that the residents in the Chitsa settlement had land claim issues and were contesting their case against national parks. Thus, it was necessary for us to focus only on wildlife issues in order to remove any suspicion associated with the land claim issues. We interviewed local people with at least 15 years. A total of 50 local people were asked to list the wild animals they sighted in the villages, fields and livestock grazing areas. Besides a structured questionnaire survey, informal discussions with villagers were also conducted and these helped to verify the

reliability of the interview data. Data on wild animal sightings in the settled and livestock grazing areas in northern GNP were summarized and presented in tabular form and responses by local people presented as frequencies.

RESULTS AND DISCUSSION

Encroachments into the GNP

The year 2000, marked a turning point in the landscape of the GNP. Figure 2 shows the northern GNP before the livestock-human settlement encroachments in 2000. Following the land reforms that occurred in Zimbabwe in 2000, some local people living adjacent to the norhern GNP took advantage of the prevailing environment, encroached and settled in the northern section of the park leading to increased livestock population in the park (Wolmer, 2005). The settled area consisted of 10 villages, 740 households and fields. The settled area together with the fields covered approximately 40 km^2 (Zimbabwe Parks and Wildlife Management Authority, 2011). It was estimated that the 740 households consisted of about 5365 people (Mombeshora, 2006). Several reasons have been suggested to have fuelled the encroachments into the GNP, among them (i) pressure to reclaim old ancestral land which is claimed to have been included in the GNP during its formation in the early 1960s, (ii) chieftainship wrangles and (iii) a way of decongesting the adjacent communal area and hence acquire new productive land in the park. According to Mombeshora & Le Bel (2009), the main driving factor to the invasion in the northern GNP was the contested chieftaincy between Headman Chitsa and Chief Tshovani. It is suggested that Headman Chitsa wanted to make a statement to the responsible authorities that he also should be upgraded to a Chief and hence, readdress the historical changes that took place in the chieftainship lineage. The human and livestock encroachments into the northern GNP, however, resulted in both landscape changes as woodlands were cleared to open up space for settlements and fields. Local residents in the Chitsa settlement practice a combination of subsistence activities, i.e., cash crop farming and livestock rearing. Farming is mostly based on crops like cotton (*Gossypium* spp.), maize (*Zea mays*) and sorghum (*Sorghum vulgare*) as cash crops as well as subsistence use mostly for maize. Livestock include cattle (*Bos taurus*), donkeys (*Equus asinus*), goats (*Capra hircus*), sheep (*Ovis aries*) and poultry (Gandiwa, 2011a).

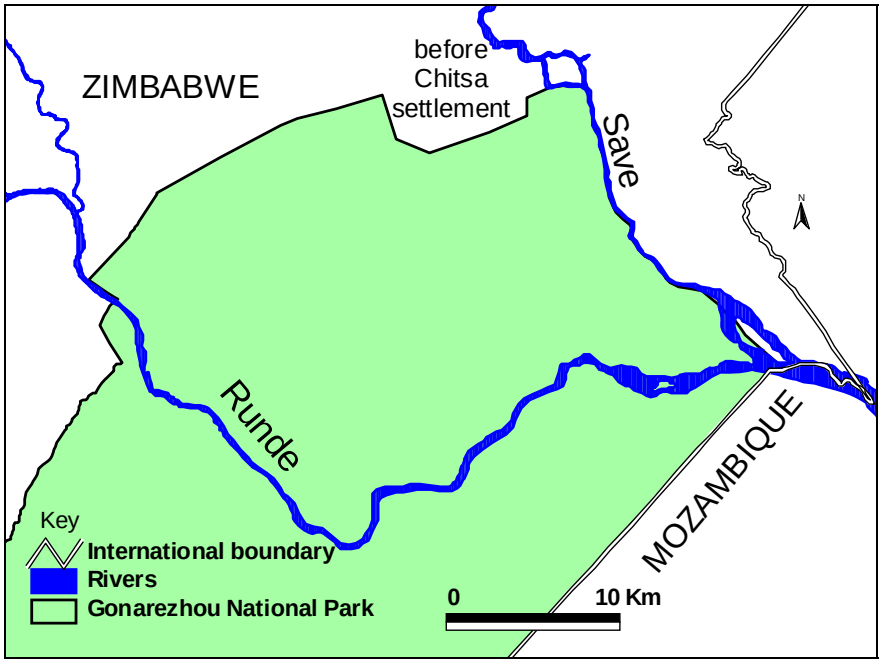

Figure 2: Northern Gonarezhou National Park, Zimbabwe, before the livestock and human encroachments in 2000.
Source: This study

Livestock grazing in northern GNP, 2000–2010

The maximum spatial extent of livestock grazing in northern GNP between 2000 and 2010 is shown in Figure 3. Livestock were herded deeper into the surrounding grasslands and woodlands in the dry season. Livestock herds were reported to enter 10–20 km deep into the park mostly for surface water and forage in the dry season. This was also evident from well-developed livestock tracks from the air. The spatial extent of grazing in the dry season varied between 90 and 320 km^2. In the wet season, livestock grazing was concentrated near the settlements due to the availability of surface water and forage resources. Past aerial surveys covering the entire GNP have recorded livestock sightings far from the settled area similar to the law enforcement patrol data. It should be noted that cattle from the adjacent areas were also being driven to graze into the park as people took advantage of the Chitsa settlement. Although law enforcement staff in the GNP constantly patrolled the areas adjacent to the Chitsa settlement, the local people continued herding their cattle deep in the park since they argued that they were contesting a bigger area than they were currently occupying in their land claim hence complicating the effectiveness of patrols in dealing with livestock grazing issues. Interactions between livestock and wildlife populations are a key issue in livestock economies worldwide, particularly in East and Southern Africa where many communities live in close contact with wildlife (Cleaveland, et al., 2002). Livestock constitutes a major financial and social asset for the rural poor particularly in Africa where it acts as a safety net in times of droughts and bad harvest (Mizutani, Kadohira, & Phiri, 2011).

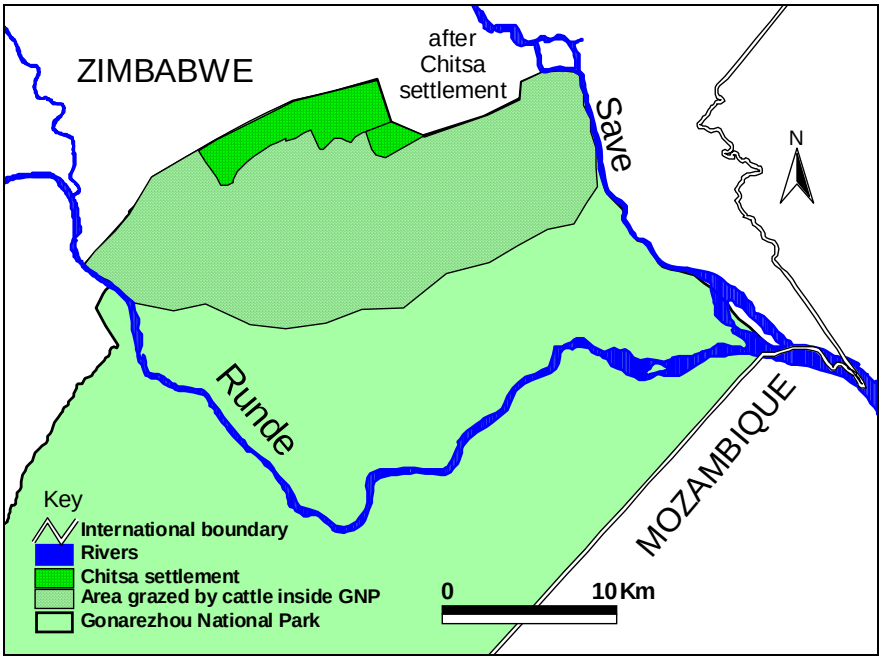

Figure 3: Land-use dynamics and spatial extent of livestock grazing areas in the northern Gonarezhou National Park, Zimbabwe between 2000 and 2010. Source: This study.

Movement of either wildlife or livestock in the predominantly livestock grazing zone (Figure 3) may lead to their direct or indirect interactions enhancing chances for possible disease exchange, competition for forage resources mostly in the dry season when resources are limiting and also conflicts with humans. Many zoonotic diseases affect the productivity of both wildlife and livestock. These include bacterial diseases such as anthrax, brucellosis and bovine tuberculosis. Although many diseases can infect wildlife hosts, most wildlife species are generally not involved to any significant extent in the transmission of disease to livestock (Wambwa, 2005). Only, a few key wildlife species are linked with transmission of major livestock diseases. For example, buffalo are a carrier of foot and mouth disease virus, and wildebeest calves are a source of malignant catarrhal fever virus. In particular, the emergence of bovine tuberculosis in wildlife in southern GNP has implications not only for the conservation of the wildlife species affected but also for the health of humans and livestock living at the wildlife-livestock-human interface in the GNP and adjacent areas (De Garine-Wichatitsky, et al., 2010).

The changes that occurred in the northern GNP between 2000 and 2010 could have influenced wild large herbivore distribution patterns and their population dynamics in the long term. Earlier studies have reported on various ways in which livestock and human settlement encroachments can influence native herbivores. For example, it has been suggested that human encroachment and uncontrolled livestock rearing in a wildlife area may in the long-term lead to the disappearance of wildlife corridors, seriously threatening elephant conservation in some areas (e.g. Silori & Mishra, 2001; Zisadza & Mandima, 2007). Elsewhere, in the Kilombero Valley, southern Tanzania, it has been reported that areas heavily grazed by livestock will be used to a lesser extent by wild animal populations, and that those areas previously used by wild animal species will be avoided following livestock encroachment (Bonnington, et al., 2007). In eastern Kenya rangelands, land fragmentation and subsequent reduction in the natural resource was reported to likely

disrupt livestock production and wildlife conservation (Otuoma, Kinyamario, Ekaya, Kshatriya, & Nyabenge, 2009). Livestock and human activities such as overgrazing, deforestation, bush fires, and cultivation are the major causes of habitat destruction (e.g. Kideghesho, et al., 2006). Livestock and human settlements encroachments may also negatively affect bird diversity in heavily impacted areas (Morris, Western, & Maitumo, 2009). In addition, settlements are known to influence large herbivore distribution in savanna ecosystems (e.g. Ogutu, et al., 2010; Okello & Kioko, 2010). Negative impacts of unregulated or poorly managed grazing include competition with wildlife for water, forage and space; degradation of forage and cover by altering vegetation composition and structure; impacts on stream hydrology, siltation and water quality; and effects of compaction on soil permeability and its potential to support plants (Young, Palmer, & Gadd, 2005).

Human-livestock-wildlife interactions in northern GNP

Table 1 summarizes the major wildlife species that were commonly sighted in the settled and adjacent areas in northern GNP between 2000 and 2010. Elephants were the most sighted species and were reported to invade the fields during the rainy season (88%). Impala (74%) were mostly seen away from the settlement area. Spotted hyenas (66%), side-striped jackals (42%) and lions (34%) were reported to attack livestock throughout the year. Other species were mostly sighted in areas far away from the settled areas, mostly when herding livestock (Table 1). Previous sample aerial surveys have provided the following estimates for cattle in northern GNP, i.e. Chipinda Pools stratum, 47 in 2001, 3145 in 2007 and 2859 in 2009 (Dunham, Van Der Westhuizen, Van Der Westhuizen, & Gandiwa, 2010). It is likely that the increase in cattle populations in the northern GNP since 2000 is a result of cattle being brought from other adjacent communal areas into the settled area since the park is perceived as having good forage and surface water throughout the year. In the adjacent communal areas, the high density of livestock and increasing human populations leads to overgrazing and land degradation, leading to the park to become more attractive for livestock grazing. The increase in livestock numbers in the park, however results in increased grazing and browsing pressure, and also possible increases in livestock depredation by large carnivores.

Table 1: Wildlife species reported to be commonly sighted in the settled and livestock grazing areas in northern Gonarezhou National Park, Zimbabwe, between 2000 and 2010. Responses from respondents are given in percentages. Note: Percentages exceed 100% since respondents gave multiple answers

Species	Scientific name	Response frequency (%)
Elephant	*Loxodonta africana*	88
Impala	*Aepyceros melampus*	74
Spotted hyena	*Crocuta crocuta*	66
Chacma baboon	*Papio ursinus*	58
Common duiker	*Sylvicapra grimmia*	56
Kudu	*Tragelaphus strepsiceros*	48
Side-striped jackal	*Canis adustus*	42
Lion	*Panthera leo*	34
Zebra	*Equus quagga*	32
Wildebeest	*Connochaetes taurinus*	24
Leopard	*Panthera pardus*	22
Waterbuck	*Kobus ellipsiprymnus*	14
Vervet monkey	*Cercopithecus aethiops*	6

Source: Fieldwork 2010.

We have attempted to provide insights into the history, extent of livestock and human settlements encroachments and some key issues related to the potential impacts of the associated human-wildlife-wildlife interactions in northern GNP between 2000 and 2010. We propose a conceptual framework (Figure 4) to outline the changes, processes, and constituent components associated with the livestock and human settlement encroachments into the northern GNP that would help direct future studies to ascertain the impacts of these changes on native wildlife. For example, it would be valuable to investigate the influence of livestock and human settlement encroachments on illegal hunting and tourism in the GNP (e.g. Gandiwa, 2011a, b). More detailed research on habitat loss and fragmentation is required in savanna ecosystems (Reid, Thornton, & Kruska, 2004), particularly taking into consideration livestock and human settlement encroachments in protected areas. Earlier studies in the GNP suggest that some woodlands have been degraded as a result of elephants, fires, droughts and past human activities (e.g. Gandiwa & Kativu, 2009; Gandiwa, Tupulu, Zisadza-Gandiwa, & Muvengwi, 2012; Mpofu, Gandiwa, Zisadza-Gandiwa, & Zinhiva, 2012; O'Connor & Campbell, 1986; Tafangenyasha, 1997, 1998, 2001; Zisadza, 2008), and the recent livestock and settlement encroachments are likely to further negatively influence some wildlife habitats and ecological processes.

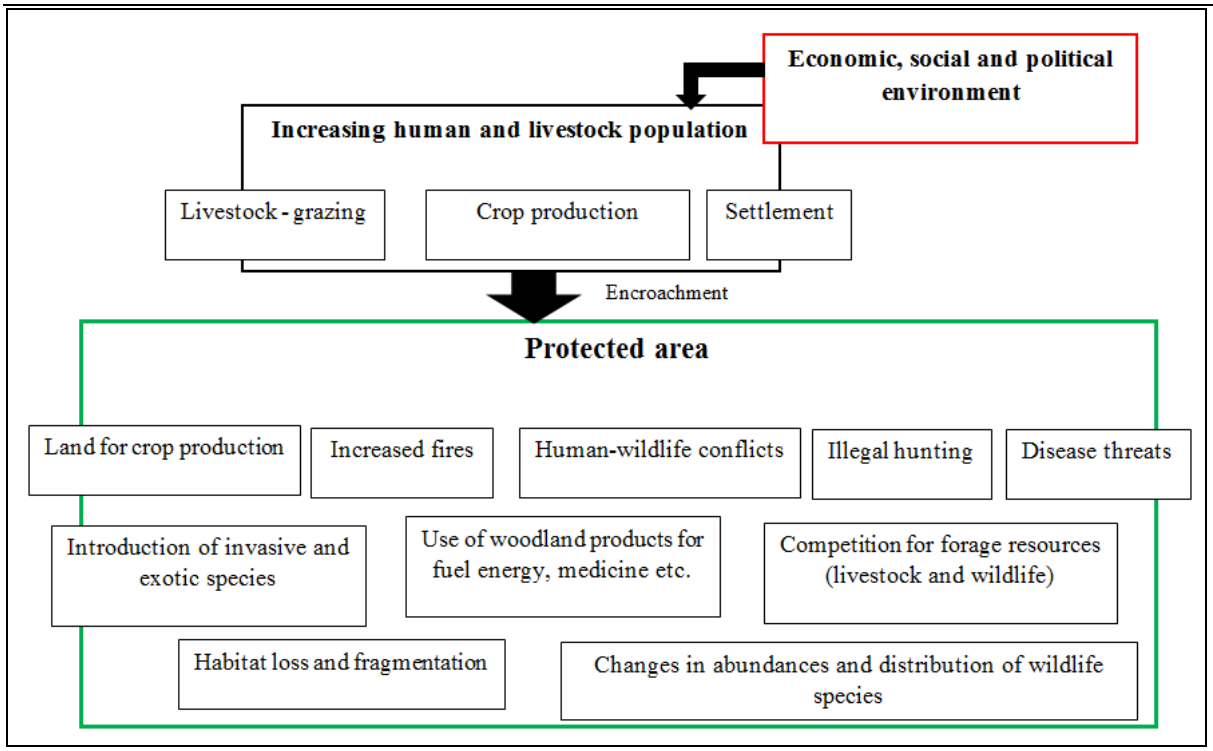

Figure 4: A conceptual framework outlining the major factors driving encroachments into a protected area and the likely impacts of this encroachment using the Gonarezhou National Park, Zimbabwe as a case study. Source: This study.

IMPLICATIONS FOR MANAGEMENT

Global debates surrounding the management of natural resources in protected areas advocate greater involvement of local populations in order to maintain sustainable resource use and conserve biodiversity (Twyman, 2001). For this involvement to be effective, and for development to be truly participatory, a deeper understanding of people's relationships with the environment is needed (Twyman, 2001). Integrated conservation and development projects (ICDPs) have long been promoted to encourage conservation and development in rural communities' adjacent to protected areas. ICDPs are typically defined as conservation projects that include rural development components and have frequently been established in Africa to improve wildlife conservation and the welfare of local communities (Barrett & Arcese, 1995). A well-known example is CAMPFIRE (Communal Areas Management Programme for Indigenous Resources) in Zimbabwe. However, effectiveness of ICDPS has been hampered by conflicts and illegal harvesting (Johannesen & Skonhoft, 2005). Therefore, in cases such as the livestock and human settlement encroachment into northern GNP, there may be need to implement alternative and complementary approaches to ICDPs to ensure sustainable development in the area (see Newmark & Hough, 2000). A social study looking at the basic needs of the community and possible projects that can be undertaken to improve the livelihoods of the community whilst at the same time promoting wildlife conservation would be valuable in aiding options to pursue.

The need to maintain the integrity of protected areas by preventing livestock and human settlement encroachment into them is very crucial (Verlinden, 1997). Large mammal populations theoretically are best conserved in landscapes where large protected areas are surrounded by buffer zones, connected by corridors, and integrated into a greater ecosystem

(Nyhus & Tilson, 2004; Zisadza & Mandima, 2007). Multi-use buffer zones, including those containing complex agroforestry systems, are promoted as one strategy to provide both economic benefits to people and conservation benefits to wildlife (Nyhus & Tilson, 2004). Livestock, wildlife and humans share many similar pathogens (Siembieda, Kock, McCracken, & Newman, 2011). In livestock-wildlife interface areas, one important control measure to prevent the spread of diseases from known wildlife reservoirs is to restrict livestock-wildlife contacts. Fences and fines have been the traditional way of minimizing human impacts and discouraging encroachment and illegal activities (Brandon & Wells, 1992). Fencing has taken on an increasingly important role in wildlife management in parts of Africa in recent years, particularly in Southern Africa (Lindsey, Masterson, Beck, & Romañach, 2012). Fencing permits the utilization of small habitat patches by reducing edge effects associated with wildlife moving out, or humans moving into the area encompassed hence reducing human-wildlife conflicts. Human-wildlife conflicts manifest when human activities affect free movement of wild animals and vice versa (Le Bel, et al., 2011). For instance, wildlife moving out of habitat patches is vulnerable to being hunted or being persecuted in response to human-wildlife conflicts. Similarly, people moving into habitat patches can threaten wildlife through disturbance, hunting or by extracting crucial resources. Well-constructed and maintained electrified fencing represents an effective tool in limiting several forms of human-wildlife conflicts, and disease among other challenges (see Lindsey, et al., 2012 for more details). For example, effective fencing can lead to non-contact between livestock and wild animals hence this reduces spread of diseases such as bovine tuberculosis, foot-and-mouth disease, brucellosis and malignant catarrhal fever. Fencing has been identified as one of the suitable options to resolve the livestock and human settlement encroachments into the northern GNP. It will be valuable, however, to also look at integrated approaches to ensure that the objectives of the fence are met whereas the local communities and the park collaboratively manage the fugitive wildlife resources to ensure long-term sustainable development in the study area and beyond.

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